Collaborative Sciences Center for ROAD SAFETY

www.roadsafety.unc.edu

Using Integrated Data to Examine Characteristics Related to Pedestrian Injuries

May 2021

Project team

University of North Carolina Highway Safety Research Center

- Katherine J. Harmon (Principal Investigator)
- Laura Sandt (Co-Principal Investigator)
- Kari Hancock
- Eric Rodgman
- Libby Thomas

Acknowledgments

Funding:

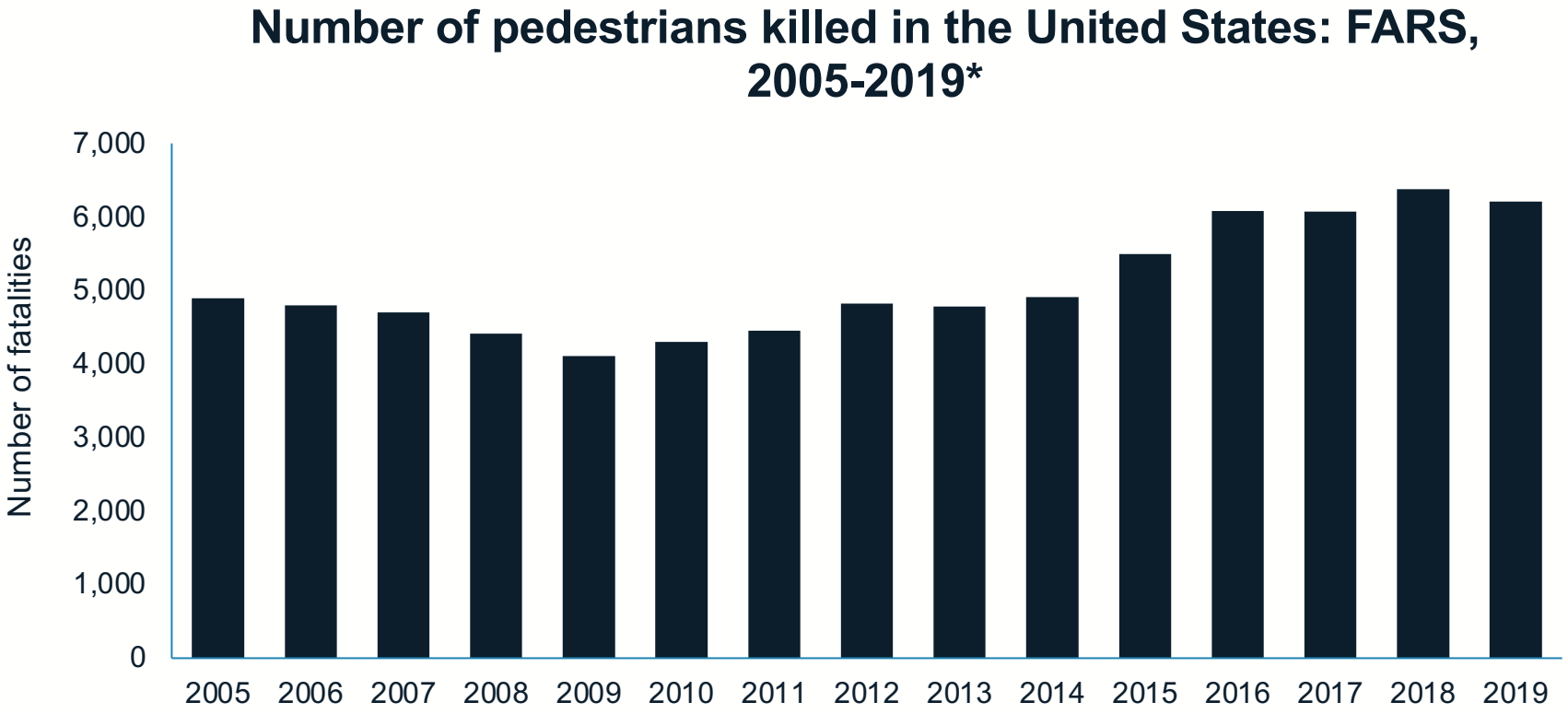
Funding was provided by the Collaborative Sciences Center for Road Safety, www.roadsafety.unc.edu, a US Department of Transportation National University Transportation Center promoting safety.

Data attribution & disclaimer:

NC DETECT is a statewide public health syndromic surveillance system, funded by the NC Division of Public Health (NC DPH) Federal Public Health Emergency Preparedness Grant and managed through collaboration between NC DPH and UNC-CH Department of Emergency Medicine's Carolina Center for Health Informatics. The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented.

Background

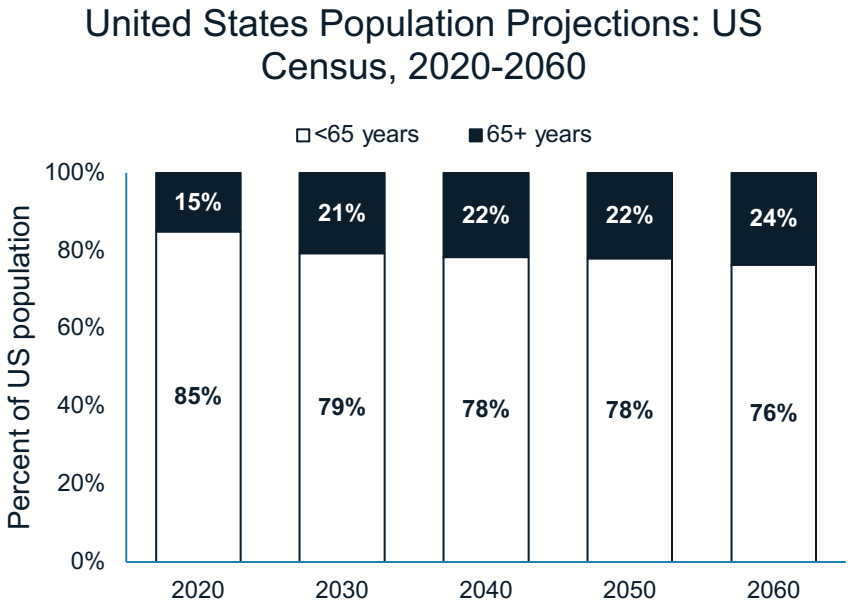
The number of pedestrian fatalities has increased over the last decade



*Fatality Analysis Reporting System (FARS), https://cdan.dot.gov/query

Why are pedestrian fatalities increasing?

- Changing demographic patterns,
  - Population is growing, especially in urban centers,
  - And population is becoming older and more diverse.*†



*Sandt, L., et al. (2020, Jun.). Toward a Shared Understanding of Pedestrian Safety: An Exploration of Context, Patterns, and Impacts. Chapel Hill, NC: Pedestrian and Bicycle Information Center.

†US Census Bureau. (2020, Feb.). 2017 National Population Projections Tables: Main Series. www.census.gov/data/tables/2017/demo/popproj/2017-summary-tables.html.

Why are pedestrian fatalities increasing?

- Changing exposure levels,
  - Increase in vehicle miles traveled.*
- Increasing posted speed limits and vehicle traveling speeds,
- Changing prevalence of driver/pedestrian impairment,
  - Also, changes in the types of impairing substances involved (e.g., marijuana, opioids).
- Changing prevalence of chronic health conditions,
- And continued lack of investment in active transportation infrastructure, especially in low-income communities.†

- (*among other factors*) -

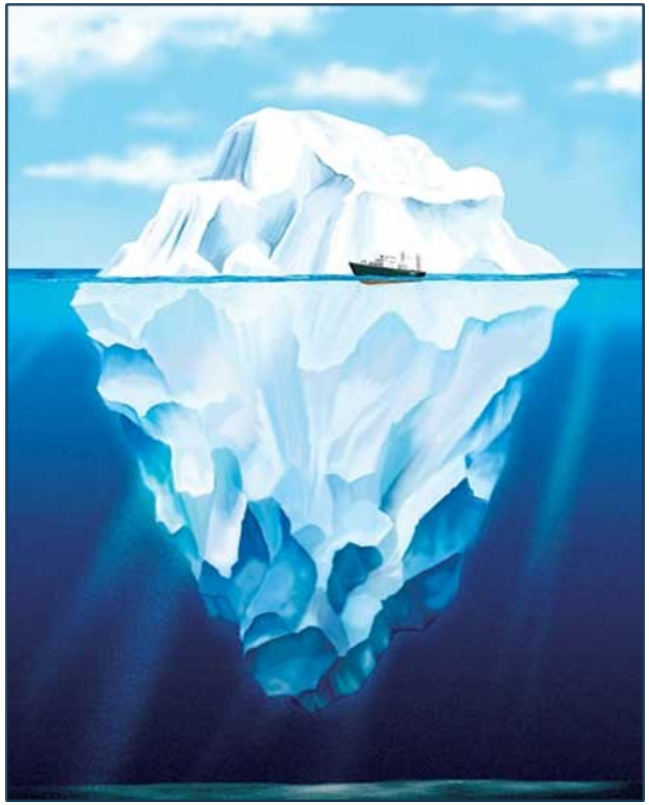
*At least until the COVID-19 pandemic.

†Sandt, L., et al. (2020, Jun.). Toward a Shared Understanding of Pedestrian Safety: An Exploration of Context, Patterns, and Impacts. Chapel Hill, NC: Pedestrian and Bicycle Information Center.

Fatalities are just part of the problem

For each pedestrian fatality,

7-10 pedestrians are treated in the emergency department (ED).*†



*Police-reported crashes, only.

†Based on NC data linkages performed by study authors (estimate varies by ED visit data

Key research goal

- There have been numerous studies examining pedestrian morbidity using crash report and healthcare data sources (EMS, trauma registry, hospital/emergency department discharge datasets, electronic medical records, etc.);
- However, the last study to use integrated (linked) crash-health outcome data occurred in 1998 (Stutts & Hunter).
  - Eight US hospitals,
  - One year of data,
  - And 643 total combined pedestrian/bicyclist injuries.*

*Stutts JC, Hunter WW. Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. *Transportation Research Record: Journal of the Transportation Research Board* 1998; 1635: 88-92

Research objectives

1. Perform a review of the epidemiologic literature describing pedestrian morbidity and mortality,
2. Integrate/Link five years of emergency department visit records to crash reports for injured pedestrians in a defined population.
3. Perform a descriptive epidemiologic study examining factors associated with serious pedestrian injury (Study 1),
4. Perform a descriptive epidemiologic study examining factors associated with specific types of injury (Study 2),
5. And identify predictors of serious pedestrian informed by the results of Study 1 (Study 3).

Literature review

Literature review

- Not a systematic review.
  - Limited scope (epidemiology of pedestrian injury)
  - No bounds (search completed December 31, 2019)
  - Reviewed 75 sources, including: manuscripts, theses, governmental reports, etc.
- Primarily designed to inform epidemiologic analyses.

Classification of study variables

- Literature review used to classify study variables.
- Variables organized into one of five “themes”:
  1. Pedestrian injury outcomes,
  2. Person-related factors,
  3. Collision-related factors,
  4. Roadway-related factors,
  5. And vehicle-related factors.
- Each theme was further subdivided into topics for exploration.
- Each topic was assigned a priority level (high, medium, low) based on the review and the perceived quality of the data.

Data linkage

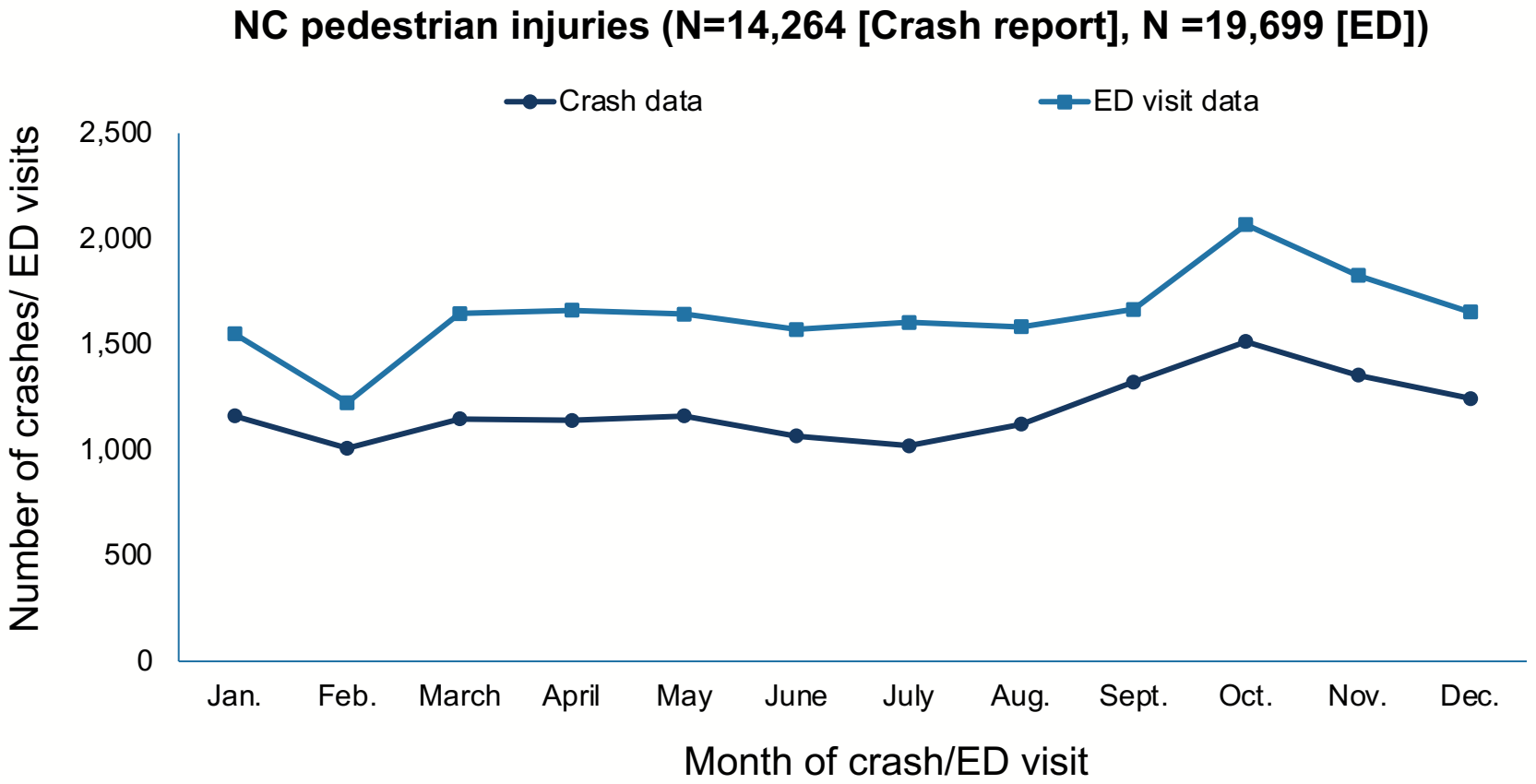
Study overview

- Study type: Descriptive epidemiologic study.
- Study period: October 1, 2010 – September 30, 2015.
- Study population: All NC pedestrian traffic crash records that linked to NC emergency department visit records.

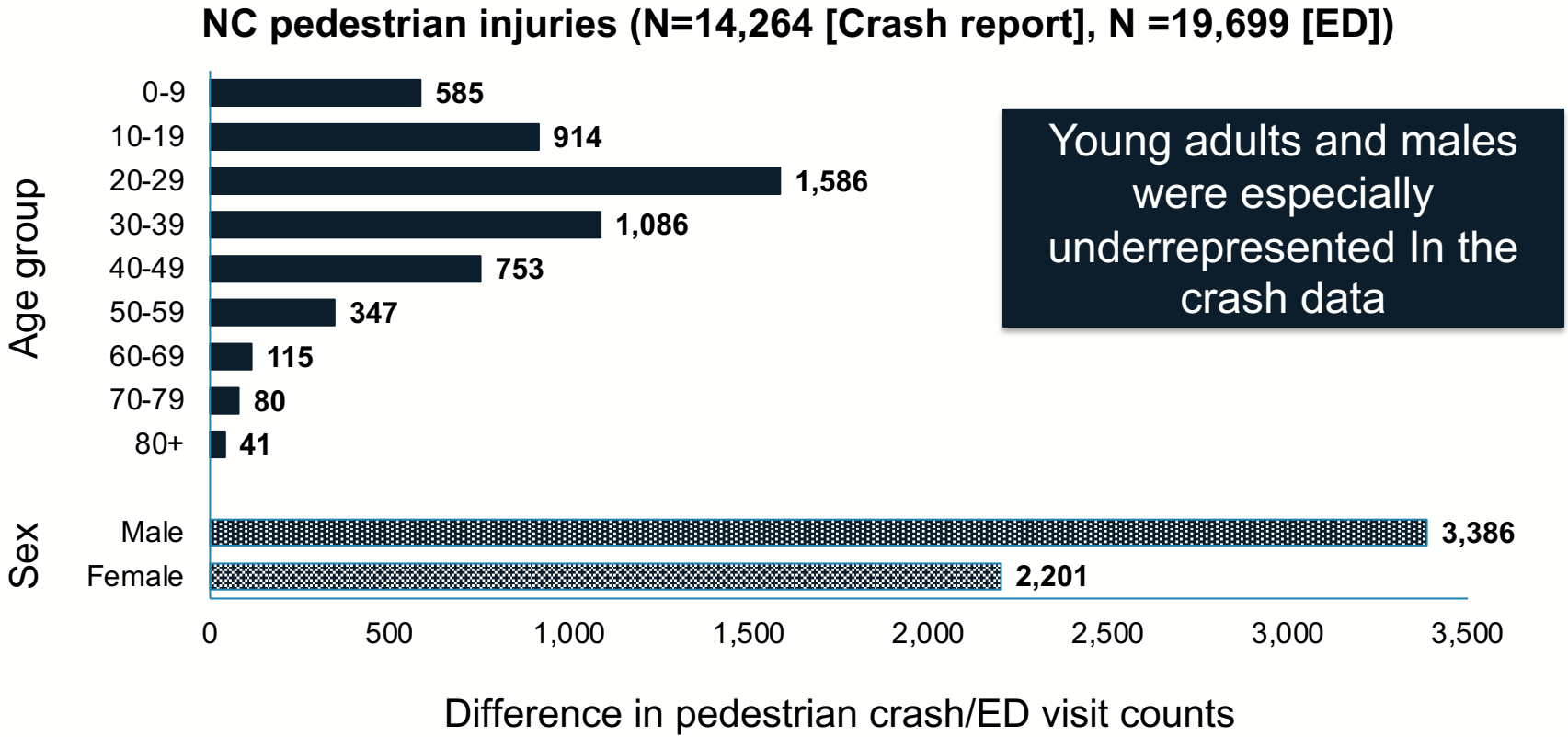
Linkage

- Restricted to pedestrian traffic records with non-missing identifiers (N=14,137).
- Restricted to NC ED visits with one or more injury diagnosis codes, non-missing identifiers, and non-transfers (N=4,181,226).
- Records linked using a hierarchical deterministic linkage mehtod.
- Records linked using sex, age, date-of-birth, ZIP code of residence, and city of residence.
- Linkages were restricted to matches in which the ED visit occurred within 7 days of the crash.
- 49% of pedestrian traffic crash records linked to the ED visit data (N=6,923).

Crash data underestimates the number of injured pedestrians



Crash data underestimates the number of injured pedestrians



Outcome of interest: serious injury

- Many previous studies have used KABCO, the injury severity score reported on the crash report record.
  - K-Killed; A-Disabling injury; B-Evident injury; C-Possible injury; O-No injury.
  - Based on a visual assessment performed by the investigating police officer.
- However, research has indicated that KABCO is not always accurate.*
- Therefore, there is a need to create a different injury severity metric based on the clinical data.

*Farmer CM. (2003) Reliability of police-reported information for determining crash and injury severity, *Traffic Injury Prevention*, 4:1, 38-44, DOI: 10.1080/15389580309855.

Serious injury case definition

- Defined a serious injury, as one that resulted in:
  - Death,
  - Admission to the hospital,
  - Fracture of any bone (except fractures of the fingers, toes, or nose),
  - Open wound or amputation,
  - Injury to any internal organ,
  - Crushing injury,
  - And/or a second- or third-degree burn, or a burn covering more than 10 percent of the body surface.*

*NTSB. (2013, Sept.). Pilot/Operator Aircraft Accident/Incident Report (Form No. 6120.1). https://www.ntsb.gov/Documents/6120_1web_Reader.pdf.

KABCO did not always provide an accurate assessment of pedestrian injury severity

Police assigned injury severity (KABCO)	Serious or fatal injury (based on clinical assessment) N (%)	Non-serious injury (based on clinical assessment) N (%)
K: Killed	206 (100%)	0 (0%)
A: Disabling injury	437 (89%)	53 (11%)
B: Evident injury	1,431 (50%)	1,440 (50%)
C: Possible injury	488 (16%)	2,523 (84%)
O: No injury	20 (12%)	141 (88%)
Total	**2,582 (38%)**	**4,157 (62%)**

Descriptive epidemiologic study 1:

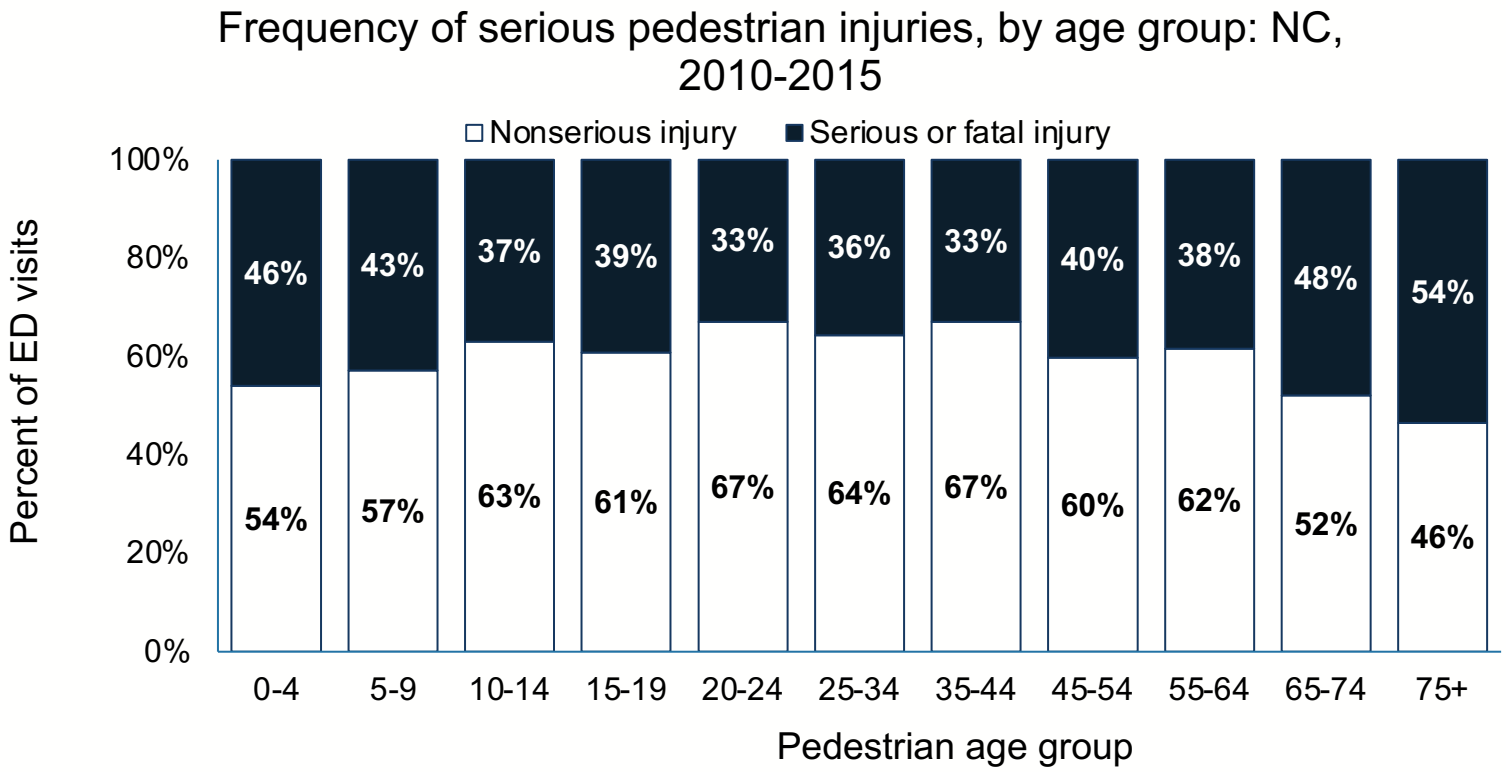
Characteristics of pedestrian injury using integrated data

Study 1: Statistical analysis

- Performed descriptive and categorical data analysis using Pearson's chi-squared tests (significance assessed at alpha =.05).
- All analyses performed using SAS® Version 9.4 (SAS Institute, Cary, NC).

*NCHS. (2020, Jun.). Bridged-Race Population Estimates 2010-2015. http://wonder.cdc.gov/wonder/help/bridged-race.html.

Pedestrian injury severity was highest for children and older adults



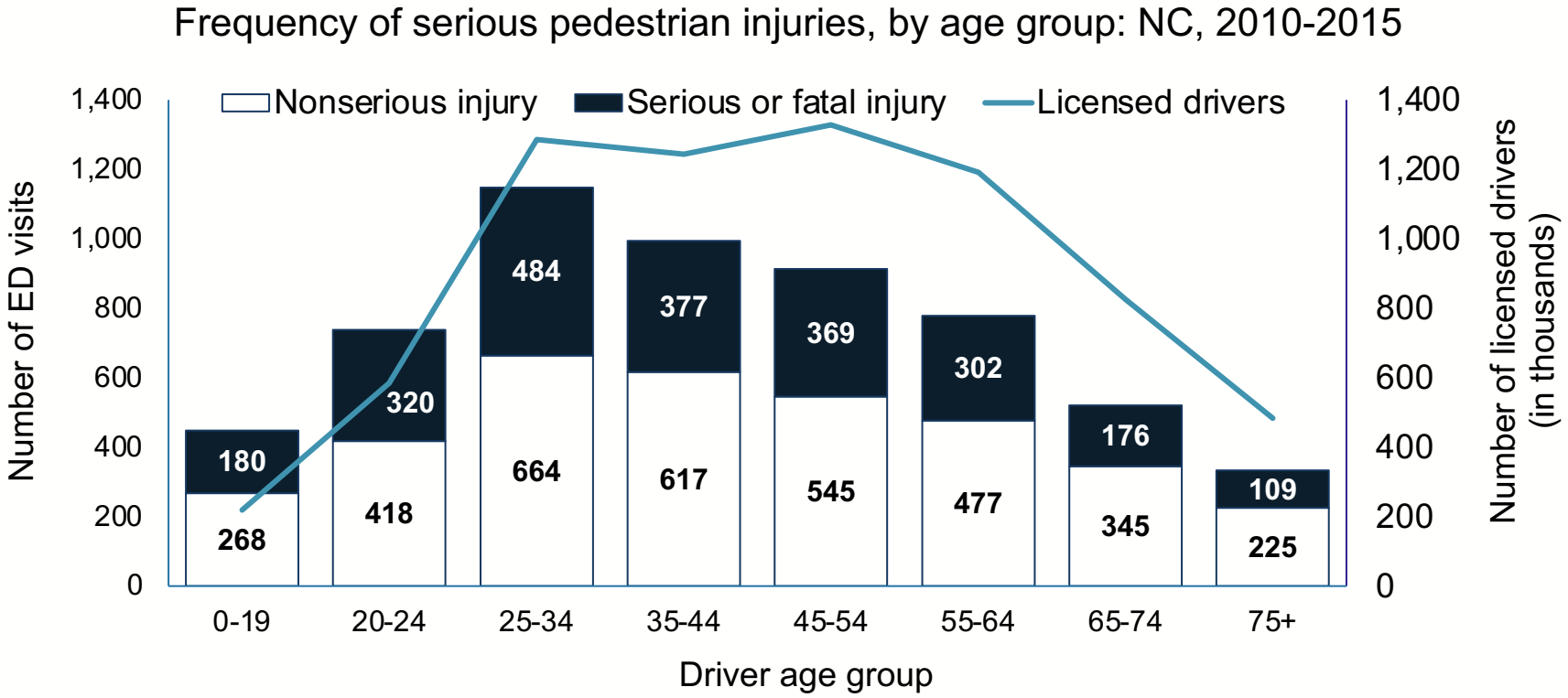
While year & month of crash did not have a significant impact on pedestrian injury severity, day of week and time of day did have a relationship

Frequency of serious pedestrian injuries (out of total pedestrian injuries) by time of day and day of week (date/time blocks for which **≥50%** of pedestrians had a serious injury are highlighted)

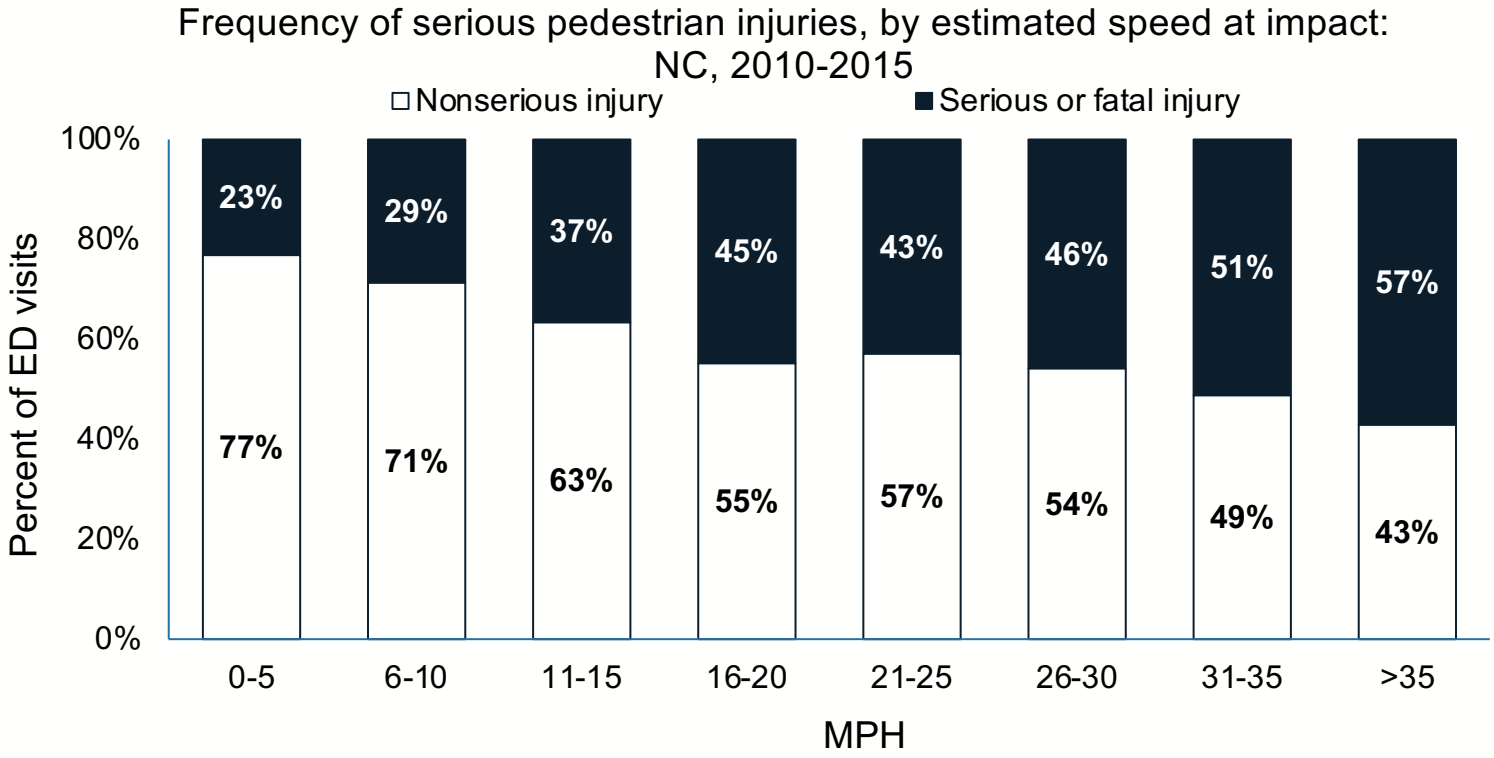
Day of week

Hour of crash	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
0:00-3:59	62%	38%	28%	30%	53%	51%	52%
4:00-7:59	41%	37%	32%	54%	48%	42%	55%
8:00-11:59	26%	33%	29%	30%	30%	29%	43%
12:00-3:59	34%	26%	29%	28%	31%	28%	29%
16:00-19:59	35%	41%	39%	39%	42%	34%	42%
20:00-23:59	50%	47%	48%	48%	52%	44%	40%

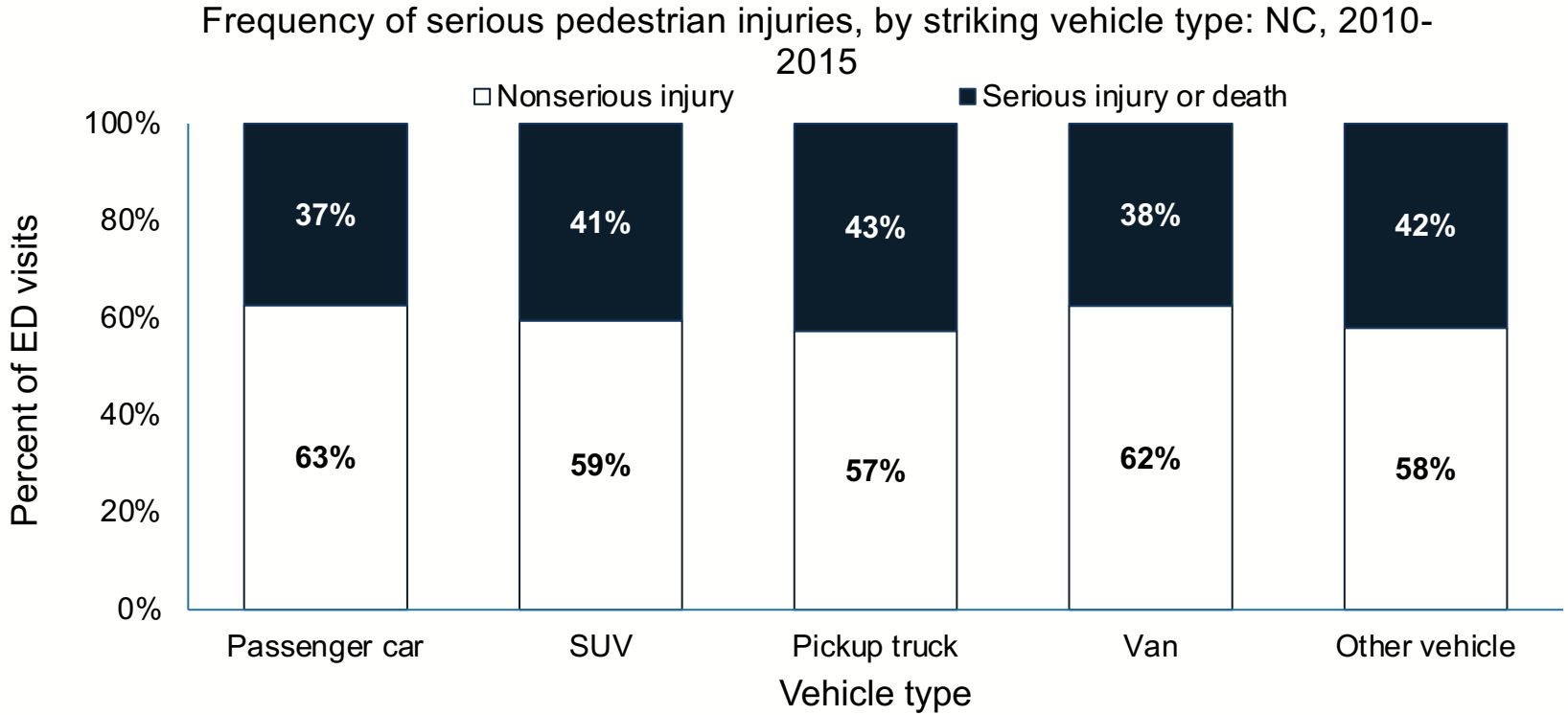
Striking driver age was also significantly associated with serious pedestrian injury, with young adults being overrepresented



Not surprisingly, estimated speed at impact was also highly associated with pedestrian injury severity, with higher speeds resulting in more serious injuries



Vehicle type was significantly associated with pedestrian injury severity, with pickup-trucks having the highest proportion of serious injuries



Descriptive epidemiologic study 2:

Examination of type and location of pedestrian injury

Study 2: Statistical analysis

- Same as study 1.
- Classified injury type and location according to the Barell Injury Diagnosis Matrix.*

*Barell V, et al. (2002) An introduction to the Barell body region by nature of injury diagnosis matrix. *Injury Prevention*, 8, 91-96.

Selected results from Study 2

- Head injuries were significantly more common among:
  - Men, youth (0-14 years), older adults (≥65 years), and pedestrians struck by vehicles traveling at estimated impact speeds >35 MPH.
- Lower extremity injuries were more common among:
  - Women, pedestrians struck by vehicles traveling at estimated impact speeds ≤35 MPH, and pedestrians struck by passenger cars.
- Fractures were more common among:
  - Men, older adults, and pedestrians struck by vehicles traveling at estimated impact speeds >35 MPH.

Multivariate modeling study:

Identifying predictors of serious pedestrian injury

Study 3: Statistical analysis

- Performed bivariate and multivariate analyses using logistic regression with serious/fatal pedestrian injury as the outcome of interest.
- For building the predictive model, used a backward elimination technique in which variables were removed one-by-one, starting with the variable least associated with the outcome.
  - If removing the variable reduced model fit (as indicated by an increase in the Akaike Information Criterion [AIC]), it was returned to the model.
  - If removing the variable improved model fit (as indicated by a decrease in AIC), it was discarded.
- Roadway and non-roadway pedestrian injuries were modeled separately.
- All analyses performed using SAS® Version 9.4 (SAS Institute, Cary, NC).

Predictive modeling study – pedestrian injuries due to roadway MVCs: NC, 2010-2015

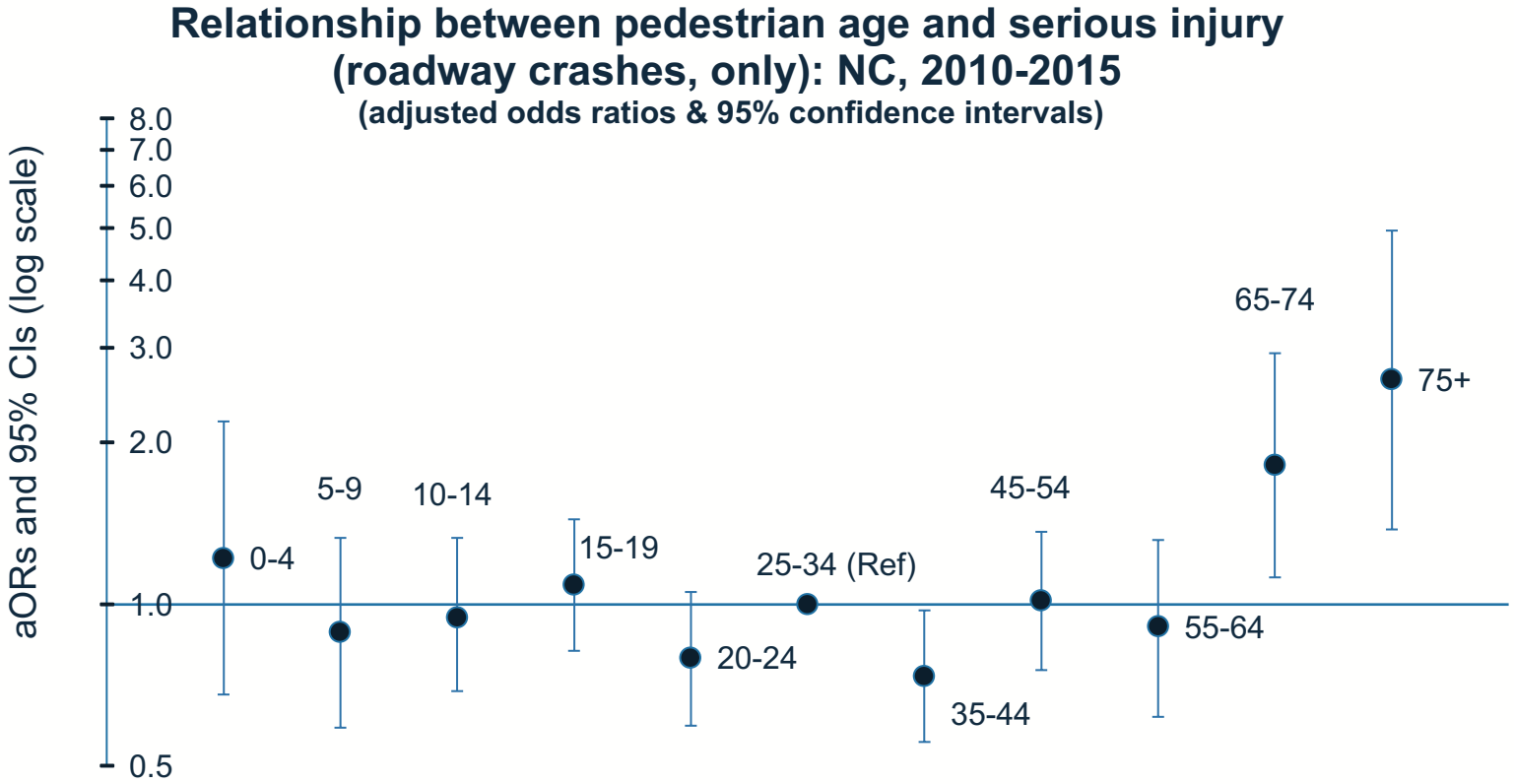
- We examined the following factors:
  - Year of crash, season of crash, weekend/weekday, **hour of crash***, **pedestrian sex****, **pedestrian age****, **race/Hispanic ethnicity of pedestrian****, **expected source of payment**, **pedestrian chronic health condition***, **suspected pedestrian impairment****, **sex of striking driver**, **age of striking driver**, **suspected driver impairment**, crash locality, **light condition***, **intersection-related*, road configuration**, **road classification***, **number of lanes**, **posted speed limit***, **estimated driver speed at impact****, striking vehicle type, and **pedestrian crash type****.

Bold = included in final model.

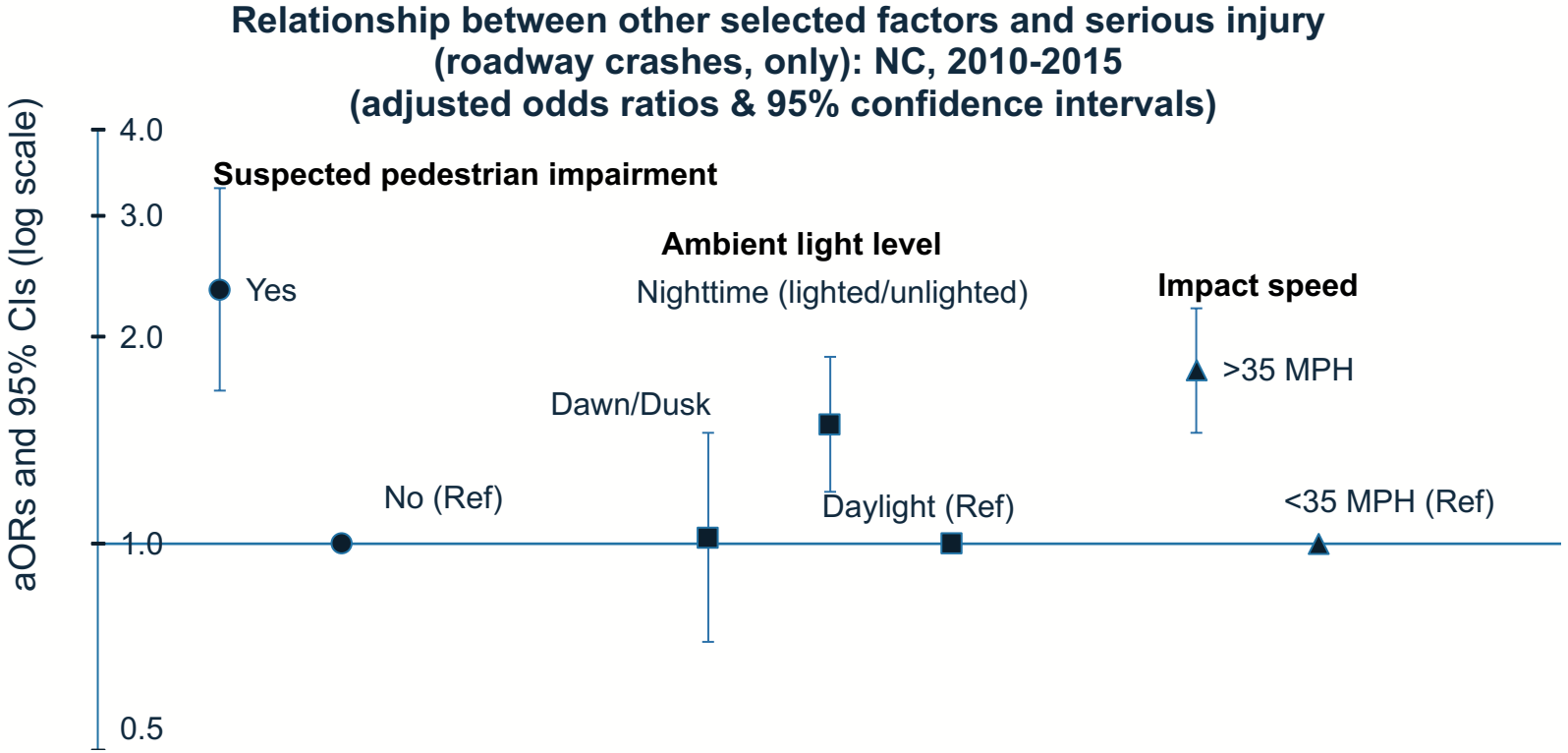
Bold* = statistically significant predictor (α =.05).

Bold** = statistically significant predictor (α =.001).

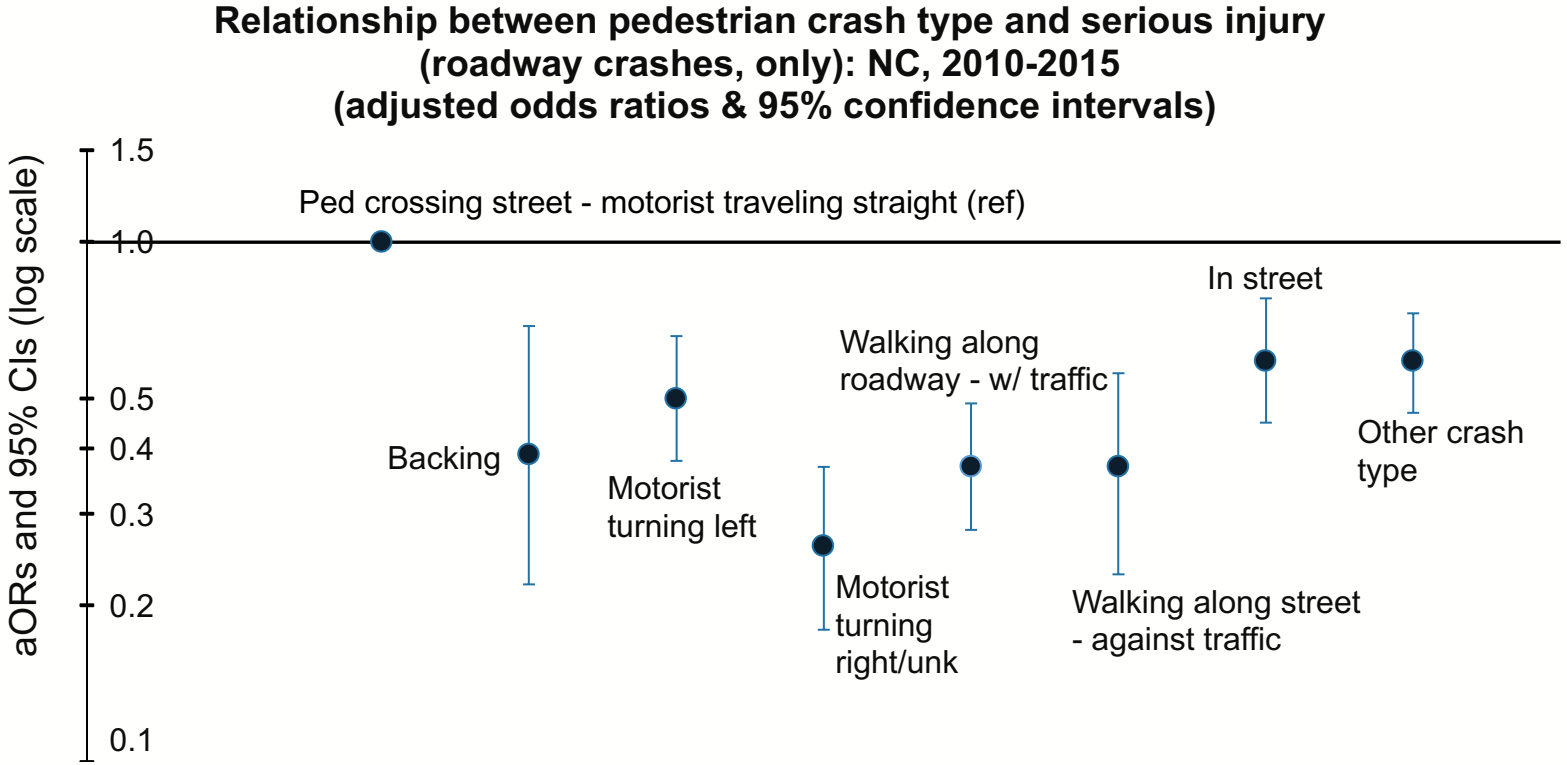
Age group was a significant predictor of serious pedestrian injury among roadway crashes



Other factors, such as suspected pedestrian impairment, ambient light level, and estimated speed at impact were also associated with pedestrian injury severity



The pedestrian crash type “pedestrian crossing street, motorist traveling straight” was more likely to result in a serious pedestrian injury than other crash types



Predictive modeling study – pedestrian injuries due to non-roadway MVCs: NC, 2010-2015

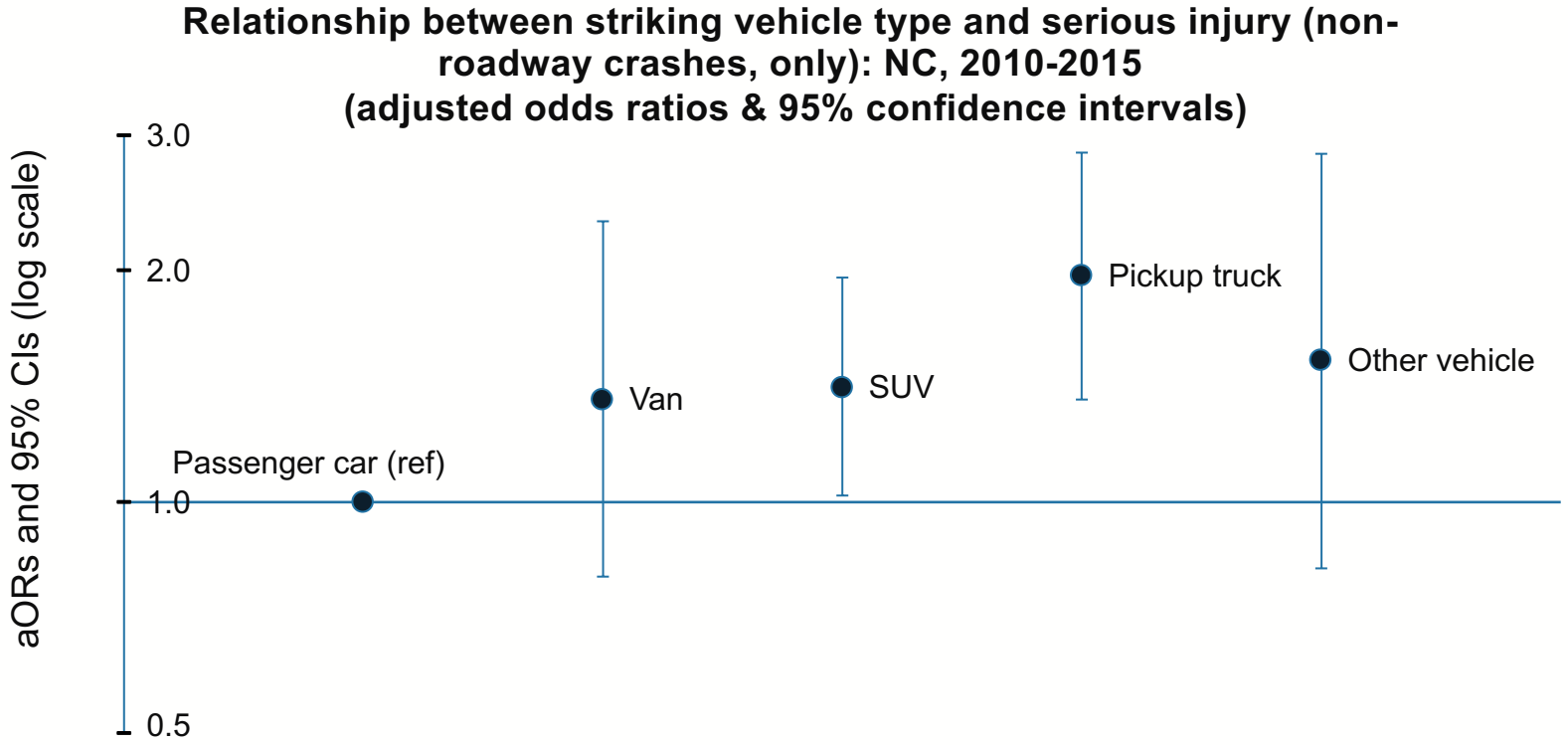
- We examined the following factors:
  - Year of crash, season of crash, weekend/weekday, **hour of crash***, **pedestrian sex***, **pedestrian age****, **race/Hispanic ethnicity of pedestrian****, **expected source of payment**, pedestrian chronic health condition, **suspected pedestrian impairment***, sex of striking driver, **age of striking driver**, **suspected driver impairment**, crash locality, **light condition**, **estimated driver speed at impact**, **striking vehicle type***, and pedestrian crash type.

Bold = included in final model.

Bold* = statistically significant predictor (α =.05).

Bold** = statistically significant predictor (α =.001).

Although striking vehicle type was not significant for roadway crashes, it was highly significant for non-roadway pedestrian crashes



Study limitations

- The study population included information only on NC pedestrians who had linked police crash report-emergency department visit records.
- Generalizability (may not be generalizable to other states/countries).
- Study period (data are outdated).
- Secondary analysis of datasets designed primarily for other uses.

Contract information

Contact information:

Katie Harmon, PhD

UNC HSRC

919.962.0745

harmon@hsrc.unc.edu