

Understanding the Impact of Vehicle Design on Pedestrian Safety

Texas Pedestrian Safety Webinar

September 17, 2026



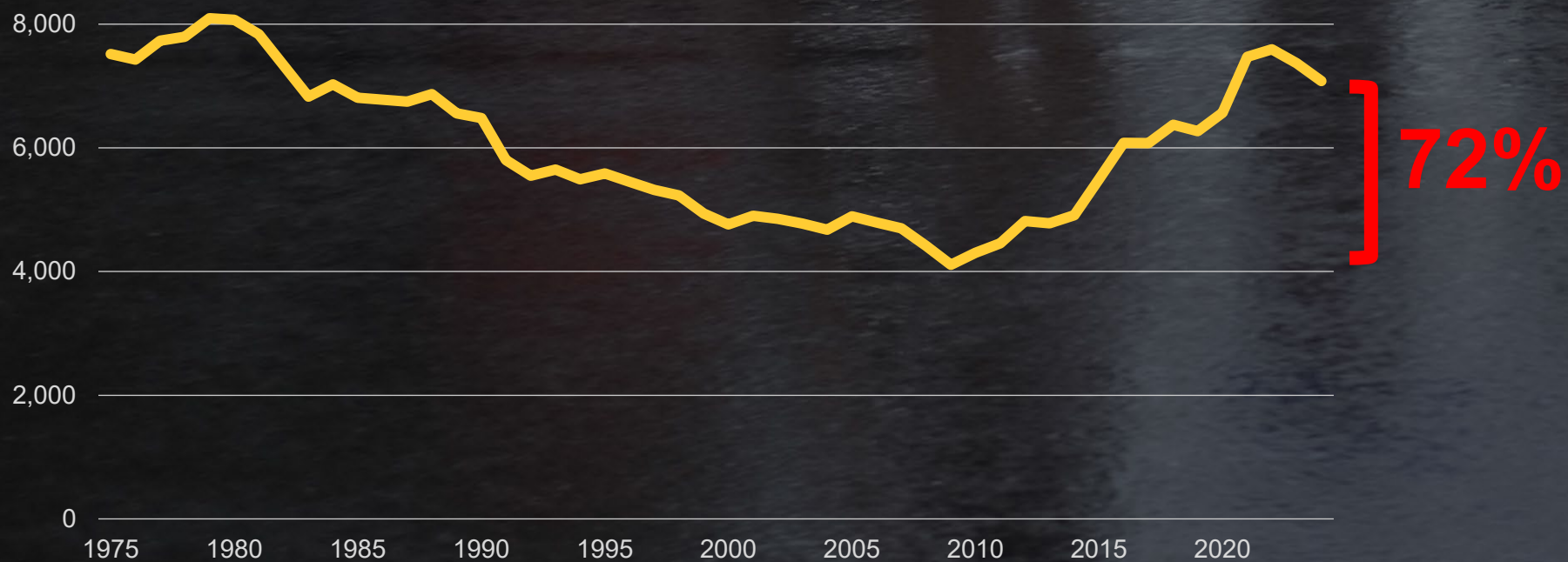
Wen Hu

Senior Research Transportation Engineer



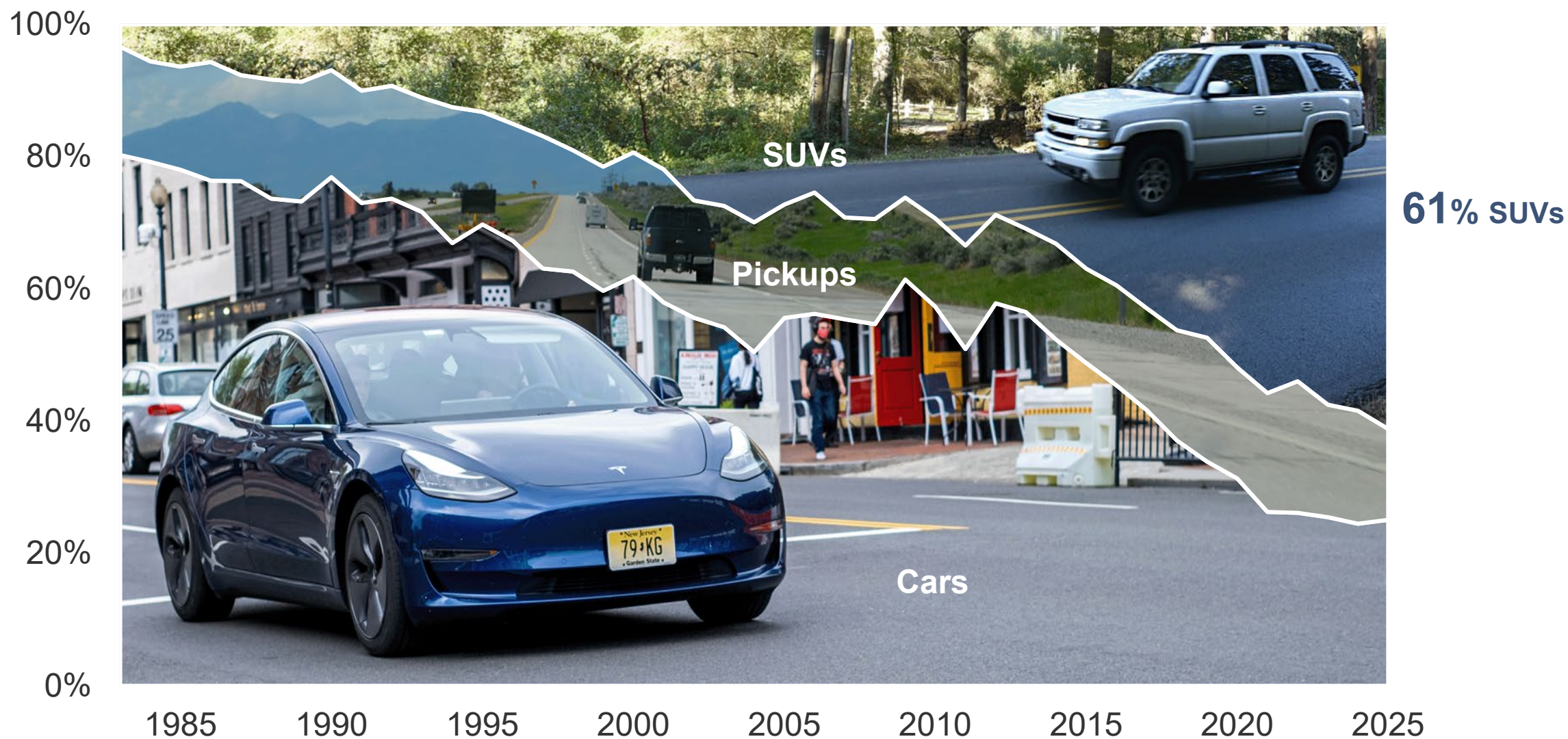
U.S. pedestrian fatalities

1975-2024



Distribution of vehicles by type

1983-2025 model years

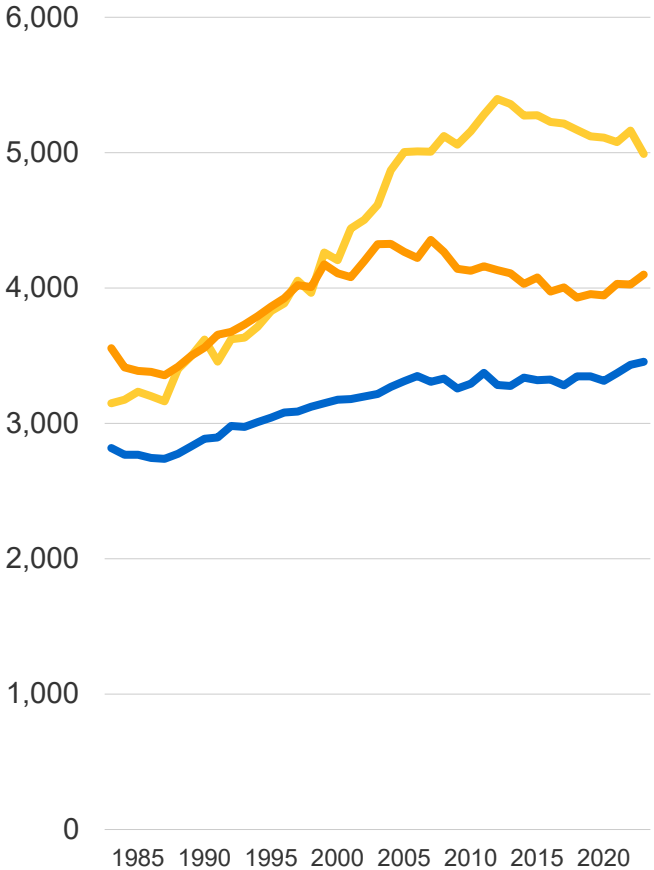


Changes in vehicle specs

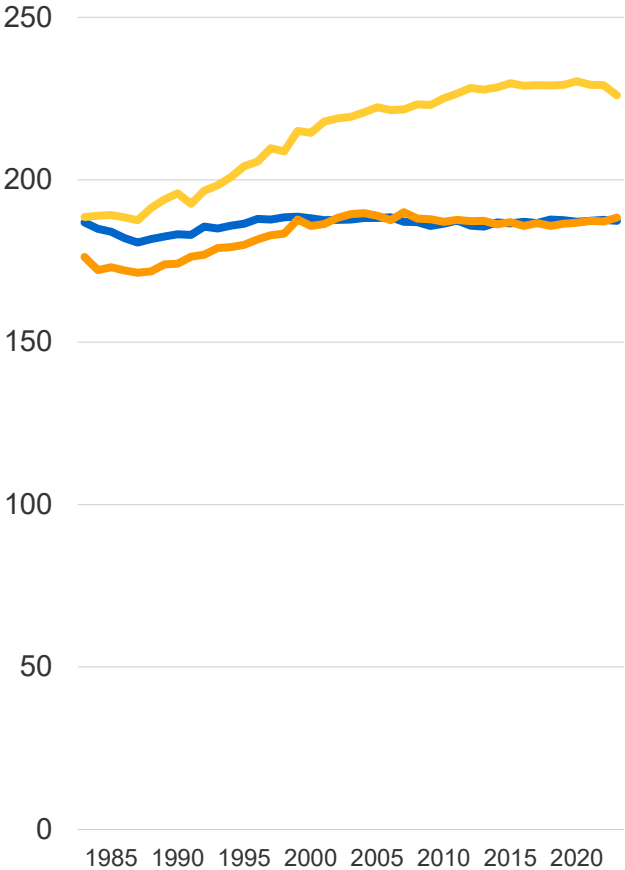
1983-2023 model years

Cars SUVs Pickups

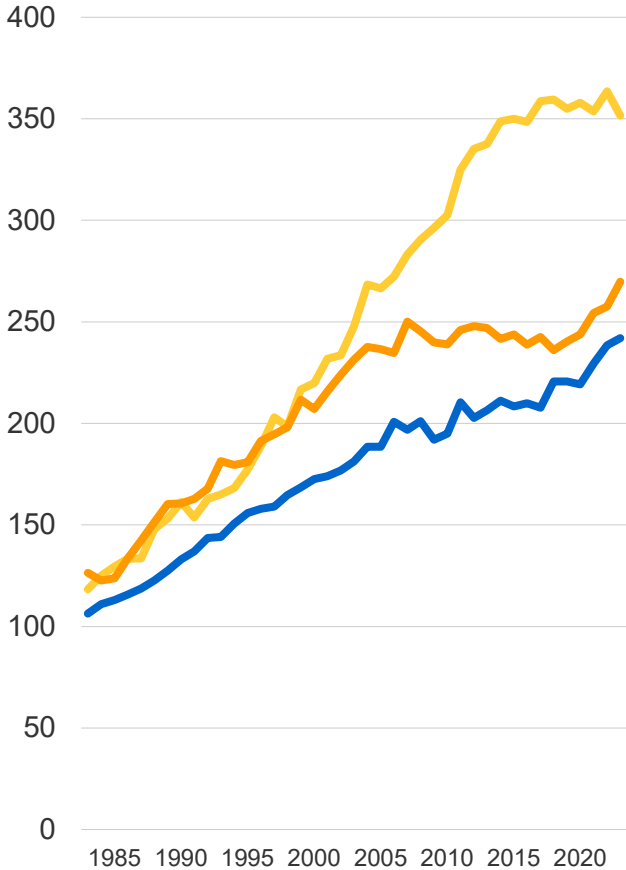
Average curb weight in pounds



Average length in inches



Average horsepower



Previous research

Vehicle size and pedestrian injuries

Pedestrian hip height relative to vehicle front end height is a key predictor of crash kinematics and injury outcomes

(Ballesteros 2005, Longhitano 2005, Roudsari 2005)

Vehicle front-ends taller than hip height are more likely to throw a pedestrian to the ground

(Roudsari 2005, Submit 2008)

Previously available datasets reflect older US field data (PCDS) or countries where American style pickups are not common

Research question

- ▶ How does the growing US vehicle fleet influence pedestrian injury patterns?

Ballesteros, M.F., Dischinger, P.C., and Langenberg, P. (2004) Pedestrian injuries and vehicle type in Maryland, 1995–1999. *Accident Analysis & Prevention* 36 (1): 73-81.

Longhitano, D., Henary, B., Bhalla, K., Ivarsson, J., and Crandall, J. (2005) Influence of vehicle body type on pedestrian injury distribution. *SAE Transactions*: 2283-2288.

Roudsari, B.S., Mock, C.N., and Kaufman, R. (2005) An evaluation of the association between vehicle type and the source and severity of pedestrian injuries. *Traffic Injury Prevention* 6 (2): 185-192.

Subit, D., Kerrigan, J., Crandall, J., Fukuyama, K., Yamakazi, K., Kamui, K., and Yasuki, T. (Year) Pedestrian-vehicle interaction: Kinematics and injury analysis of four full scale tests. *Proc. 2008 IRCOBI Conference*.

Datasets

International Center for Automotive Medicine (Pedestrian Consortium)

Vulnerable road user Injury Prevention Alliance (VIPA)

- ▶ 211 pedestrians (data collection ongoing)
- ▶ Founded 2015; MY 2005 or newer vehicles
- ▶ Impact speed from modeling and formulas

National Highway Traffic Safety Administration

Vulnerable Road User Indepth Crash Investigation Study (VICIS)

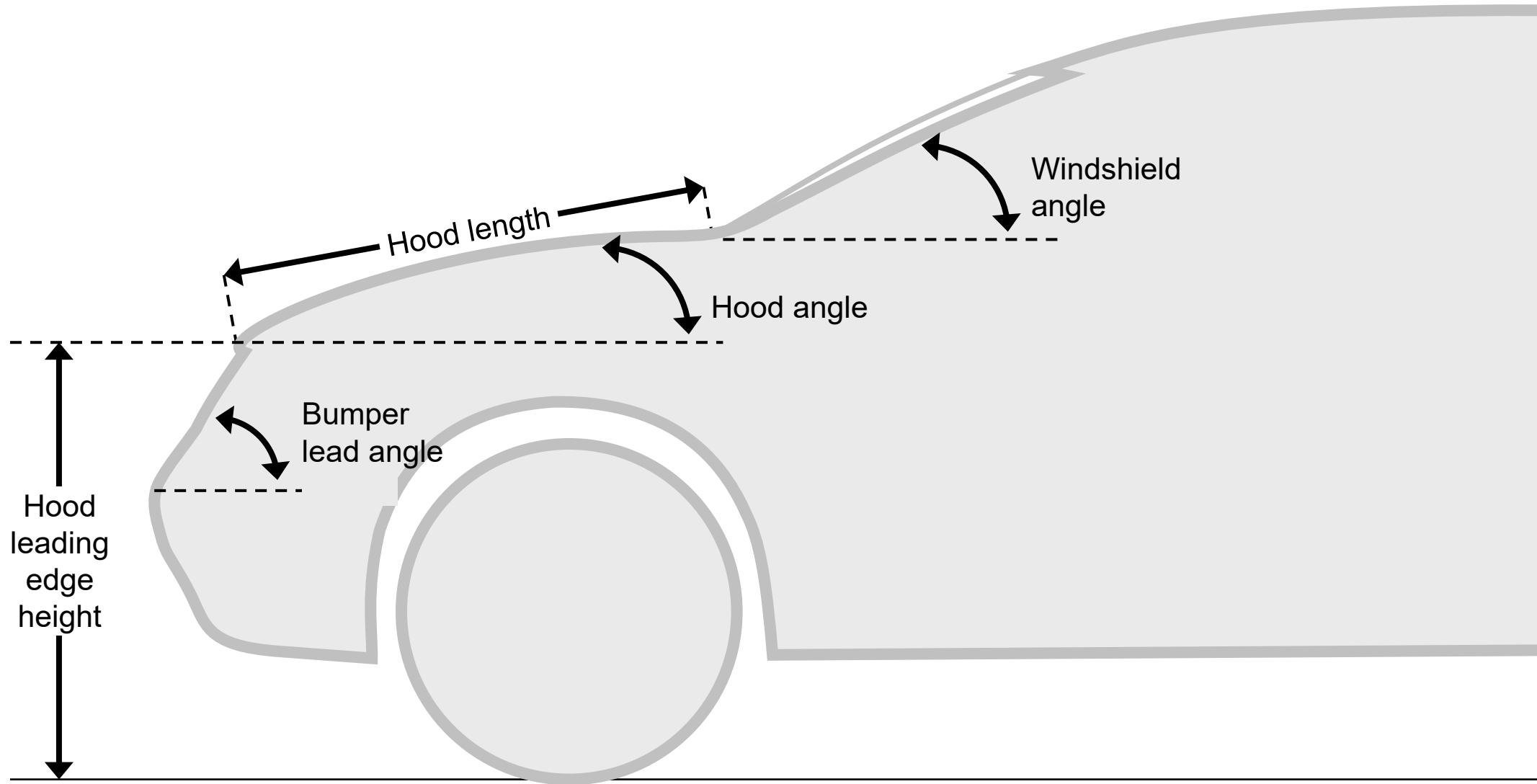
- ▶ 92 pedestrians from 4 collection centers in US
- ▶ Collected 2022; MY 2004 or newer vehicles
- ▶ Impact speed from EDRs and formulas

State Crash Data

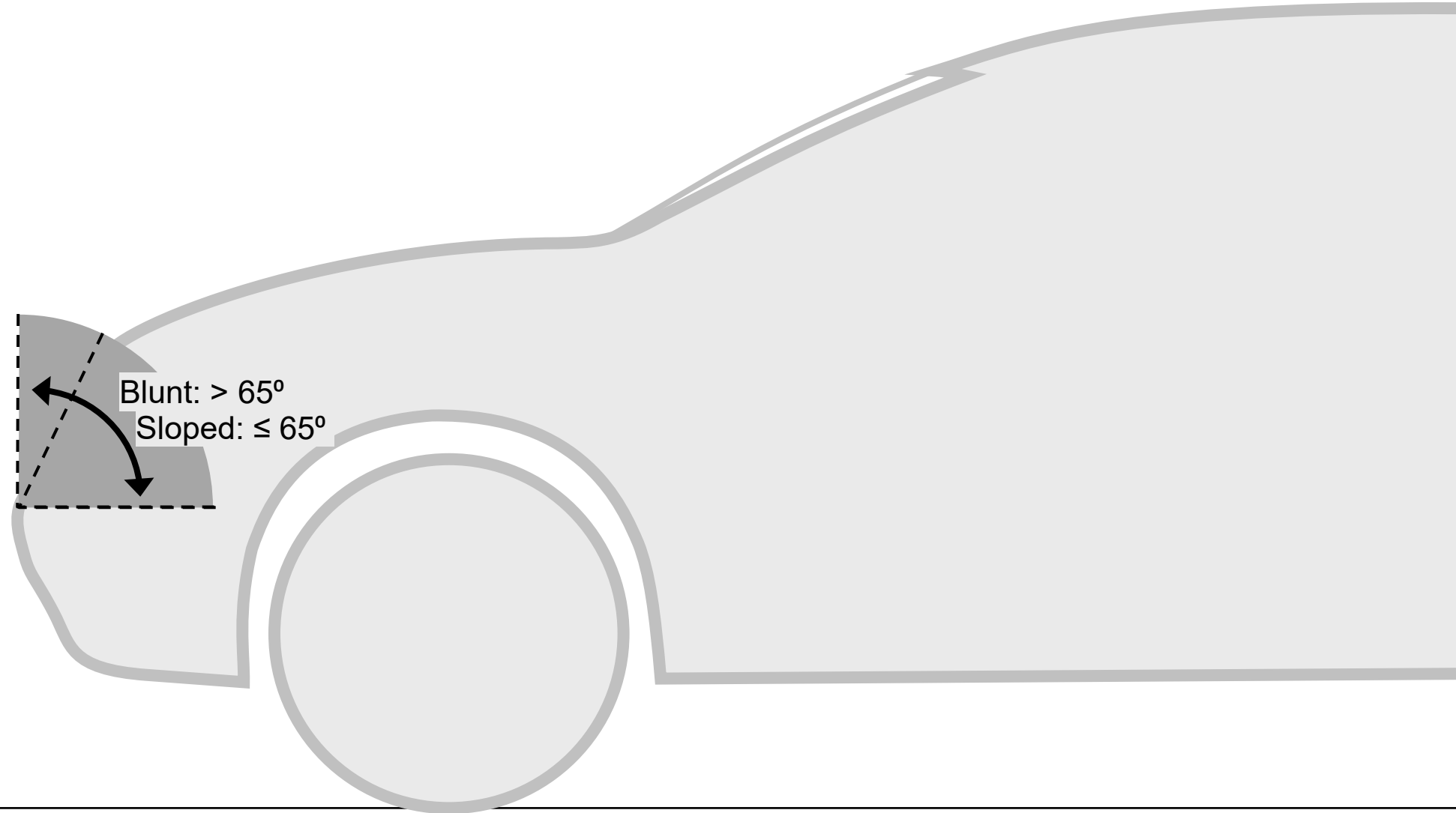
Police-reported crashes aggregated from 7 states

- ▶ 17,897 pedestrians; 664 unique vehicle designs
- ▶ Crashes from 2017 - 2022
- ▶ Fatality outcomes but no impact speed

Vehicle front end profile measurements



Bumper lead angle



Vehicle examples of different front-end shapes

Blunt

Sloped

Tall
>40"



Medium
>30" and ≤40"



Low
≤30"

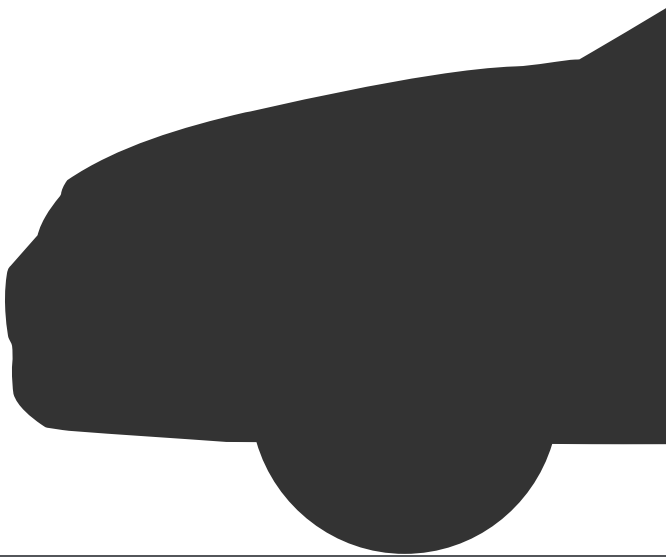


Tall, blunt vehicles put pedestrians at risk

Risk of pedestrian death in a crash, from database of nearly 18,000 crashes

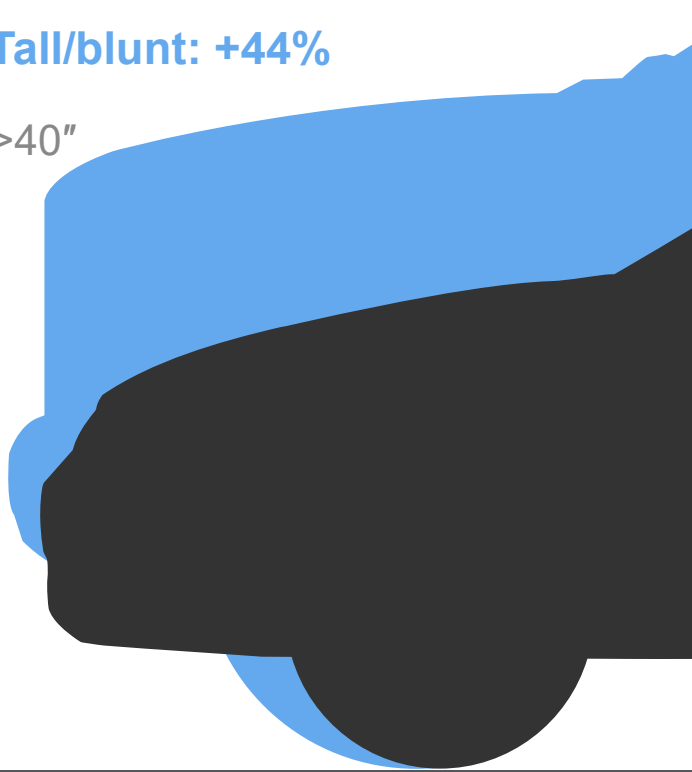
BASELINE: low/sloped

$\leq 30''$



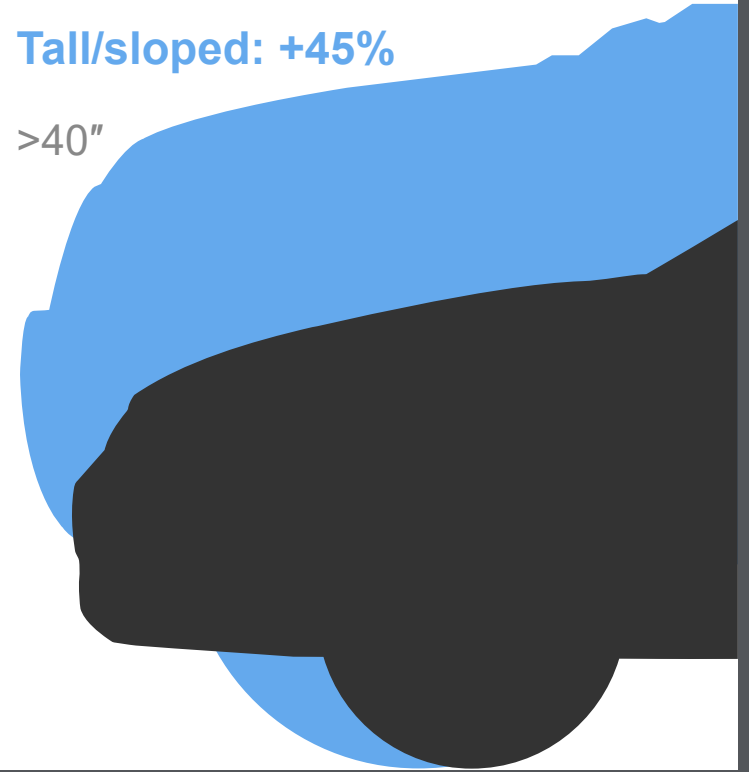
Tall/blunt: +44%

$>40''$



Tall/sloped: +45%

$>40''$

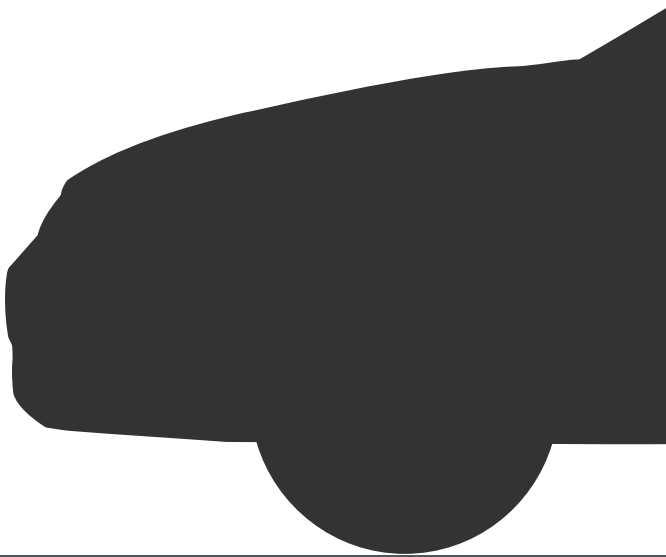


Tall, blunt vehicles put pedestrians at risk

Risk of pedestrian death in a crash, from database of nearly 18,000 crashes

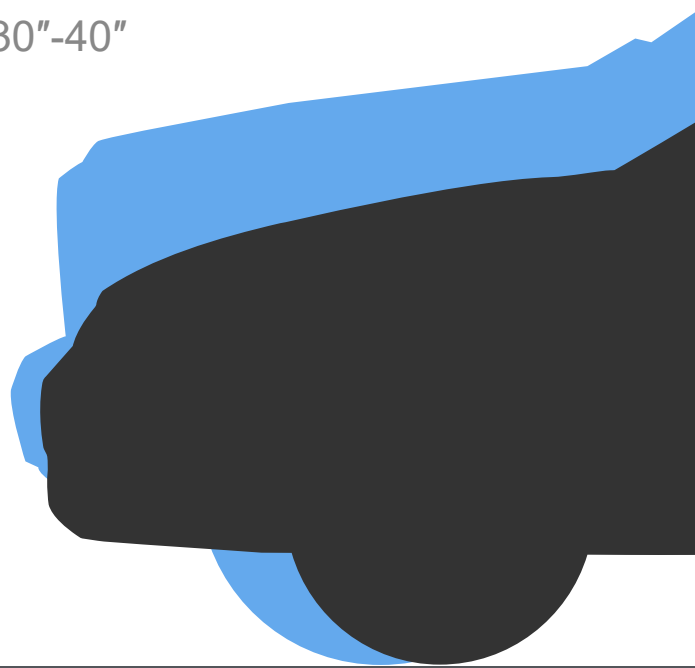
BASELINE: low/sloped

$\leq 30''$



Medium/blunt: +26%

30"-40"

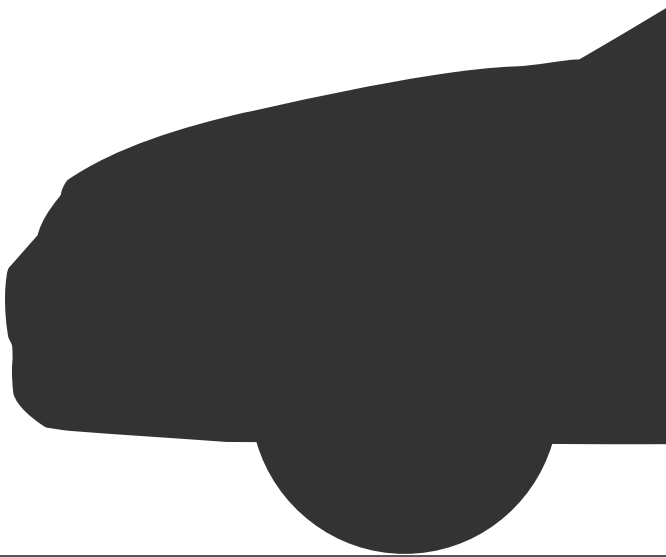


Tall, blunt vehicles put pedestrians at risk

Risk of pedestrian death in a crash, from database of nearly 18,000 crashes

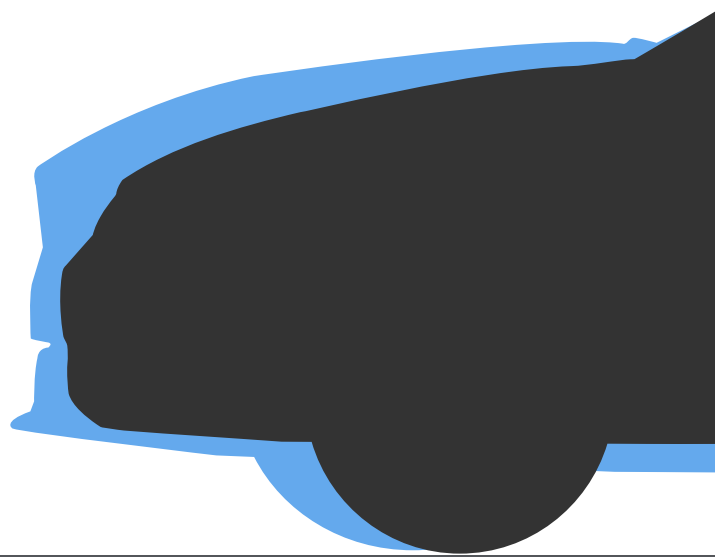
BASELINE: low/sloped

$\leq 30''$



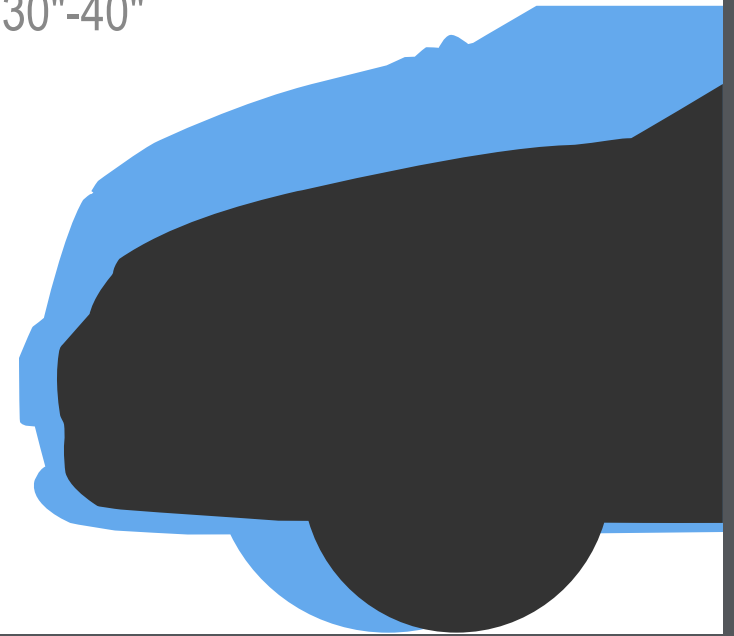
Low/blunt: similar risk

$\leq 30''$



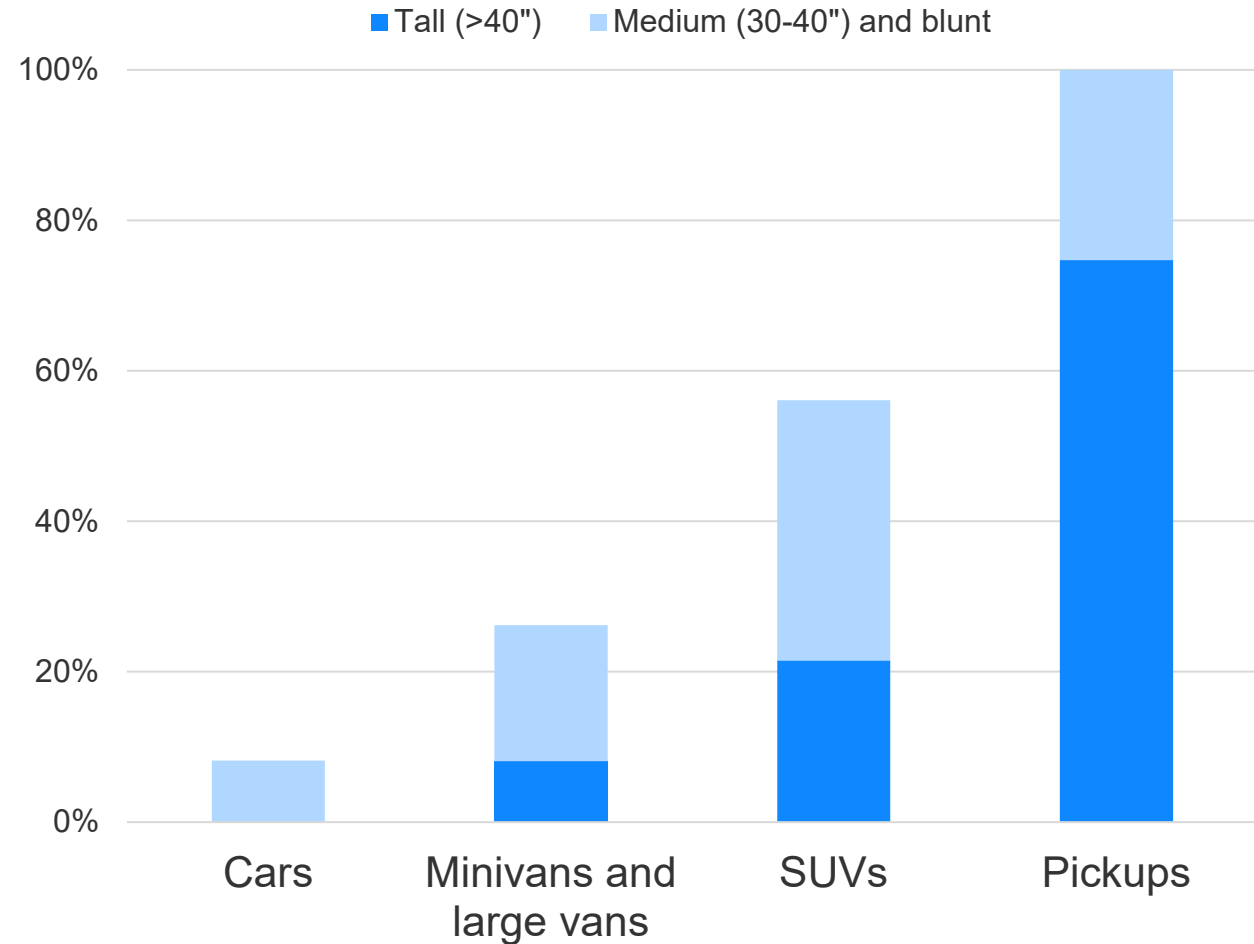
Medium/sloped: similar risk

30"-40"



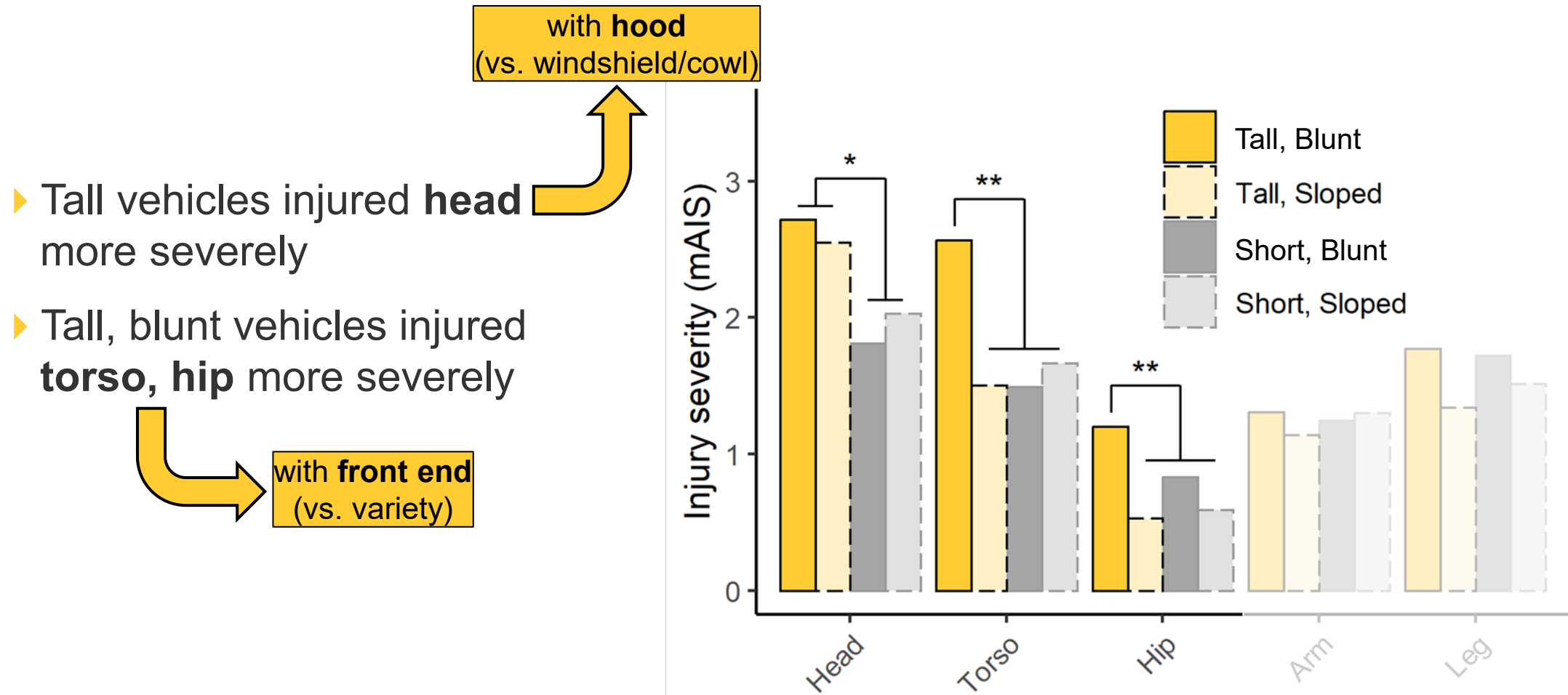
56% of SUVs and
100% of pickups
had front-end shapes
with increased
fatality risk

Percent of study vehicles with higher-risk front-end shapes



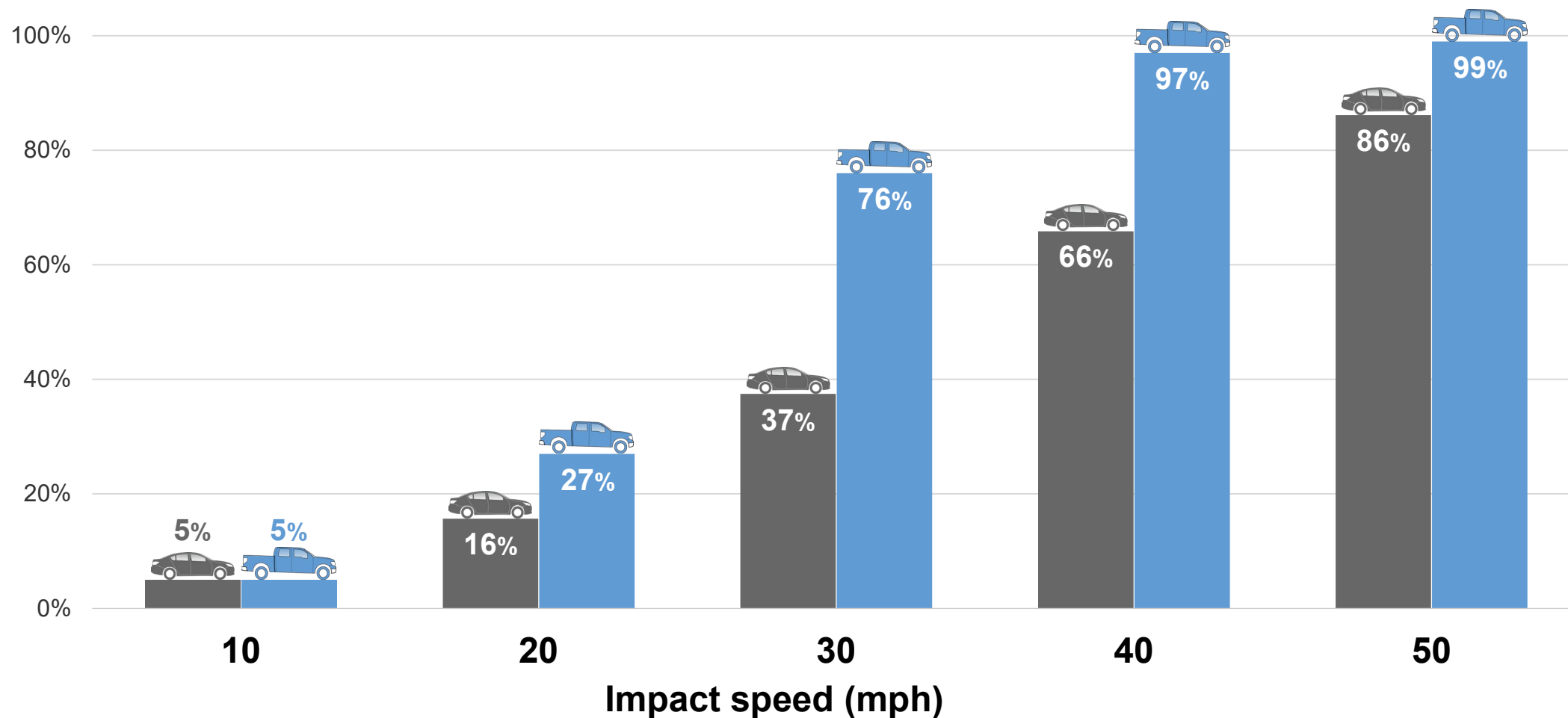
Excess injury risk stems from differences in torso, hip, head injuries

Analysis of 121 in-depth pedestrian crash records between 2015-21



Risk of serious injury to a struck pedestrian by impact speed for median car and median pickup

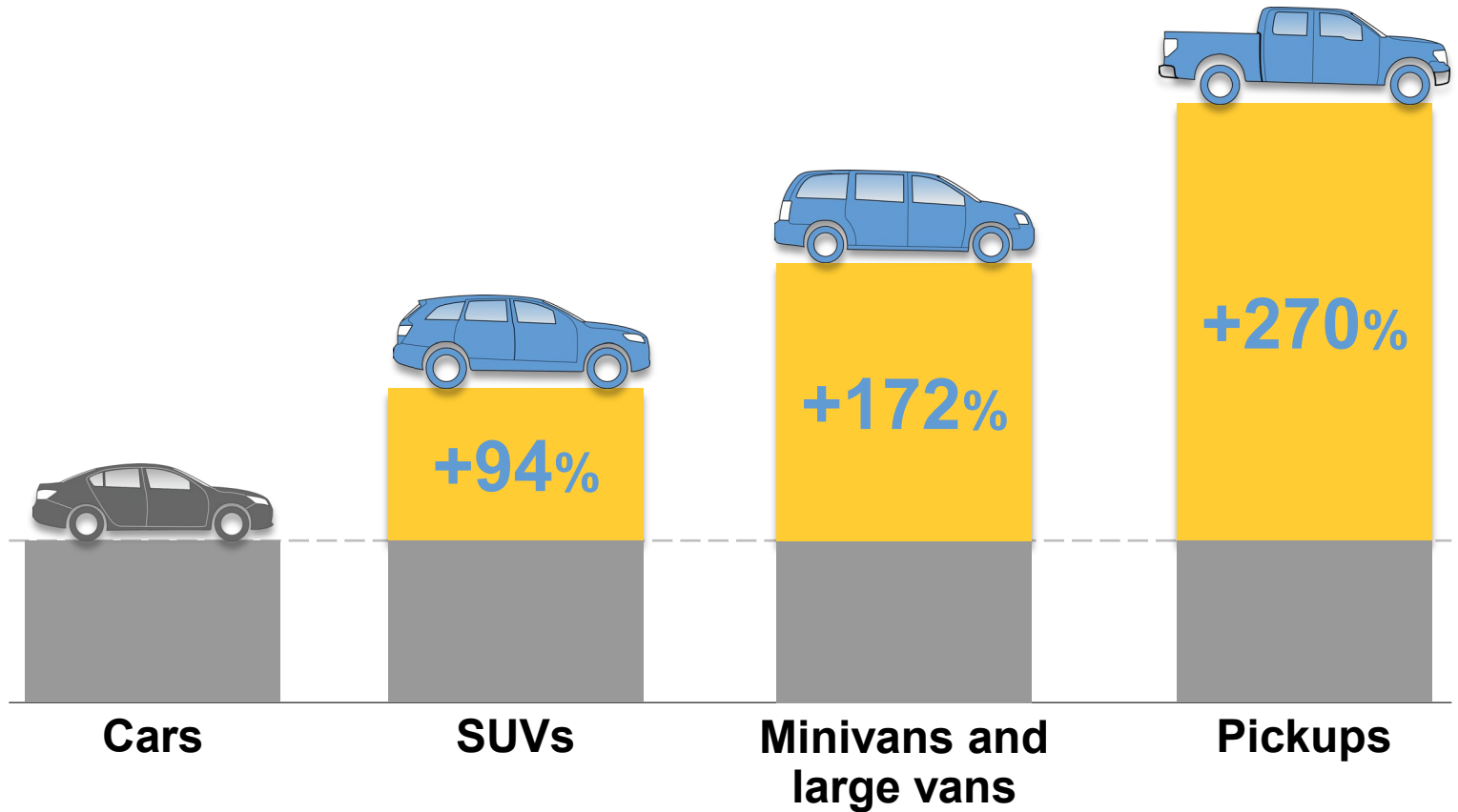
Monfort, 2025



Odds a vehicle was
turning left vs. going straight in
a fatal pedestrian intersection crash

Relative to cars

Visibility in larger
vehicles may increase
left turn crash risk



Direct vision measurements



Capture
photos



Process images
to get nearest
visible ground point



Create
blind zone map



Research question

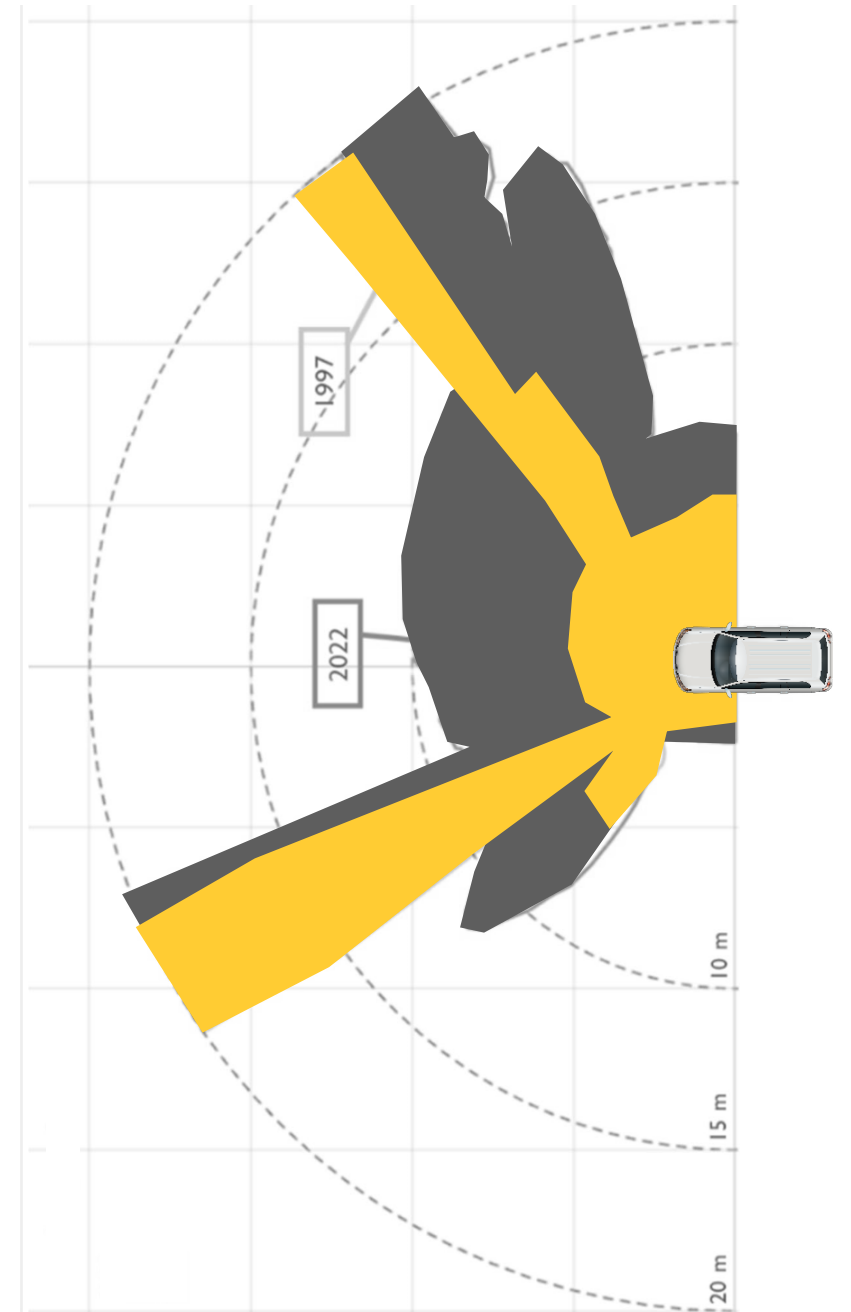
How are vehicle blind zones changing over time?



Honda CR-V

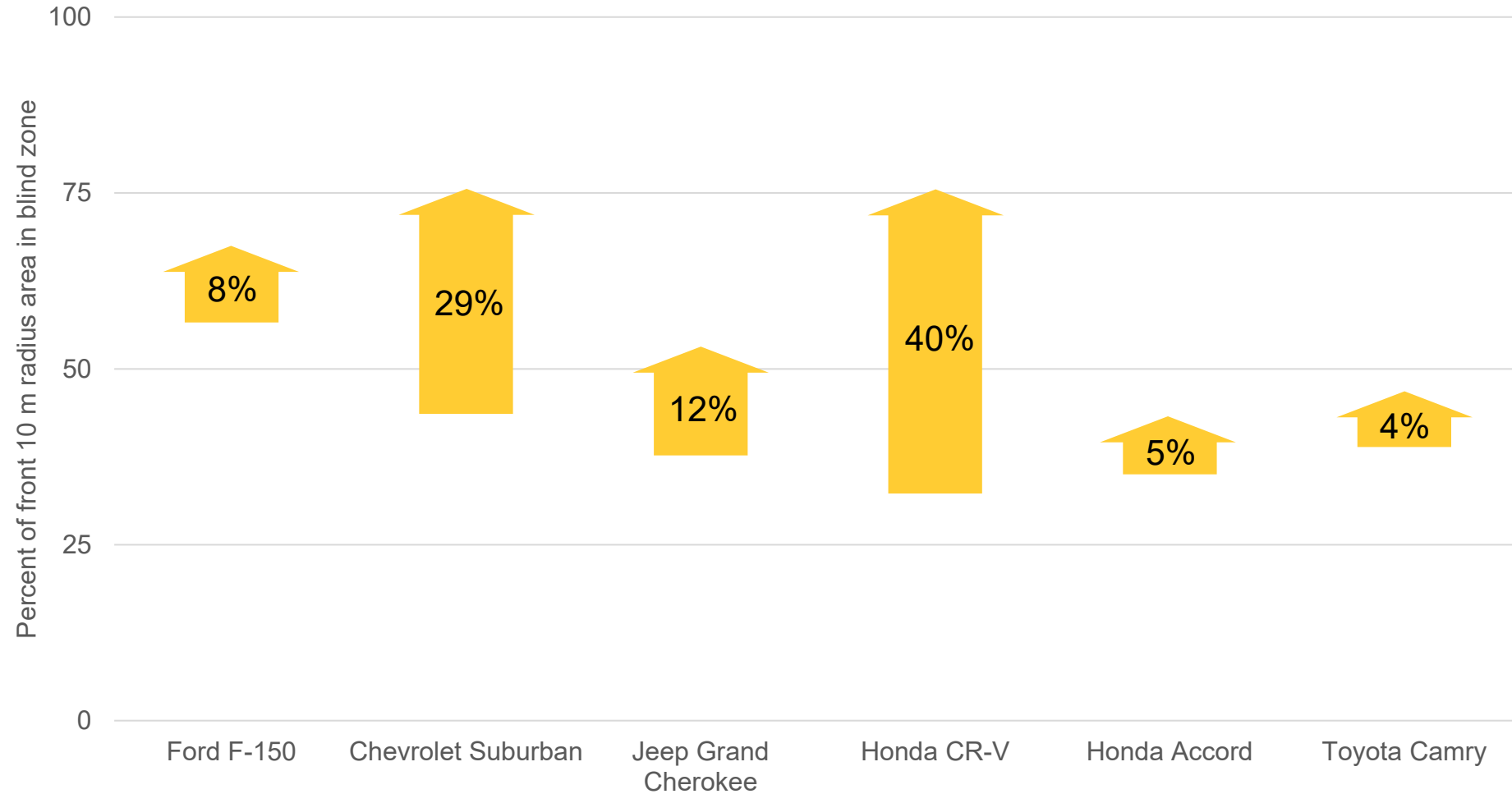
1997

2022



Blind zones are increasing over time

Collaboration with US DOT Volpe Center

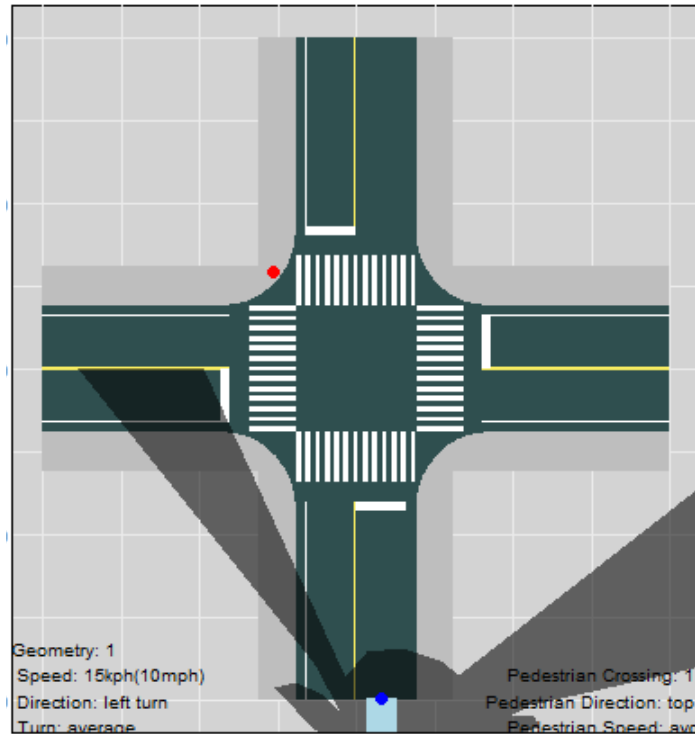


Mathematical simulations (504 each vehicle, 10,080 total)

Left turn

2019 Ford F-150 Supercab _ 1

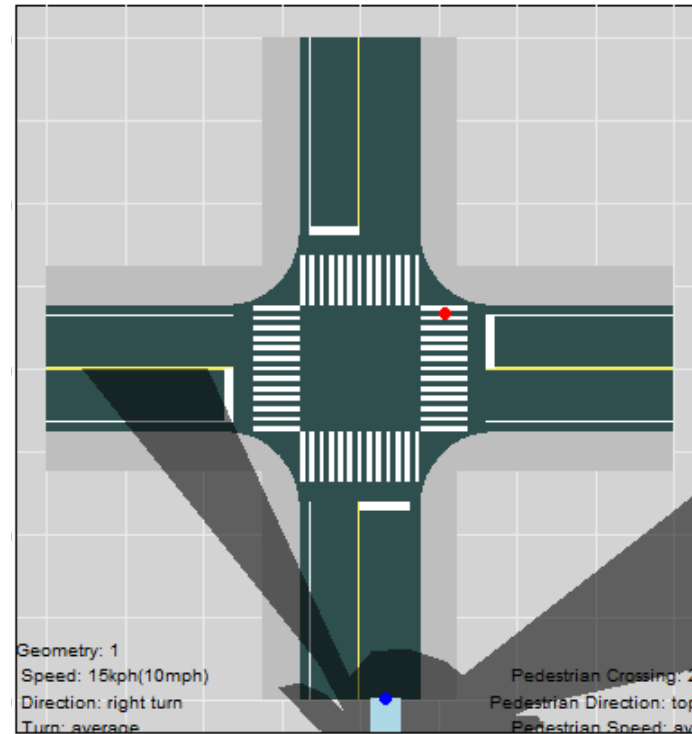
Time(s): 4.1



Right turn

2019 Ford F-150 Supercab _ 37

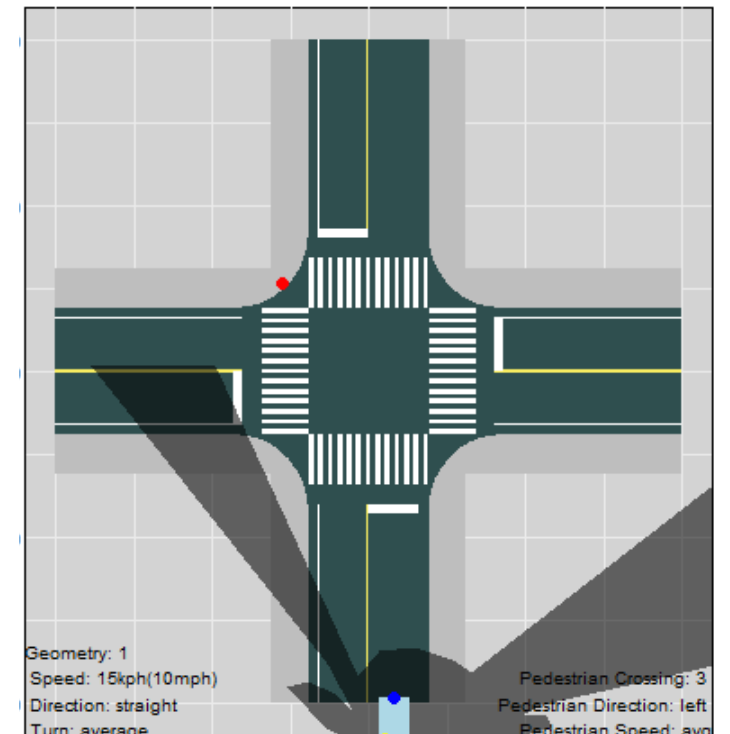
Time(s): 5.4



Straight

2019 Ford F-150 Supercab _ 145

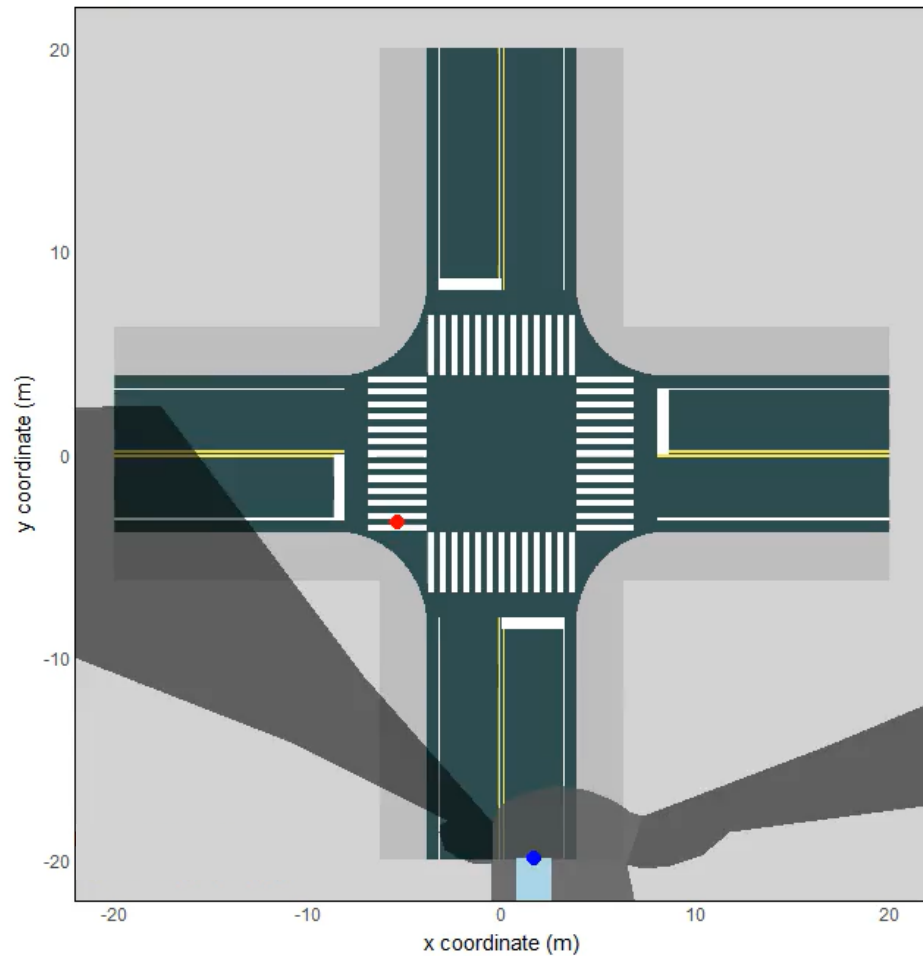
Time(s): 4



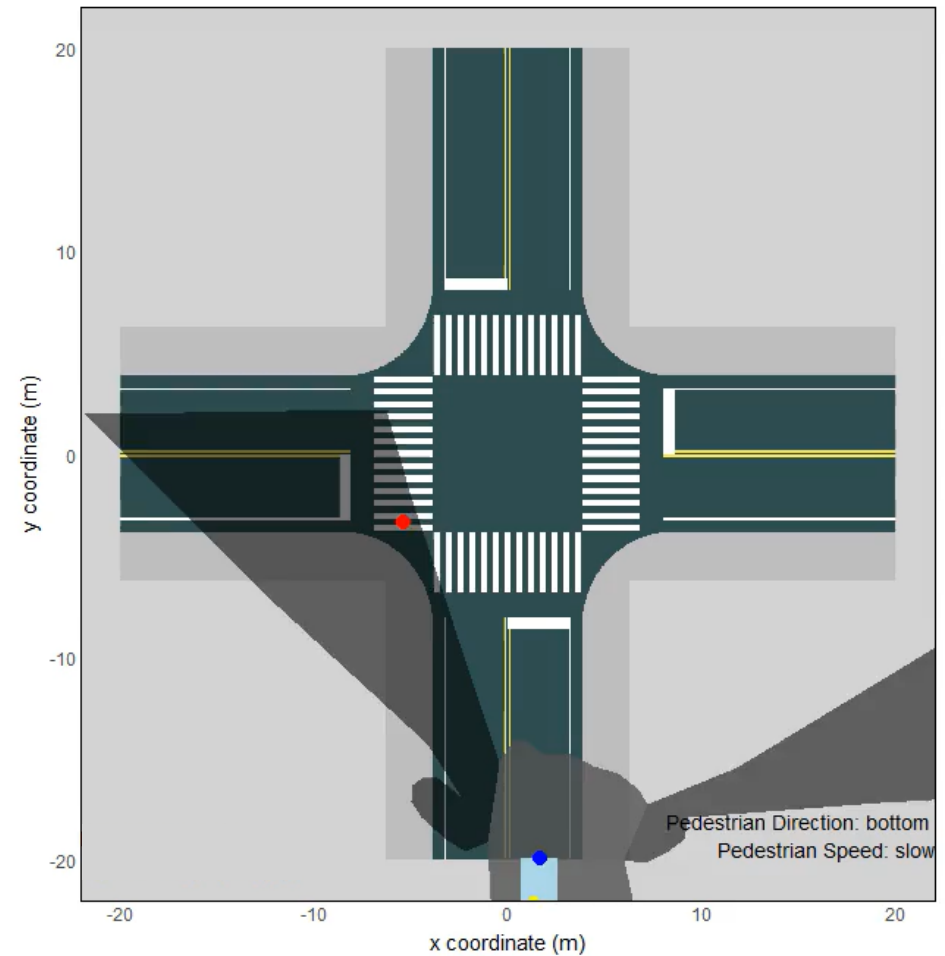
Simulation examples

Pedestrian time in blind zone

Better visibility
2014 Lexus ES 350



Worse visibility
2020 Kia Sportage

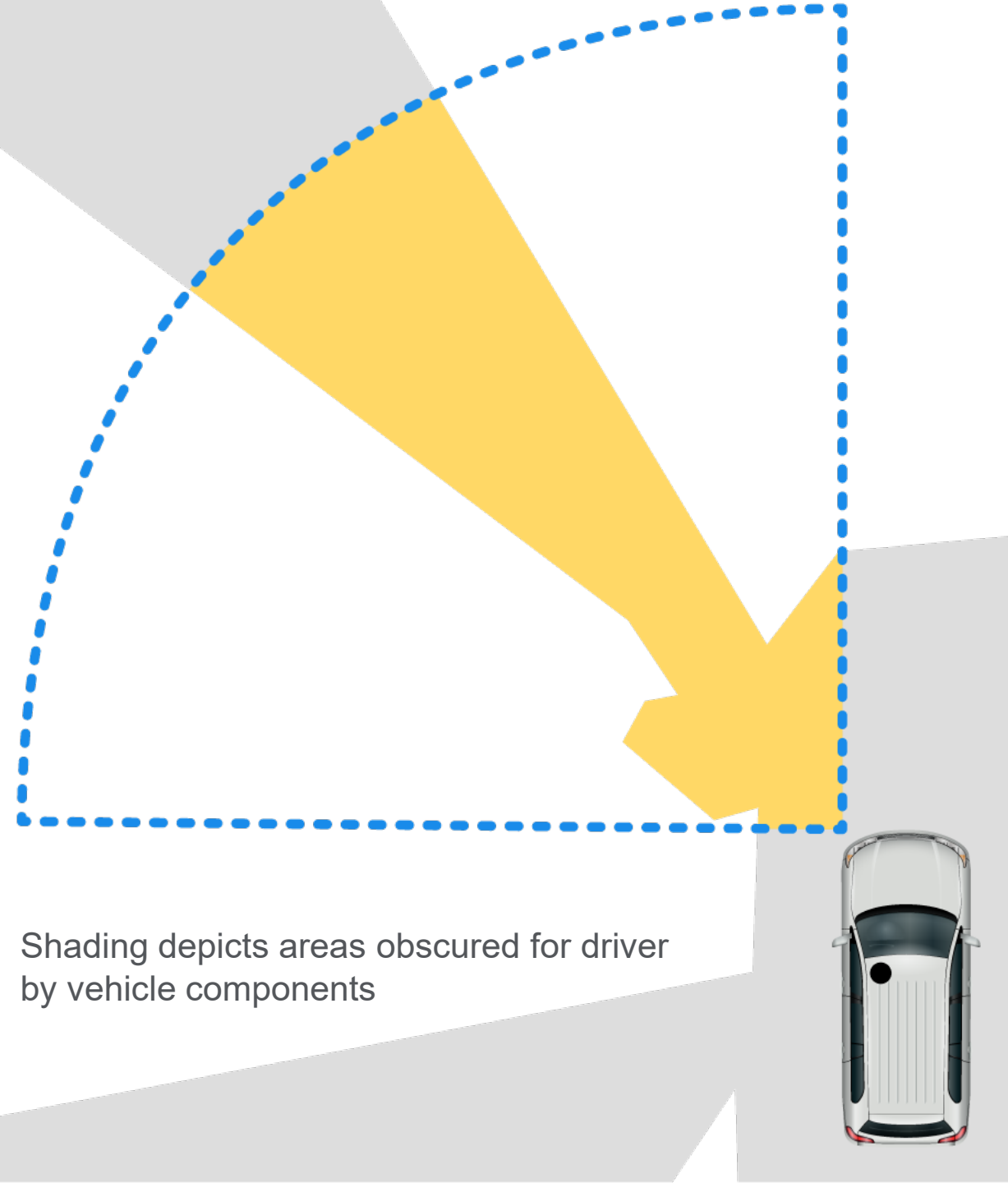


Left-turning blind zone



Blind zone areas of interest

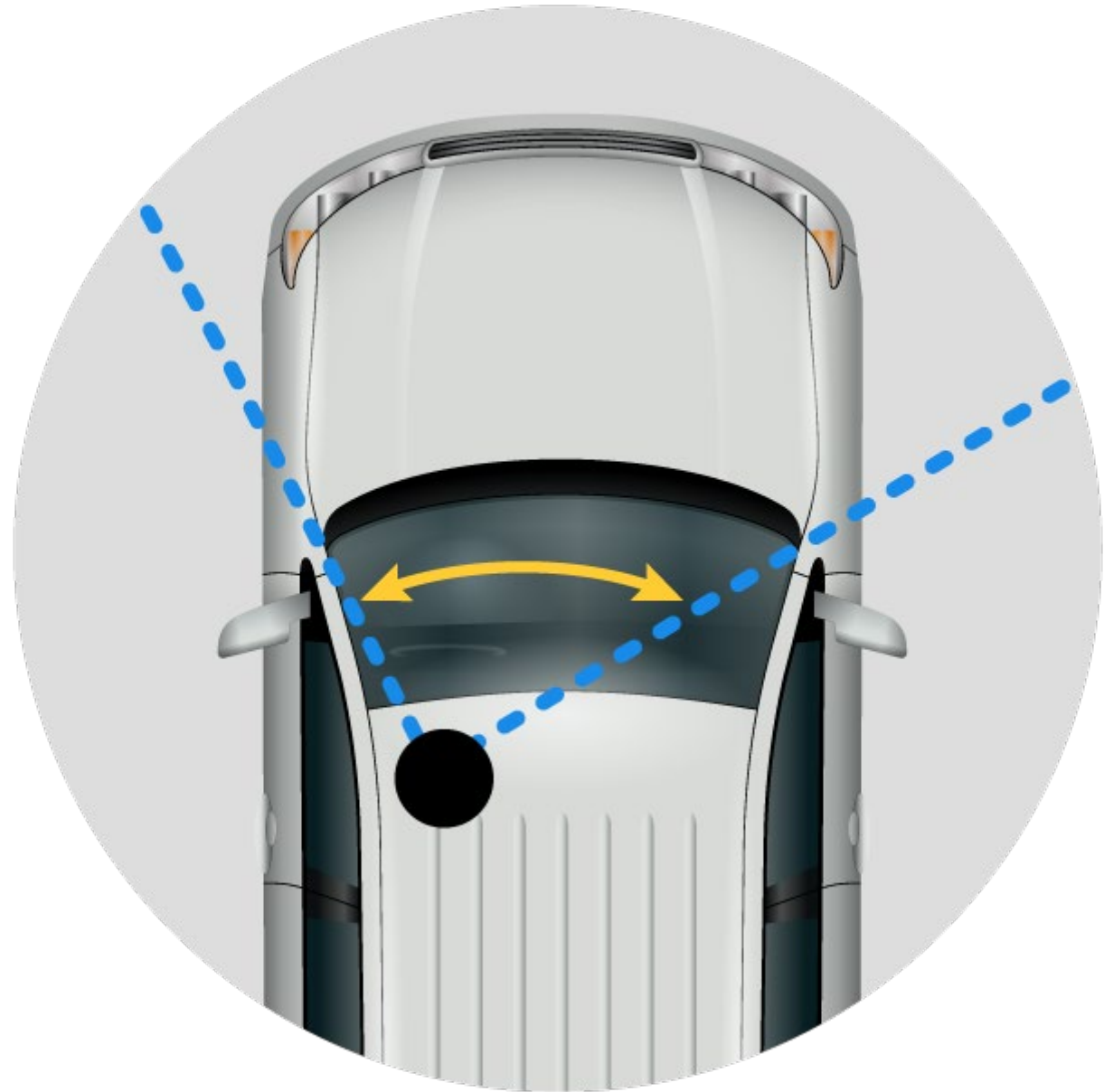
Size of blind zone



Blind zone areas of interest

Size of blind zone

Front field of view



Blind zone areas of interest

Size of blind zone

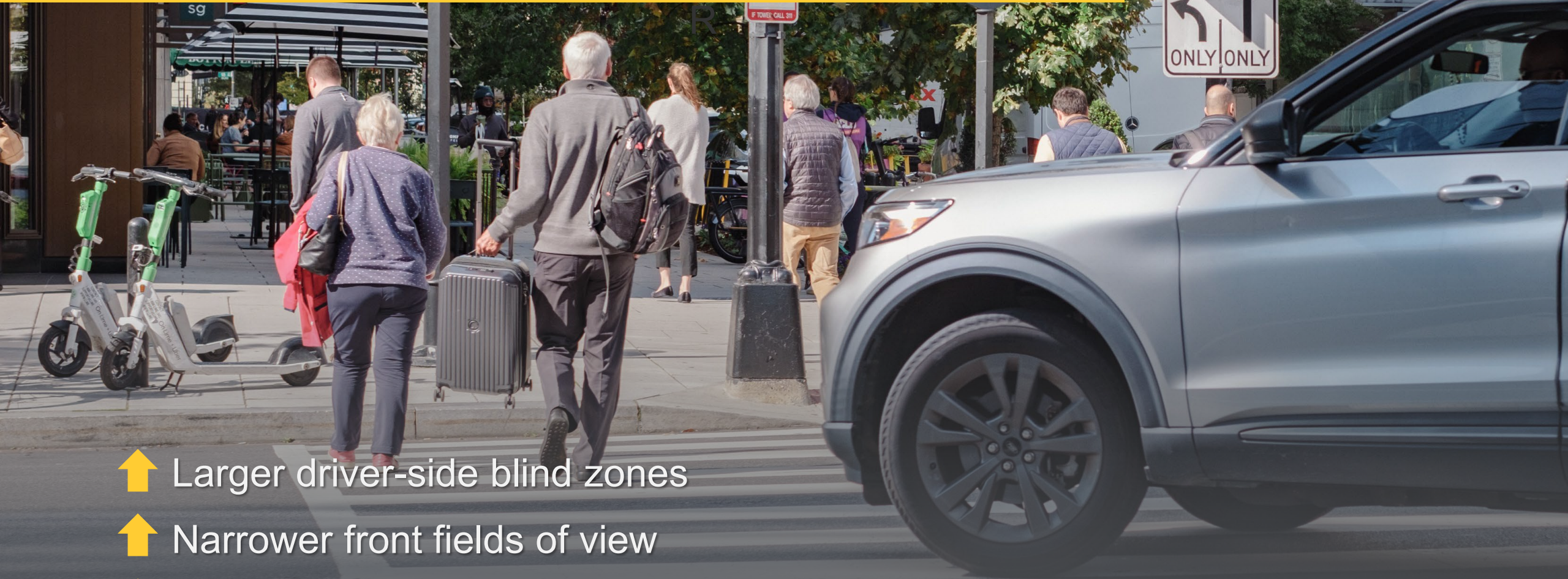
Front field of view

Nearest visible point

Shading depicts areas obscured for driver by vehicle components



Risk of left-turning pedestrian crashes



- ↑ Larger driver-side blind zones
- ↑ Narrower front fields of view
- ↑ Longer distances to nearest front visible point



Goals for driver vision assessment

- ▶ Optimize direct vision while maintaining vehicle crashworthiness
- ▶ Identify and assess effectiveness of indirect vision aids, i.e., mirrors, cameras, alerts, that can supplement driver direct vision

Insurance Institute for Highway Safety
Highway Loss Data Institute

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THANK YOU



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