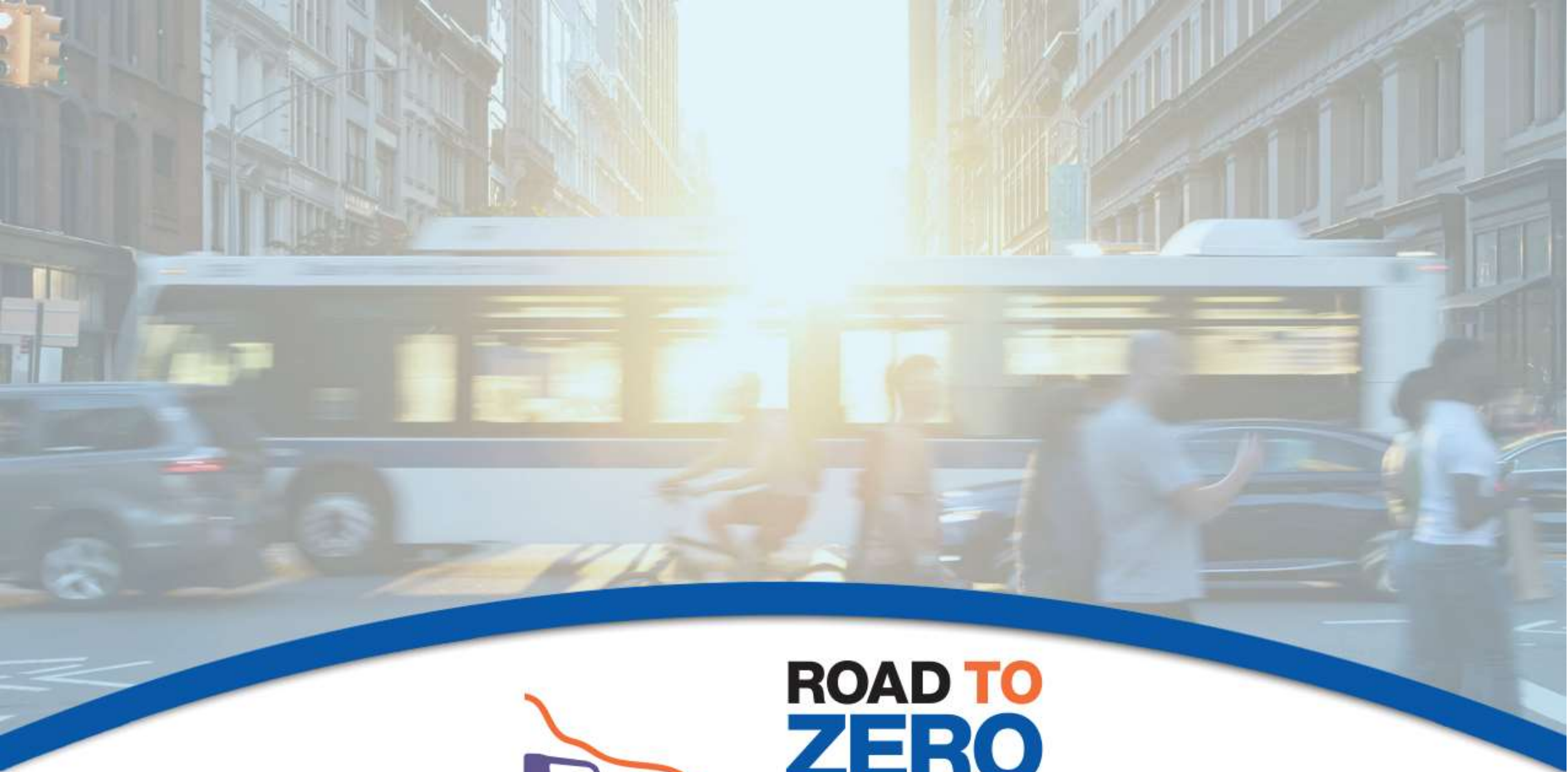


Massive Hazards:

How Bigger, Heavier Light Trucks Endanger Lives on American Roads

A Report by the Road to Zero Coalition

October 2024

About the Road to Zero Coalition

The Road to Zero Coalition (RTZ), an initiative of the National Safety Council (NSC), is the nation's largest traffic safety alliance, with the goal of ending roadway deaths in the United States by 2050. Since the Coalition's launch in 2016, members have represented a variety of traffic safety stakeholders, including professional engineering and planning organizations; public-sector organizations; safety advocates; vehicle manufacturers; technology developers; public health, emergency medical, and trauma organizations; and law enforcement and judicial system representatives. RTZ promotes the Safe System Approach to preventing roadway deaths, disseminating best practices and enabling communities through our Community Traffic Safety Grants.

The Program Manager for RTZ is Julia Kite-Laidlaw. All questions and comments on this report may be directed to RoadToZero@nsc.org. To join the Coalition, and to receive the monthly newsletter, please visit https://www.nsc.org/roadtozero. New webinars and resources are posted regularly about topics in mobility safety, the Safe System Approach, equity in mobility safety, grant opportunities, traffic safety culture, and more.

About the National Safety Council

The National Safety Council eliminates preventable deaths at work, in homes and communities, and on the road through leadership, research, education, and advocacy. A 501(c)3 nonprofit, chartered by the United States Congress, with local chapters, global networks, and more than 50,000 individual members, NSC relies on philanthropic funds to advance our mission to keep people safe from the workplace to anyplace. Under the leadership of President and CEO Lorraine Martin, NSC has grown to over 13,000 member companies and is a valuable source of news and information, practical resources, training, and networking opportunities. For more information, please visit https://www.nsc.org.

Executive Summary

A safety crisis on American roadways has been developing for decades, fueled by an appetite for larger, heavier vehicles. The market landscape for automobiles in 2024 would be unrecognizable to a time traveler from just 30 years earlier: The sedans and wagons that once dominated U.S. roads have nearly vanished, replaced by sport utility vehicles (SUVs), pickups, and vans that account for about 75 percent of vehicles produced today.[1] Although these light trucks have existed for decades, their footprints have been steadily increasing in size.[2] Their weight, poor visibility from the driver's seat, and high, flat front ends prove far more lethal, especially to pedestrians, than smaller passengers cars.

How did Americans come to believe that, on the road, bigger is better, even when some popular pickup trucks have a blind zone that can obscure the view of almost a dozen young children in front of the vehicle? How has regulation failed to protect road users from vehicles that, ironically, consumers buy with their own safety in mind? And – crucial to both understanding and addressing the problem – what exactly about these vehicles makes them so dangerous? It is not merely a hunch that the size of American vehicles puts the public in danger: Statistics and data clearly quantify their risks. This report represents, to the best of our knowledge, the first aggregation of academic and professional research around this topic.

Historic Consequences

The urgency for this work stems from the need to understand and address the rise in fatalities among people traveling outside of vehicles. 2022 was the deadliest year for pedestrians in the United States since 1981,[3] and the deadliest for bicyclists in the 47-year existence of the National Highway Transportation Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS).[4] These grave statistics represent the latest results of a decades-long trend in which vehicle occupants (drivers and passengers) comprise a smaller proportion of total motor vehicle fatalities, while the proportion of nonoccupants (those walking, rolling, biking, or otherwise moving outside of the vehicle) continues to grow, as illustrated by the chart below. Furthermore, data from as far back as the early 1990s show the risk of pedestrian death decreasing for collisions with

[1] United States Environmental Protection Agency. "The EPA 2022 Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology Since 1975." December 2022. EPA 420-R-22-029. https://www.epa.gov/system/files/documents/2022-12/420r22029.pdf

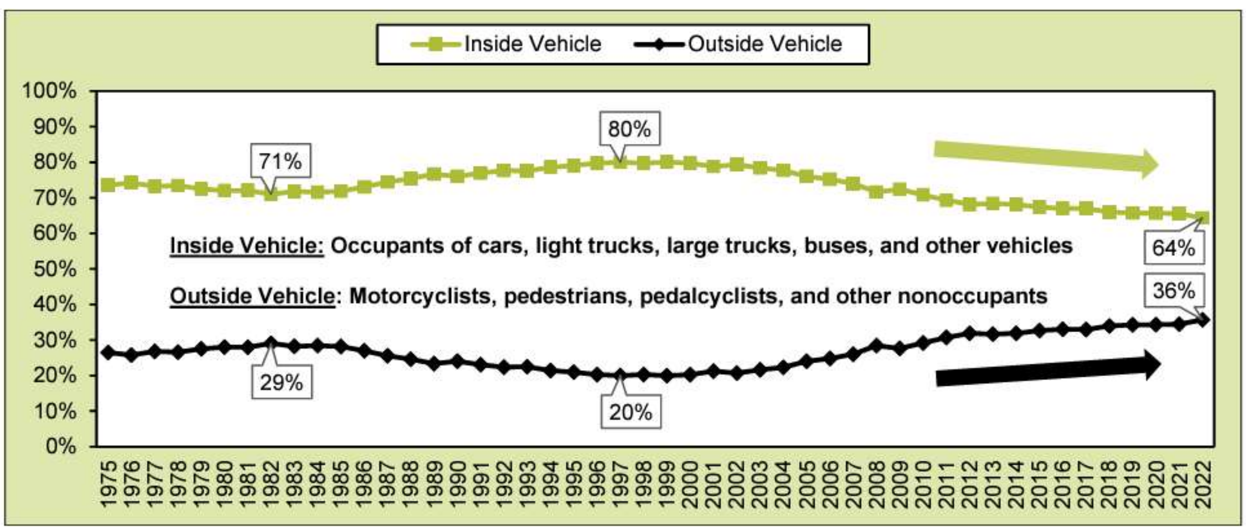
[2] Ibid.

[3] Governors Highway Safety Association (2023). Pedestrian Traffic Fatalities by States: 2022 Preliminary Data. https://www.ghsa.org/sites/default/files/2023-06/GHSA%20-%20Pedestrian%20Traffic%20Fatalities%20by%20State%2C%202022%20Preliminary%20Data%20%28January-December%29.pdf

[4] National Highway Traffic Safety Administration (2024). "Traffic Safety Facts Research Note: Overview of Motor Vehicle Traffic Crashes in 2024." https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813560

passenger cars and increasing for collisions with light trucks – SUVs, pickup trucks, and vans[5] – in a way that could not be explained only by changing market share of each vehicle type.[6] Certain features of these vehicles make them so deadly, and this report presents to the American public exactly what they are: Their **height and weight** relative to pedestrians, **crash incompatibility** with smaller cars, unique **front-end geometry and stiffness**, large **blind zones**, and the compounding impacts of **speed and acceleration.**

Proportion of Traffic Fatalities Inside/Outside Vehicles, 1975-2022



Source: FARS 1975-2021 Final File, 2022 ARF

Source: National Highway Traffic Safety Administration (NHTSA)

Unsafe By Design

Federal Motor Vehicle Safety Standards (FMVSS) and New Car Assessment Program (NCAP) crash testing are meant to ensure the safety of the public on America's roads, both inside and outside vehicles. Yet the research

[5] Terminology in this report generally follows NHTSA's regulatory definitions. Sedans, coupes, and station wagons are referred to as "cars," while pickup trucks, minivans, and full-sized vans are considered "light trucks." The classification of an SUV depends on specific attributes: Generally, two-wheel drive SUVs under 6,000 pounds gross vehicular weight will be classified as cars, while those with four-wheel drive *or* weight above 6,000 pounds will be classified as light trucks. However, in the NHTSA Fatality Analysis Reporting System (FARS) data, all "utility" vehicles are considered light trucks. Unless otherwise noted, our use of the term "SUV" refers to both types of SUV, considering them light trucks. Box trucks, minibuses, and other medium- or heavy-duty vehicles weighing over 10,000 pounds are not considered "light trucks."

[6] Lefler DE & Gabler HC (2004). The fatality and injury risk of light truck impacts with pedestrians in the United States. *Accident Analysis and Prevention* 36(2): 295-304. https://doi.org/10.1016/S0001-4575(03)00007-1

discussed in this report, along with fatality statistics, show that current protocols have thus far not adequately addressed several hazards of light trucks: How poor direct vision from the driver's seat increases the risk of a turning vehicle striking a pedestrian, how a vehicle's high hood height makes it more likely a struck pedestrian will die, or how people who continue to ride in sedans can be far more grievously injured if they collide with a pickup truck than with a car similar in size to their own. Manufacturers' choices to build vehicles with the safety problems outlined in this report, enabled by outdated incentives and tax policies, leave consumers feeling that they have no option but to keep up with the "arms race" and buy light trucks to protect themselves. In doing so, they continue a dangerous cycle, making the streets ever more lethal for those outside their cars. This is not merely a matter of consumer choice – it is also the influence of several decades of policy decisions that have failed to put safety first.

The Safe System Approach adopted by the United States Department of Transportation (USDOT) as the framework behind its National Roadway Safety Strategy (NRSS) recognizes that safer vehicles are essential for eliminating roadway deaths.[7] Under this approach, it is not enough to teach drivers to operate vehicles more responsibly; vehicles must be safer by design so that human errors do not have fatal consequences. However, this principle needs to be backed by more action to fulfill the commitments made in the NRSS, and the Safe System Approach needs to be recognized beyond federal government, utilizing what research tells us about vehicle size, weight, and direct vision. Without stronger government intervention, enhanced research and development, policy reform, and commitments to safety from manufacturers, the national safety crisis that claimed an estimated 40,990 lives on roadways in 2023[8] will prove difficult, if not impossible, to abate.

As will be discussed throughout this report, the increasing electrification of the U.S. vehicle fleet, and the associated increase in vehicle weights commensurate with battery packs that allow longer ranges between charges, add to the sense of urgency for understanding and addressing issues related to vehicle mass and size. Policies adopted during this time of transition can maximize the benefits of fleet transition to electric vehicles, such as the reduction in greenhouse gases, while ensuring that potential negative impacts for safety stemming from increased acceleration and EV battery weight are avoided.

[7] United States Department of Transportation (2022). "National Roadway Safety Strategy" https://www.transportation.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf

[8] United States Department of Transportation, National Highway Traffic Safety Administration. "Traffic Safety Facts: Early Estimate of Motor Vehicle Traffic Fatalities in 2023." April 2024. DOT HS 813 561 https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813561

A Problem We Can Fix

This report concludes with a set of actionable recommendations for federal, state, and local governments, as well as for private industry. All have a part to play in addressing this aspect of the road safety crisis in the United States. Although only the federal government can set mandatory standards for vehicle design and the protocols for crash testing, or close loopholes that incentivize the manufacture and purchase of light trucks, state and local governments can disincentivize the purchase of larger vehicles through the use of registration and parking fees, and lead by example through the types of vehicles they procure for government fleets. And by understanding that the different aspects of the Safe System Approach work in tandem, state and local governments can focus on best practices in street and speed management to mitigate some of the dangers that light trucks pose to other road users.

Attention and activity are already visible on this issue: In June 2024, following efforts by Congressman Jamie Raskin (D-MD), the Government Accountability Office (GAO) agreed to conduct a review of vehicle safety standards and their impacts on vulnerable road users.[9] Then, in August 2024, shortly before this report's publication, Representative Mary Gay Scanlon (D-PA) introduced legislation focused on pedestrian roadway fatalities and light truck design.[10] Some in-vehicle safety technologies, including Intelligent Speed Assistance (ISA) and Pedestrian Automatic Emergency Braking (PAEB), have already been deployed at scales large enough to prove their efficacy; however, without wider adoption, their full lifesaving benefits will go unrealized. Other solutions, such as designing narrower A-pillars to improve a driver's direct vision or optimizing the frames of electric vehicles to both protect their batteries from fire and minimize damage to other vehicle occupants in a crash, require more research and development. With this report, the Road to Zero Coalition aims to both present a thorough accounting of the problems and inspire solutions.

[9] See https://raskin.house.gov/2024/6/rep-raskin-celebrates-gao-decision-to-review-u-s-vehicle-safety-design-standards-during-roadway-safety-week
[10] See https://scanlon.house.gov/uploadedfiles/one_pager_pedestrian_protection_act.pdf

Report Structure

This report begins with a discussion of the Safe System Approach – the framework adopted internationally as the standard for holistically addressing death and serious injuries on roadways. A focus on vehicle mass, size, and vision fits within that framework as a means to creating safer vehicles by design. Next, the historical background leading to the current situation and more recent trends in vehicle sales will be described in detail before we delve into specific areas of research concerning vulnerable road users, vehicle-to-vehicle crash compatibility, vehicle front-end geometry and stiffness, blind zones, and speed and acceleration. Recognizing that regulatory and design changes to motor vehicles can take years to develop, enforce, and permeate throughout the consumer market, and that safer roads must accompany safer vehicles in a Safe System Approach, we include a section on countermeasures in street redesign that may in part improve safety outcomes in the interim. Finally, we present recommendations for action at the federal, state, and local government levels, and well as for private industry.

Disclaimer

To better understand the safety issues related to vehicle mass, size, and vision, the Road to Zero Coalition Steering Group organized a task force comprising researchers, advocates, industry representatives, and safety professionals. The people and organizations that contributed to this report represent a wide variety of perspectives and focus areas within the realm of mobility safety. Although this team worked collaboratively and with the singular goal of preventing death and serious injury on U.S. streets and roads, the viewpoints and recommendations expressed here do not represent those of every involved individual or organization, or of all members of the Road to Zero Coalition.

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Contents

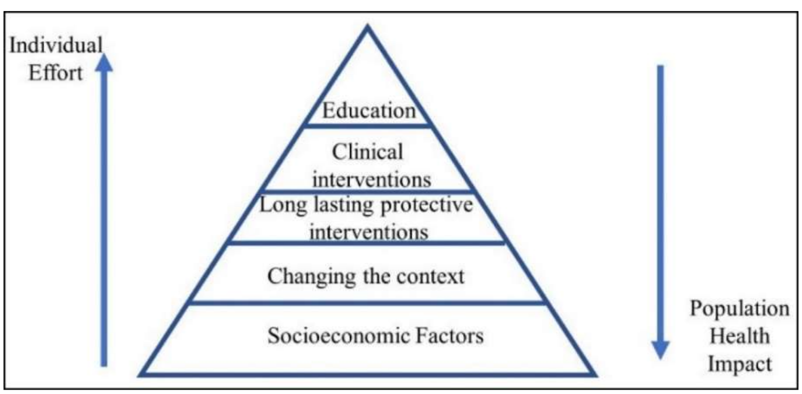
The Role of Vehicle Mass, Size, and Vision within a Safe System

Supporting implementation of the Safe System Approach is a primary focus of the Road to Zero Coalition and one of the three pillars identified in the Coalition's original visioning document, *The Road to Zero: A Vision for Achieving Zero Roadway Deaths by 2050*.[11] The Safe System Approach acknowledges the following principles:

- Death and Serious Injuries are Unacceptable
- Humans Make Mistakes
- Humans are Vulnerable
- Responsibility is Shared
- Safety is Proactive
- Redundancy is Crucial

Source: USDOT

This report places special emphasis on the interplay between these Safe System Approach principles and how issues related to vehicle design characteristics such as vehicle blind zones and front-end geometry may exacerbate safety issues related to speed, roadway design, post-crash care, and road user behavior. The report was also guided by the integration of public health and mobility safety frameworks conceptualized by Ederer et. al (2023) and others.[12] Recommendations place emphasis on actions that require the least dependence on individual efforts while delivering the greatest impact to safety for all road users.



Source: Ederer et. al (2023)

[11] https://www.nsc.org/roadtozero

[12] Ederer DJ, Panik RT, Botchwey N & Watkins K (2023). The Safe Systems Pyramid: A new framework for traffic safety. *Transportation Research Interdisciplinary Perspectives*, 21, https://doi.org/10.1016/j.trip.2023.100905.

Vehicle Mass, Size, and Vision Affect Mode and Vehicle Choice

The foundation for today's predominance of light trucks in the consumer marketplace was laid half a century ago, in a perhaps unexpected place – the oil crisis of 1973. After oil prices in the United States skyrocketed following an embargo by the Organization of the Petroleum Exporting Countries (OPEC), and American vehicle owners struggled with shortages of gasoline, the 1975 Energy Policy and Conservation Act established fuel efficiency standards at the federal level. The Corporate Average Fuel Economy standards, or CAFE, mandated that automobile manufacturers achieve certain fleet-wide average miles per gallon for cars and trucks, starting with the 1978 model year.[13] CAFE stipulated that within the decade following the enactment of the law, passenger vehicle fuel efficiency would need to reach 27.5 miles per gallon.[14] However, USDOT set a separate, lower standard for light trucks, which at the time were most often used by farmers and blue-collar workers who needed their cargo or off-road capabilities.[15] By 1990, light trucks needed to reach only 20 miles per gallon, while passenger cars were held to 27.5 miles per gallon.[16] Automakers, by switching their car models to a light truck chassis, could avoid having to meet stricter fuel economy standards and needing to invest in costly research and development efforts, and were arguably incentivized to shift toward producing SUVs rather than sedans.[17]

Likewise, the federal "Gas Guzzler Tax" enacted in 1978, a penalty levied on vehicle manufacturers or importers for vehicles that do not meet minimum fuel efficiency standards, never applied to vehicles classified as light trucks, only to passenger cars.[18] The rationale – that very few of these vehicles were available in 1978, and most were used for commercial purposes[19] – is clearly outdated. The Environmental Protection Agency's greenhouse gas emissions standards have also set weaker standards for larger vehicles.[20] The increase in light truck sales seen during the 1990s was largely attributed to the fuel economy and emissions standards for this class of vehicle,[21] and by 2002, more light trucks than cars were sold in the United States.[22] In 2007, the Energy Independence and Security Act raised mileage per gallon standards for both cars and light trucks for the first time in nearly two decades, but did not eliminate lower standards for larger vehicles.[23] Instead, they

[13] U.S. Department of Transportation. Corporate Average Fuel Economy (CAFE) Standards. https://www.transportation.gov/mission/sustainability/corporate-average-fuel-economy-cafe-standards
[14] Pew Charitable Trusts (2011). "The History of Fuel Economy in the U.S." https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2011/04/20/driving-to-545-mpg-the-history-of-fuel-economy
[15] Aronoff K. "The Truck-Sized Loophole in the EPA's Car Emissions Rule." *The New Republic*, April 1, 2024.
[16] United States Department of Energy Alternative Fuels Data Center. Vehicle Fuel Efficiency (CAFE) Requirements by Year. https://afdc.energy.gov/data/10562
[17] Gillingham KT and Weber SM (2021). Fuel Economy Standard: Impacts on Safety. *International Encyclopedia of Transportation* 296-303. https://doi.org/10.1016/B978-0-08-102671-7.10139-3
[18] Green DL et al (2005). Feebates, rebates and gas-guzzler taxes: a study of incentives for increased fuel economy. *Energy Policy* 33(6): 757-775. https://doi.org/10.1016/j.enpol.2003.10.003
[19] https://www.epa.gov/fueleconomy/gas-guzzler-tax
[20] Linn J (2023). "How Much Do Regulations for Fuel Economy and Emissions Incentivize the Production of Larger Vehicles?" University of Maryland Transportation Economics and Policy Blog. https://blog.umd.edu/transportation/2023/06/08/how-much-do-regulations-for-fuel-economy-and-emissions-incentivize-the-production-of-larger-vehicles/
[21] Pew (2011)
[22] United States Department of Transportation, Bureau of Transportation Statistics. "New and Used Passenger Car and Light Truck Sales and Leases" National Transportation Statistics Table 1-17, https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles
[23] Pew (2011)

became based on vehicle footprint rather than category.[24] By this time, the consumer cultural shift away from sedans had become entrenched.

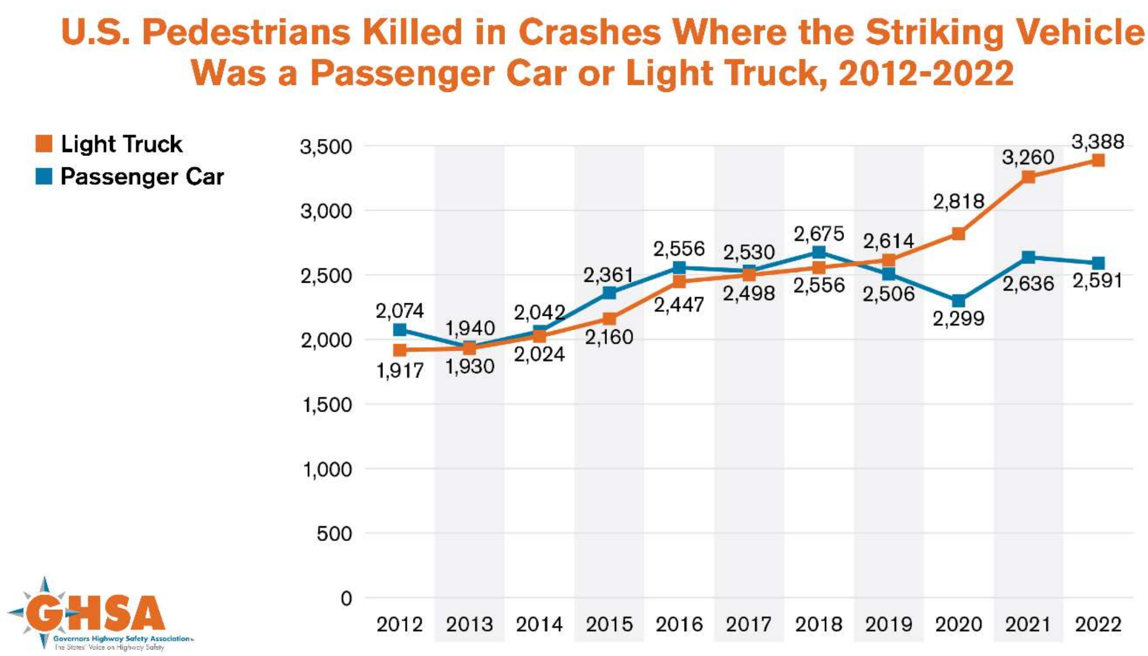
Tax policies also incentivize the purchase of bigger, heavier vehicles. Section 179 of the Internal Revenue Code allows business owners to write off the cost of vehicles weighing over 6,000 pounds that are used for business purposes. In tax year 2024, businesses will be able to deduct a maximum of $30,500 for an SUV under Section 179,[25] while a smaller car is limited to $12,200.[26]

The proliferation of large vehicles within the U.S. passenger vehicle fleet creates a feedback loop with profound safety implications. Nonmotorized travel is less likely to inflict injury (i.e., a person riding a bicycle or walking is less likely to kill or seriously injure another road user in a collision than someone driving a vehicle would in the same collision). However, the surge in market share of larger passenger vehicles, such as SUVs, minivans, and pickups, poses a direct threat to the safety of pedestrians and cyclists and may discourage people from choosing to travel on foot or on two wheels.[27] [28] The absence of people using active transportation modes can, in itself, lead to decreased safety for those walking, rolling, and bicycling.[29]

Furthermore, as larger vehicles gain a greater share of the consumer market, drivers of smaller cars may perceive that they would personally be safer if they, too, upsized their vehicle, creating a feedback loop or "arms race" that further increases demand for light trucks and leads to these vehicles becoming an even greater proportion of what is on the road. Li (2012) found that light trucks indeed improve safety for their occupants, albeit at the expense of the safety of other road users, and consumers are willing to pay a premium for the safety advantage of light trucks when compared to cars.[30] Winston and Yan (2020) found that traffic congestion encourages consumers to choose larger vehicles because of their perceived comfort and safety.[31] Overall, drivers looking to buy a vehicle largely make purchasing decisions out of concern for *their own* safety, but in doing so, they negatively impact safety for drivers of smaller vehicles and nonoccupants.[32]

[24] Gillingham KT and Weber SM (2021).
[25] Department of the Treasury, Internal Revenue Service (2024). Publication 946: How to Depreciate Property. https://www.irs.gov/pub/irs-pdf/p946.pdf
[26] Department of the Treasury, Internal Revenue Service. Publication 463: Travel, Gift, and Car Expenses. https://www.irs.gov/pub/irs-pdf/p463.pdf
[27] Soto GW et al (2022). Traffic as a barrier to walking safely in the United States: Perceived reasons and potential mitigation strategies. *Preventive Medicine Reports*. 2022 Sep 27;30:102003. doi: 10.1016/j.pmedr.2022.102003.
[28] Loukaitou-Sideris, A. (2006). Is it Safe to Walk? Neighborhood Safety and Security Considerations and Their Effects on Walking. *Journal of Planning Literature*, 20(3), 219-232. https://doi.org/10.1177/0885412205282770
[29] Jacobsen, PL. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention* 9:205-209. https://injuryprevention.bmj.com/content/9/3/205.info
[30] Li S (2012). Traffic safety and vehicle choice: Quantifying the effects of the "arms race" on American roads. *Journal of Applied Econometrics* 27: 34-62. https://doi.org/10.1002/jae.1161
[31] Winston, C and Yan, J (2021). Vehicle size choice and automobile externalities: A dynamic analysis. *Journal of Econometrics* 222(1A), 196-218. https://doi.org/10.1016/j.jeconom.2020.07.032.
[32] Thomas, JA, and Walton, DK (2008). Vehicle Size and Driver Perception of Safety. *International Journal of Sustainable Transportation* 2(4):260-273. DOI:10.1080/15568310701359015

White (2004) estimated that for every fatal crash averted by the occupants of an SUV or a pickup truck, at least 4.3 deaths of pedestrians, bicyclists, motorcyclists, or smaller vehicle occupants will occur.[33] Two decades later, the Economist Intelligence Unit (2024) analyzed 7.5 million two-vehicle crashes from 14 U.S. states and found even greater externalization of negative impacts: For every life saved in the heaviest 1% of light trucks, more than a dozen occupants of other vehicles will die.[34] The number of pedestrian deaths involving SUVs, pickup trucks, and vans rose about 77% between 2012 and 2022, while over the same period, the number of sales and leases of such vehicles rose by 50%.[35] This dynamic underscores the urgent need for comprehensive strategies within the Safe System Approach to address the complex interplay between vehicle size, safety, and transportation mode choices.

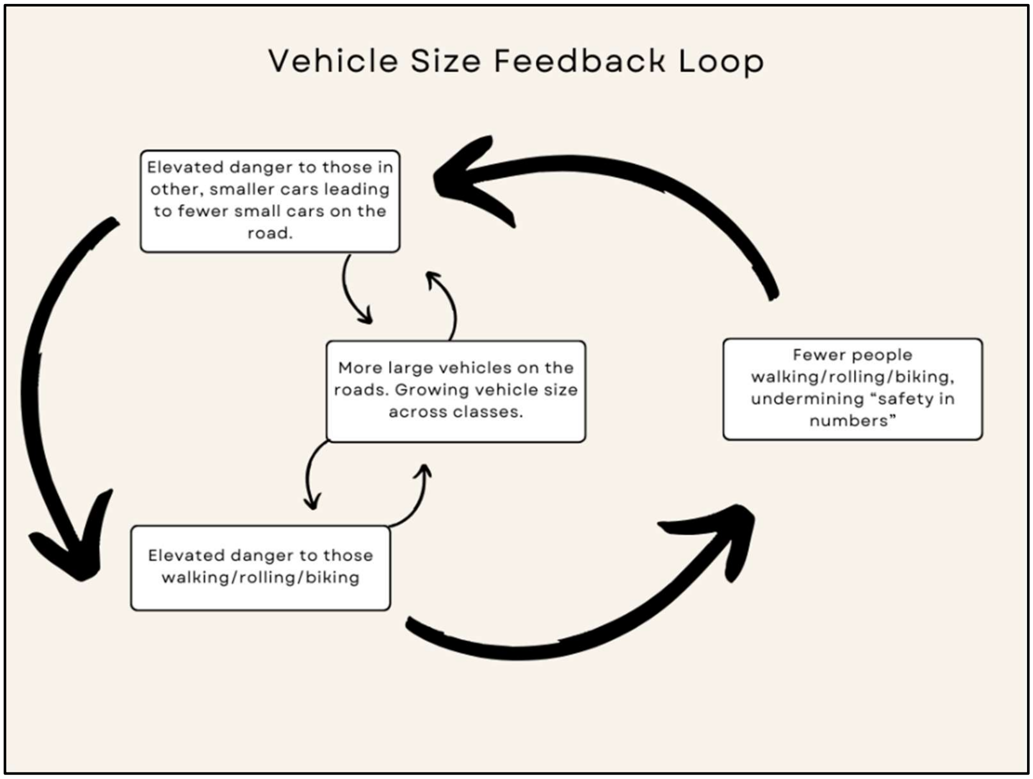


Source: Governors Highway Safety Association; data from NHTSA Fatality Analysis Reporting System (FARS)

[33] White M (2004). The "Arms Race" on American Roads: The Effect of Sport Utility Vehicles and Pickup Trucks on Traffic Safety. *Journal of Law and Economics* 47(2): 333-355. https://doi.org/10.1086/422979

[34] "Americans' Love Affair with Big Cars is Killing Them" *The Economist*, 31 August 2024.

[35] Governors Highway Safety Association (2024). *Spotlight on Highway Safety: Pedestrian Traffic Fatalities by State, 2023 Preliminary Data (January-December)*. https://www.ghsa.org/sites/default/files/2024-06/2023%20Pedestrian%20Traffic%20Fatalities%20by%20State.pdf



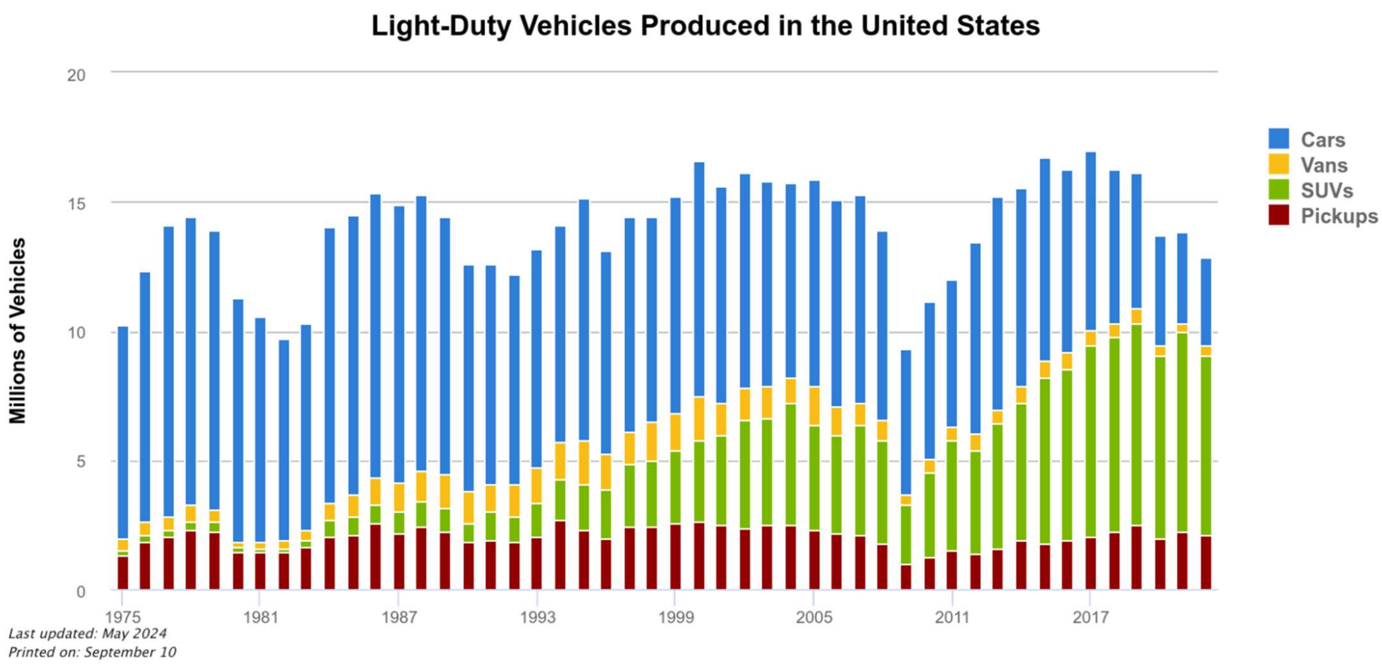
Trends in Vehicle Size and Mass

Market Share of Light Trucks

- In 2022, light trucks accounted for approximately 79% of total new passenger vehicle sales and leases in the United States.[36]
- The share of smaller vehicles, such as sedans and wagons, has seen a significant decline, dropping from 50% of new passenger vehicles sold or leased in 2012 to only 21% in 2022.[37]

[36] United States Department of Transportation, Bureau of Transportation Statistics. "New and Used Passenger Car and Light Truck Sales and Leases" National Transportation Statistics Table 1-17, https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles
[37] *Ibid.*

- In 1975, 4 in 5 light-duty vehicles produced in the United States were passenger cars (sedans and wagons). In 2020, nearly 3 in 4 vehicles produced were light trucks (vans, SUVs, or pickups).[38]



Source: U.S. Department of Energy[39]

Changes in Vehicle Characteristics:

- Average new vehicle weight and footprint are at record highs.[40] The overall average footprint – the product of wheelbase times average track width, or the area enclosed by all four wheels – increased by 6% between model year 2008, when the EPA began tracking data, and 2022. Increases in footprint correlate with increased weight, which in turn increases a vehicle's emissions. Average weight for sedans and wagons has declined by 11% since 1975, while average weight for pickups has increased by 29% over the same period, creating a gap between the heaviest and lightest vehicles of about 37% of average new vehicle weight.[41] In contrast, in 1975, this gap was only about 5%.

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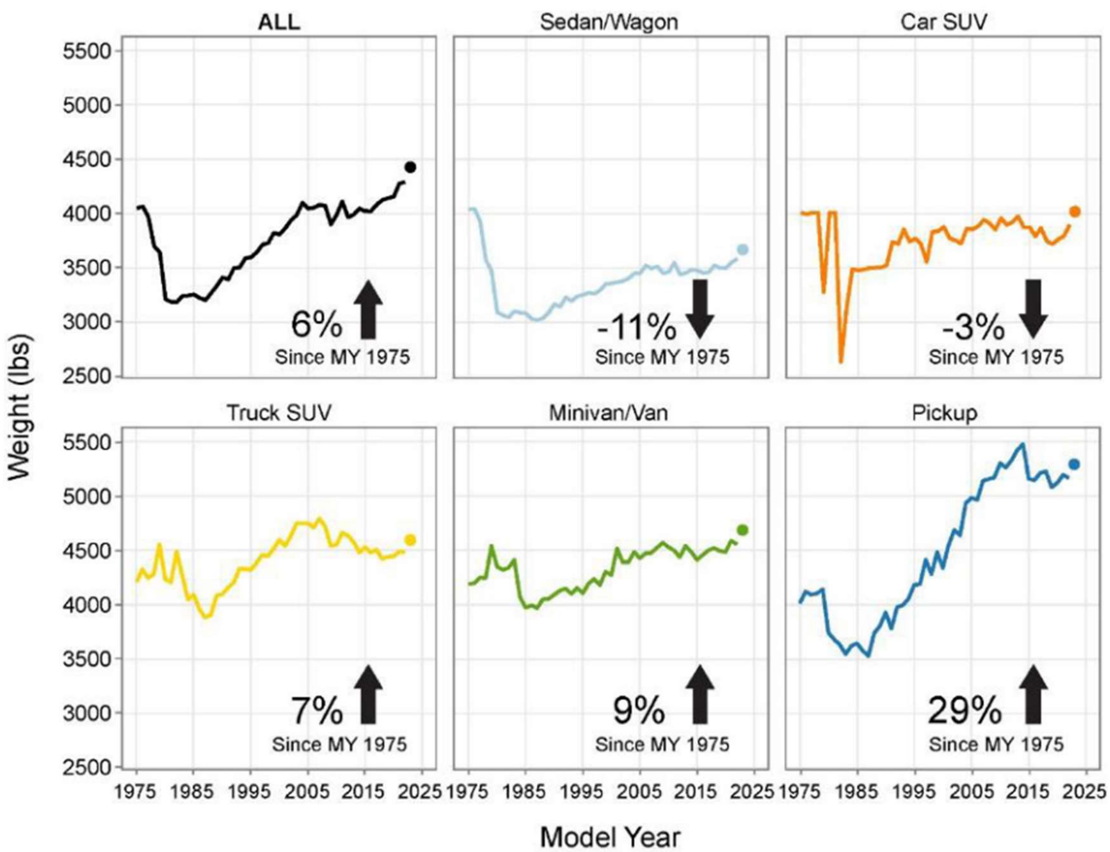
[38] United States Department of Energy, Alternative Fuels Data Center (2024). "Light Duty Vehicles Produced in the United States" https://afdc.energy.gov/data/10314
[39] Ibid.
[40] United States Environmental Protection Agency (2023). "The 2023 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975." https://www.epa.gov/system/files/documents/2023-12/420r23033.pdf
[41] Ibid.

Average New Vehicle Weight by Vehicle Type



Source: Environmental Protection Agency[42]

- According to the Insurance Institute for Highway Safety (IIHS), "Over the past 30 years, the average U.S. passenger vehicle has gotten about 4 inches wider, 10 inches longer, 8 inches taller and 1,000 pounds heavier."[43]

- The average hood height of passenger trucks increased by at least 11% between 2000 and 2021, and their average weight increased by 24% between 2000 and 2018, according to a Consumer Reports analysis of industry data.[44]

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[42] Ibid.
[43] https://www.iihs.org/news/detail/vehicles-with-higher-more-vertical-front-ends-pose-greater-risk-to-pedestrians
[44] https://www.consumerreports.org/car-safety/the-hidden-dangers-of-big-trucks/

- A 2023 YouGov survey of 1,116 American adults found that 41% of all respondents, and 39% of light truck drivers, believe light trucks have gotten too big. About 3 in 4 Americans who don't drive these vehicles, and about two-thirds of those who do, believe that there should be some form of regulation of the size and design of trucks for safety.[45]

- Electric vehicles (EVs), which typically weigh more than similar-class vehicles with internal combustion engines (ICEs) because of the added weight of batteries, are expected to continue growing their market share in the United States and around the world.[46] Light trucks that already weigh significantly more than sedans in their ICE models become even heavier with the addition of batteries that can sustain a long-range charge.[47] Not only is this increased weight a concern in collisions with other vehicles or vulnerable road users, it has implications for infrastructure as well: Guardrail-related crash tests performed by researchers at the University of Nebraska – Lincoln in 2023 on a Rivian R1T EV truck and a Tesla Model 3 sedan indicated that traditional guardrails may be insufficient in preventing run-off-road crashes for electric vehicles because of added weight and the associated 20-50% greater impact energy when compared to ICE vehicles.[48]

[45] https://business.yougov.com/content/48631-many-americans-think-that-suvs-and-trucks-have-become-too-large-and-should-be-regulated
[46] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/why-the-automotive-future-is-electric
[47] https://slate.com/technology/2022/08/electric-trucks-cars-too-heavy-inflation-reduction-act.html
[48] https://engineering.unl.edu/news/240131/mwrsf_evs_safety/

Death and Serious Injury Outcomes for Vulnerable Road Users

Research Takeaway #1: Death and serious injury outcomes are more likely for people walking, rolling, biking, and using other micromobility devices when the striking vehicle is a light truck compared with a sedan.

Vehicle size and weight have long been recognized as some of the primary determinants of injury severity in crashes involving pedestrians,[49] and several studies vividly illustrate this correlation. Research included in this section is focused on the relationship between larger passenger vehicles and increased likelihood of death and serious injury outcomes for struck pedestrians and cyclists. Although different studies have found different magnitudes of risk, their common conclusion is that when these large, heavy vehicles hit vulnerable road users, the latter tend to suffer more catastrophic injuries than they might have received if hit by the smaller vehicles that are increasingly rare on American roadways. Subsequent sections will delve into the design features that contribute to this greater lethality.

Research Summary

- Results from a meta-analysis of 12 independent injury data studies by Desapriya et. al (2010) showed that pedestrians are 50% more likely to die when struck by an SUV or pickup truck than when struck by a passenger car.[50]
- DiMaggio et al. (2006) found that school-age children (5 to 19 years old) struck by light trucks were more than twice as likely to die as those struck by passenger cars. The difference was even greater for the younger set (ages 5–9); their fatality risk is four times greater from SUVs and pickup trucks than from passenger cars.[51]
- An analysis of over 23,000 pedestrian and bicyclist crashes in Illinois by Edwards & Leonard (2022) indicated that "a child (under age 18) struck by an SUV was eight times more likely to be killed than a child struck by a passenger car … SUVs were the striking vehicle in greater than 40% of childhood fatalities, even though SUVs were involved in just 16.9% of childhood cases."[52] Across all age groups in the data, SUVs were involved in just under 15% of crashes with pedestrians and cyclists, but accounted for 25% of fatalities. Meanwhile, adults hit by pickup trucks were four times more likely to die than adults hit by passenger cars.

[49] Desapriya E. et al. (2010). 'Do light truck vehicles (LTV) impose greater risk of pedestrian injury than passenger cars? A meta-analysis and systematic review.' *Traffic Injury Prevention* 11,48–56. https://doi.org/10.1080/15389580903390623
[50] Ibid.
[51] DiMaggio C., Durkin M, & Richardson L (2006). The association of light trucks and vans with pediatric pedestrian fatality. *International Journal of Injury Control and Safety Promotion*, 13(2):95–99. https://doi.org/10.1080/17457300500310038
[52] Edwards, M and Leonard, D (2022). Effects of large vehicles on pedestrian and pedalcyclist injury severity. *Journal of Safety Research* 82: 275-282. https://doi.org/10.1016/j.jsr.2022.06.005

- After controlling for crash characteristics, Tyndall (2024) estimated that a pedestrian is 70% more likely to die if the involved vehicle is a pickup truck rather than a car, and death is twice as likely if the vehicle is a large SUV rather than a car.[53]

- Roudsari et al. (2004) found that, between 1994 and 1998, light trucks were three times as likely as smaller vehicles to cause severe pedestrian injuries in crashes, and twice as likely to kill.[54] Considering that this data set reflected a time when average weight and footprint of vehicles was smaller, the risk may have widened since the time this research was completed.

- The Vias Institute (2023) found that when a cyclist or pedestrian is hit by a pickup instead of a car, the risk of serious injury increases by 90% and the risk of death increases by almost 200%.[55]

- Tyndall (2021) examined crashes and vehicle registrations between 2000 and 2019, a period during which pedestrian fatalities rose 30% even as deaths among motor vehicle occupants declined. During this period, according to Federal Highway Administration (FHWA) data, the share of registered vehicles categorized as SUVs increased threefold, while the share of vehicles classified as cars fell by about a third.[56] Concluding that the increasing popularity of larger vehicles, and their associated body features, are partially responsible for the substantial increase in pedestrian fatalities, Tyndall estimated that, “If all light trucks were replaced with cars, over 8,000 pedestrian deaths would have been averted” in the first two decades of the 21st century.[57]

- Anderson (2008) found that the association between greater adoption of light trucks and increased danger to other road users is not a new phenomenon: Data from 1980-2004 suggest that for every percentage point increase in the share of total vehicles that are pickup trucks, SUVs, or vans, annual traffic fatalities increase by about 143 individuals, with approximately 4 in 5 victims being the occupants of other vehicles, pedestrians, or cyclists.[58]

- Buehler and Pucher (2021) recognized that from 2010 to 2018, pedestrian fatality rates in the United States were 5 to 10 times higher than those of many European countries.[59] While many factors are responsible for this gap, the greater prevalence of larger, more powerful vehicles in the United States was identified as a likely component.

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[53] Tyndall, J (2024). The effect of front-end vehicle height on pedestrian death risk. *Economics of Transportation* 37: 100342. https://doi.org/10.1016/j.ecotra.2024.100342.

[54] Roudsari BS et al. (2004). Pedestrian crashes: higher injury severity and mortality rate for light truck vehicles compared with passenger vehicles. *Injury Prevention* 10:154–158. https://doi.org/10.1136/ip.2003.003814

[55] Vias Institute. “Des voitures plus lourdes, plus hautes et plus puissantes pour une sécurité routière à deux vitesses?” 30 August 2023 https://www.vias.be/fr/newsroom/des-voitures-plus-lourdes-plus-hautes-et-plus-puissantes-pour-une-securite-routiere-a-deux-vitesses-/

[56] Tyndall J (2021). Pedestrian deaths and large vehicles. *Economics of Transportation*, 26-27: 100219. https://doi.org/10.1016/j.ecotra.2021.100219.

[57] Ibid.

[58] Anderson (2008). Safety for whom? The effects of light trucks on traffic fatalities. Journal of Health Economics 27(4): 973-989. https://doi.org/10.1016/j.jhealeco.2008.02.001

[59] Buehler R and Pucher J (2021). The growing gap in pedestrian and cyclist fatality rates between the United States and the United Kingdom, Germany, Denmark, and the Netherlands, 1990-2018. *Transport Reviews* 41(1); 48-72.

Outstanding Research Questions:

- By how much is the gap in vulnerable road user deaths between the United States and other developed countries explained by the size and weight of vehicles?

Vehicle Front-End Geometry and Stiffness

Research Takeaway #2:

SUVs, pickups, and vans are not simply scaled-up versions of sedans; they have specific design features that can prove deadlier to occupants of other vehicles as well as vulnerable road users. They tend to have higher bumpers and more boxy front ends than sedans, two features that are associated with higher rates of death and serious injury for those outside of vehicles.[60] Their more rigid frames absorb less energy during a crash, meaning more damage will occur to whatever person or object the larger vehicle hits.[61] This problem may be exacerbated by fleet electrification in the future.

Research Summary

- Several studies have shown that higher and more vertically oriented front ends have direct impact on crash injury outcomes for nonoccupants. Higher hoods have been shown to increase the frequency and severity of head, torso, thorax, and chest injuries and can force pedestrians forward, increasing the likelihood of being run over by drivers.[62], [63] Shorter, more sloped hoods and wider windshields are associated with reduced pedestrian injury severity.[64]

- Monfort and Mueller (2019) found that SUVs are more dangerous to bicyclists than sedans, in part because their high front ends and large size push cyclists down below the vehicle rather than onto the hood. They also found that SUVs are more likely to cause head injuries, involve ground impact, and cause more severe injuries, indicating that the size and shape of SUV front ends are responsible for the differences in bicyclist injury outcomes between the two vehicle types.[65]

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[60] Monfort SS, Hu W, and Mueller BC (2024). Vehicle front-end geometry and in-depth pedestrian injury outcomes. *Traffic Injury Prevention* 25(4): 631-639. https://doi.org/10.1080/15389588.2024.2332513

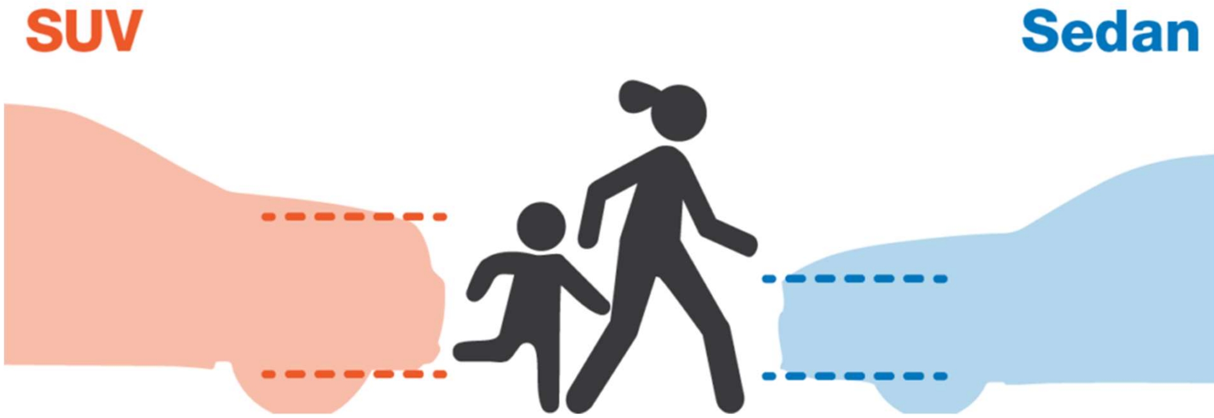
[61] Desapriya E. et al. (2010). Do light truck vehicles (LTV) impose greater risk of pedestrian injury than passenger cars? A meta-analysis and systematic review. *Traffic Injury Prevention*, 11,48–56. https://doi.org/10.1080/15389580903390623

[62] Crocetta G et al(2015). The influence of vehicle front-end design on pedestrian ground impact. *Accident Analysis & Prevention* 79: 56-69. https://doi.org/10.1016/j.aap.2015.03.009

[63] Hu W, Monfort SS, and Cicchino JB (2024). The association between passenger-vehicle front-end profiles and pedestrian injury severity in motor vehicle crashes. *Journal of Safety Research* 90: 115-127. https://doi.org/10.1016/j.jsr.2024.06.007

[64] Ibid.

[65] Monfort SS and Mueller BC (2023). Bicyclist crashes with cars and SUVs: injury severity and risk factors. *Traffic Injury Prevention* 24(7): 645-651. https://doi.org/10.1080/15389588.2023.2219795



Source: Smart Growth America[66]

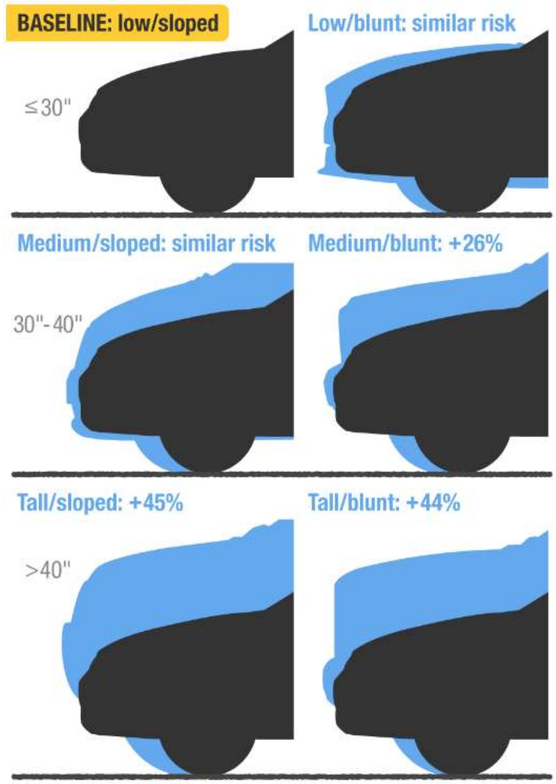
- Tyndall (2024) found that front-end height was one of the most important factors contributing to pedestrian death outcomes in a crash, with a 10 centimeter (about 4 inch) increase in front-end height elevating the overall risk of fatality by 22%. This risk is exacerbated for women and children: “While a 10 cm increase in front-end height raises male pedestrian death probability by 19%, it raises female pedestrian death probability by 31% … [and] it raises the probability a child pedestrian will die by 81%, roughly four times the effect among adults.”[67] In his estimation, enforcing a limit of 1.25 meters, or approximately 4 feet 1 inch, on the front-end height of vehicles could potentially reduce pedestrian deaths in the United States by 509 per year.

- Likewise, the Vias Institute (2023) in Belgium found that when a pedestrian or cyclist is hit by a vehicle with a front end 90 centimeters (about 35 inches) high, the risk of fatal injuries increases 30% compared to being hit by a front end just 10 cm (about 4 inches) lower.[68]

[66] Davis, Steve. “Bigger Vehicles are Directly Resulting in More Deaths of People Walking.” Smart Growth America. https://smartgrowthamerica.org/bigger-vehicles-are-directly-resulting-in-more-deaths-of-people-walking/ April 12, 2021.
[67] Tyndall, J (2024). The effect of front-end vehicle height on pedestrian death risk. *Economics of Transportation* 37: 100342. https://doi.org/10.1016/j.ecotra.2024.100342
[68] Vias Institute (2023).

- An IIHS study of nearly 18,000 crashes involving a single passenger vehicle and a single pedestrian in seven states indicated that regardless of front-end shape, vehicles with a leading edge over 40 inches in height are 45% more likely to cause fatalities than vehicles with a hood height of 30 inches or less and a sloping profile.[69] Pedestrians struck by these vehicles were more likely than those hit by smaller cars to suffer head and chest injuries, or to be thrown forward. Even among vehicles with front ends between 30 and 40 inches high, those with blunt, more vertical profiles were 26% more likely to cause pedestrian fatalities than lower and more sloped vehicles.

- Analysis of NHTSA Pedestrian Crash Data Study records (Roudsari et al. 2007) showed that in 93% of crashes between light truck-type vehicles and child pedestrians, the child was thrown forward or knocked down, compared with 46% of crashes involving child pedestrians struck by cars. This contact with the ground was responsible for the majority of facial, abdominal, and arm injuries, and for all of the spinal injuries in crashes with light trucks.[70] Front-end geometry and stiffness were cited as factors influencing these injuries.

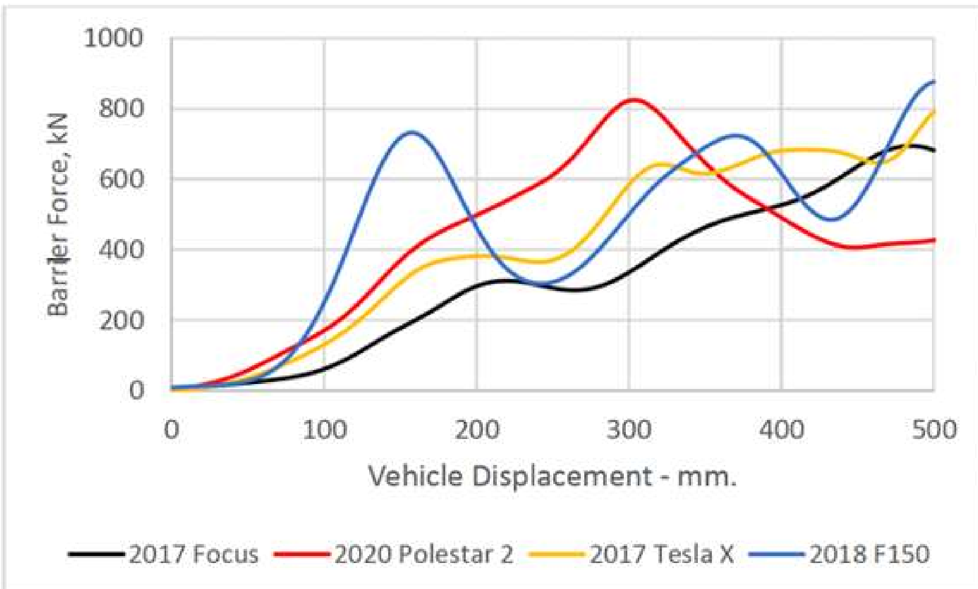


Source: Insurance Institute for Highway Safety[71]

- Monfort and Nolan (2019) and Baker et al. (2008) found that a "vertical misalignment between energy-absorbing structures"[72] caused by differences between front-end height and curb weight between vehicles can produce crashes in which "one or both vehicles fail to engage their primary energy-absorbing structures."[73] In other words, the design differences and gap in size between smaller and larger passenger vehicles can lead to significant injuries for vehicle occupants in a crash.

[69] Hu W, Monfort SS, and Cicchino JB (2024). The association between passenger-vehicle front-end profiles and pedestrian injury severity in motor vehicle crashes. *Journal of Safety Research* 90: 115-127. https://doi.org/10.1016/j.jsr.2024.06.007
[70] Roudsari BS, Mock CN, and Kaufman R (2007). An evaluation of the association between vehicle type and the source and severity of pedestrian injuries. *Traffic Injury Prevention* 6(2):185-192. https://doi.org/10.1080/15389580590931680
[71] https://www.iihs.org/news/detail/vehicles-with-higher-more-vertical-front-ends-pose-greater-risk-to-pedestrians
[72] Baker BC et al (2008). Crash compatibility between cars and light trucks: Benefits of lowering front-end energy-absorbing structure in SUVs and pickups. *Accident Analysis and Prevention* 40: 116-25. https://doi.org/10.1016/j.aap.2007.04.008
[73] Monfort SS and Nolan JM (2019). Trends in aggressivity and driver risk for cars, SUVs, and pickups: Vehicle incompatibility from 1989 to 2016, *Traffic Injury Prevention* 20:sup1, S92-S96, https://doi.org/10.1080/15389588.2019.1632442

Comparative Front-End Stiffness



Source: Digges et al. 2023[74]

This graph shows how much frontal crush four different vehicles will experience in a crash, and, by extension, how much damage they may do to each other. At a barrier force of about 800 kilonewtons, representing a major crash impact, the Polestar 2, an electric vehicle, will have about 300 mm (one foot) of its front end crushed, whereas the Tesla Model X EV and the F-150 ICE pickup truck will have about 500 mm of front-end crush damage. The smallest, lightest vehicle, meanwhile – the non-electric Focus – will sustain more than 500 mm of crush.[75] The greater the front-end crush a vehicle sustains, the more likelihood of intrusion into the passenger compartment, and the greater the risk of injury to people riding inside it. The net effect will be that in a head-on collision with other vehicles, the Polestar 2 will significantly damage the other vehicles. In other words, the energy absorbed in the first 300 mm of front-end crush (the area under the curve) is higher for the Polestar 2 than for the other vehicles. The heavy weight and high stiffness of the Polestar 2 will result in self-protection of its own occupants at the expense of those it collides against. Furthermore, the advantage of the high stiffness may be protective for a vehicle's own occupants in two-vehicle collisions, but it may not be protective in relatively more-frequent lower-velocity impacts with similar vehicles or fixed objects. In these types of crashes, occupants will be exposed to higher inertial forces than in vehicles designed with less stiff front ends.

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[74] Digges K, Dalmotas D, and Prasad P (2023). "A NCAP Rating for Females." Proceedings of the 27th ESV Conference, Number 23-0323, April 2023. https://index.mirasmart.com/27esv/PDFfiles/27ESV-000323.pdf
[75] Ibid.

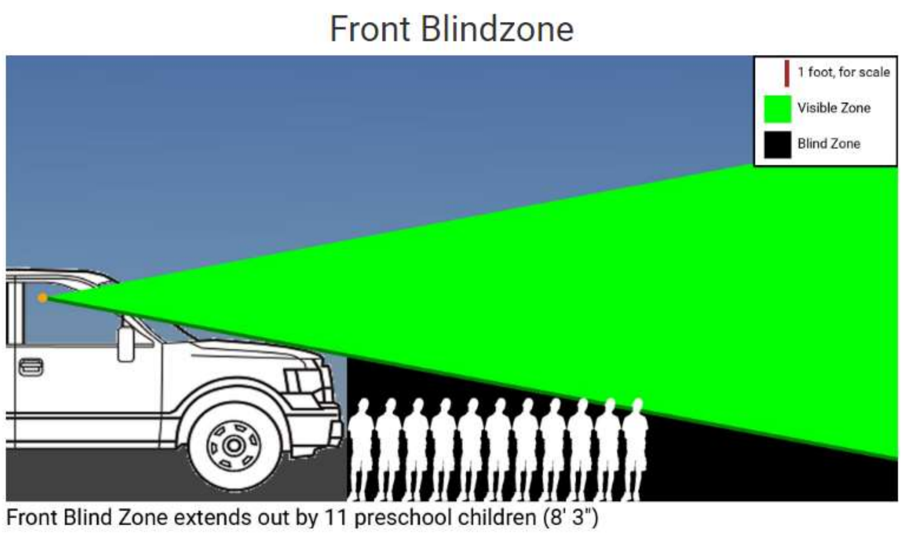
Outstanding Research Questions:

- What are the quantifiable impacts of recent changes to bumper stiffness on safety?
- How does an increase in electric vehicles in a fleet impact the safety of other road users?

Vehicle Blind Zones

Research Takeaway #3:

Light trucks often have blind zones that extend multiple feet beyond those of sedans. High hood height creates a large space in front of a vehicle in which children and smaller adults cannot be seen from the driver's seat. Wider A-pillars in light trucks, which support the greater weight of the vehicle, reduce pedestrian and bicyclist visibility at the left and right front corners of a driver's field of view, as do larger side mirrors. At or near intersections, large vehicles were more likely than passenger cars to be involved in fatal pedestrian crashes that involved a turn rather than going straight, possibly due to these blind zones.[76] Additionally, larger vehicles tend to have larger side and rear blind spots than passenger cars, limiting the driver's ability to see smaller vehicles sharing the road. Drivers cannot avoid what they cannot see, and while backup cameras have been required by law on all new cars since 2018, there is no required United States standard for forward vision from the driver's seat.[77] This is in contrast with UN regulations in place for more than 50 countries.[78] Only direct vision – a line of sight between the driver's own eyes and other road users – allows for eye contact and communication between drivers and those outside the vehicle.



Front blind zone for a light-duty pickup truck. Source: USDOT Volpe Center, Santos Family Foundation

[76] Hu W and Cicchino JB (2022). Relationship of pedestrian crash types and passenger vehicle types. *Journal of Safety Research* 82:392-401. https://doi.org/10.1016/j.jsr.2022.07.006

[77] Senator Richard Blumenthal (D-CT) previously introduced S.5080, the STOP Frontovers Act of 2022, which would have created a new FMVSS to require technology enabling drivers to detect objects in front of their vehicle. https://www.congress.gov/bill/117th-congress/senate-bill/5080

[78] This includes UN Regulations No. 125: Driver Forward Field of Vision; No. 166: Uniform Provisions Concerning the Approval of Devices and Motor Vehicles with Regard to the Driver's Awareness of Vulnerable Road Users in Close Proximity to the Front and Lateral Sides of Vehicles; and No. 167: Uniform Provisions Concerning the Approval of Motor Vehicles with Regard to Their Direct Vision

Research Summary:

- According to Consumer Reports, "Full-sized pickup trucks, which are the most popular models on the market, can have a blind zone 11 feet longer than a car, and 7 feet longer than an SUV."[79]

- In 2021, 82% of child pedestrian fatalities and 78% of child bicyclist fatalities in single-vehicle crashes involved being struck by the front of the vehicle, according to NHTSA.[80]

- NHTSA does not record deaths that occur in parking lots and private lands in FARS[81], but the agency does report these non-roadway deaths separately. In 2021, the most recent year of data available, 543 people outside of vehicles were killed by forward-moving vehicles and 13,643 were injured.[82] Many of these casualties were frontover collisions, which are often linked to blind zones. According to advocacy group Kids and Car Safety, 75% of frontover fatalities involve vans, trucks, or SUVs, which often have high front hoods that block a driver's view of smaller people on the road.[83] [84] Children's smaller size makes them particularly vulnerable to this kind of crash, and frontover deaths of children aged 14 and under have increased from an average of fewer than 10 annually between 1990-2004 to an average of more than 40 per year between 2005-2020.[85]

- Ogawa et al (2013) proposed that larger and thicker A-pillars, designed to prevent rollover crashes for higher vehicles, make it more difficult for drivers to see pedestrians during turning movements and may lead to increased pedestrian fatalities.[86]

- Hu and Cicchino (2022) found that, looking at crashes at intersections in which a crossing pedestrian was killed, the odds that the crash involved a left turn by the vehicle versus no turn were about twice as high for SUVs, almost 3 times as high for vans, and almost 4 times as high for pickups as they were for cars. For right turns versus no turn, those odds were 89% higher for pickups and 63% higher for SUVs than for cars.[87] Between 2014-18, these kinds of turning crashes accounted for more than 900 of about 5,800 fatal pedestrian crashes at or near intersections.[88]

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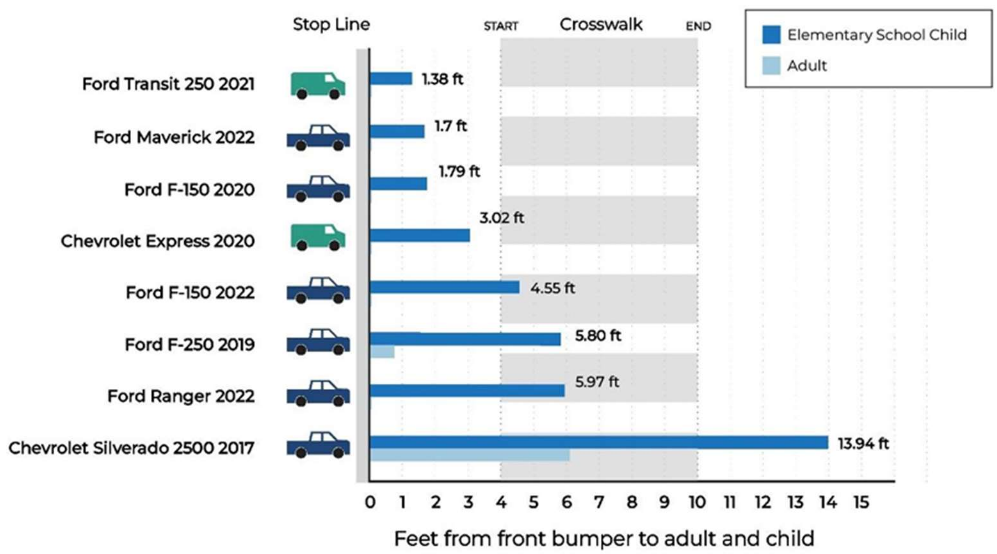
[79] https://www.consumerreports.org/car-safety/the-hidden-dangers-of-big-trucks/
[80] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813456
[81] https://injuryfacts.nsc.org/motor-vehicle/overview/comparison-of-nsc-and-nhtsa-estimates/#:~:text=NSC%20uses%20NCHS%20death%20certificate,Analysis%20Reporting%20System%20(FARS).
[82] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813539.pdf
[83] https://www.wthr.com/article/news/investigations/13-investigates/13-investigates-millions-vehicles-have-unexpected-dangerous-front-blind-zone/531-9521c471-3bc1-4b55-b860-3363f0954b3b
[84] http://www.kidsandcars.org/wp-content/uploads/2019/06/Frontover-Fact-Sheet.pdf
[85] Ibid.
[86] Ogawa S et al. Effect of Visibility and Pedestrian Protection Performance on Pedestrian Accidents. 23rd International Technical Conference on the Enhanced Safety of Vehicles (ESV), Seoul, South Korea, May 2013. https://researchmap.jp/ogawa-sh/published_papers/18131810/attachment_file.pdf
[87] Hu W and Cicchino JB (2022). Relationship of pedestrian crash types and passenger vehicle types. *Journal of Safety Research* 82:392-401. https://doi.org/10.1016/j.jsr.2022.07.006
[88] https://www.iihs.org/news/detail/suvs-other-large-vehicles-often-hit-pedestrians-while-turning

- A direct vision study by the Massachusetts Department of Transportation and the USDOT Volpe Center found that many recent models of light truck, when appropriately stopped at the stop bar before an intersection, would potentially leave drivers unable to see an elementary school-aged child in front of them in the marked crosswalk.[89]

Forward Distance at Which Adults and Children are First Visible to Drivers in Selected Vehicles



Source: Massachusetts Department of Transportation / USDOT Volpe Center

- Direct vision matters because reaction times are faster through windows than with mirrors or cameras: In a study of truck drivers in the United Kingdom, drivers responded to seeing a pedestrian twice as fast with direct vision (through windows) than indirect vision (through mirrors or cameras); in doubling the driver response time, indirect vision also doubled the distance traveled before the driver could take appropriate measures to avoid a crash relative to with direct vision.[90] Although these findings relate specifically to heavy-duty trucks and not to SUVs, vans, or pick-up trucks, it is notable and suggests that direct vision may be quantifiably safer than indirect vision with regard to vulnerable road users encountering any vehicle. It invites further research into the topic.

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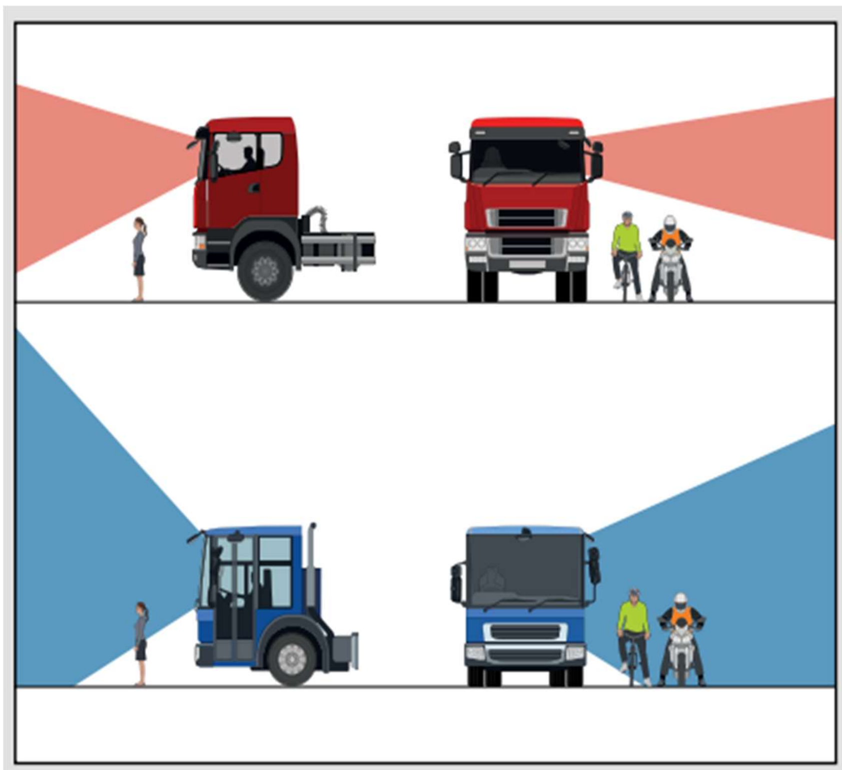
[89] Brodeur A et al. (2024). Commonwealth of Massachusetts Direct Vision Study: Current Fleet Analysis and Potential Safety Criteria. https://www.mass.gov/doc/commonwealth-of-massachusetts-direct-vision-study/download

[90] "Exploring the road safety benefits of direct vision" Transport for London, Arup & The University of Leeds PAC Lab. https://content.tfl.gov.uk/road-safety-benefits-of-direct-vs-indirect-vision-in-hgv-cabs-summary.pdf

- Side and rear blind spot detection warning systems are commercially available for new SUVs and pickup trucks, and a Consumer Reports national survey found that 82% of licensed drivers planning to buy or lease a new vehicle in the next 12 months thought it was important to have these systems, yet they are often provided only as part of add-on packages at additional cost.[91]

Depiction of Direct Vision in a Heavy-Duty Vehicle



Source: Transport for London[92]

Note: Images depict left-hand side driving on UK roads

[91] https://www.consumerreports.org/cars/car-safety/consumers-may-pay-thousands-more-for-life-saving-feature-cr-a8886263392/?srsltid=AfmBOoouyyS8ctTFT6Udo6d_64vWKl06ouOwIY7opCpzmzbKsXLSLEdE

[92] Transport for London. "Direct Vision: Working Towards the Direct Vision Standard for London's Heavy Goods Vehicles." https://content.tfl.gov.uk/working-towards-direct-vision-hgvs.pdf

Outstanding Research Questions:

- How effective are heads-up displays and other augmented reality in-vehicle display technologies when compared to direct vision?
- For drivers of light trucks, what are the differences in response times when a pedestrian is seen directly versus indirectly?
- In electric vehicles with no front engine block, what opportunities are there to redesign front ends to improve direct vision?

Vehicle-to-Vehicle Crash Compatibility Between Cars and Light Trucks

Research Takeaway #4

Pedestrians are not the only ones who are in greater danger from light trucks. While strides have been made over the years in reducing deaths in crashes between cars and some light trucks, size and weight differentials between cars and pickups in particular continue to persist, presenting significant safety concerns to occupants of smaller vehicles as the share of pickups in the U.S. passenger vehicle fleet continues to rise. The term “crash compatibility” refers to whether the vehicles involved in a collision will inflict similar severity of damage on each other; factors influencing compatibility include differences in weight, vehicle frame height, and stiffness.[93] In head-on crashes, the front ends of the colliding vehicles must effectively transfer energy throughout the structure of the vehicle so that crash forces do not injure the people traveling within them, and stiffness is one factor influencing how this energy is absorbed.[94] With large differences in size or design features, the occupants of smaller, lighter vehicles may be at greater risk of injury or death, and may join the “arms race” by buying a larger vehicle themselves, with all the negative externalities that greater light truck mode share brings to pedestrians and cyclists.

Research Summary

- The Enhancing Vehicle-to-Vehicle Crash Compatibility Agreement (EVC) was established in 2003 as a voluntary measure among automakers that standardized the height of energy-absorbing structures, such as bumpers, across all vehicles. Baker et al. (2008) and Greenwell (2012) separately examined the effectiveness of the EVC on crash compatibility between cars and light trucks. Both studies indicated a significant reduction in risk of death for a car driver when the colliding SUV’s energy-absorbing structures were placed at a lower level – in other words, when the vehicle front ends were compatible.[95] However, Greenwell did *not* find a fatality reduction in the case of crashes between pickups and cars, indicating that other factors are significant and influential.

- Monfort and Nolan (2019) confirmed the importance of vehicle-to-vehicle compatibility, showing that the fatality rate for car drivers in crashes with 1- to 4-year-old SUVs from 2013 to 2016 was 28% higher than the fatality rate for car drivers in crashes with other cars, compared to being 132% higher in 1989-92. The same study showed that incompatibility between pickups and cars persists, noting that the fatality rate for car drivers in crashes with 1- to 4-year-old pickups from 2013 to 2016 was 159% higher compared with crashes between two cars,

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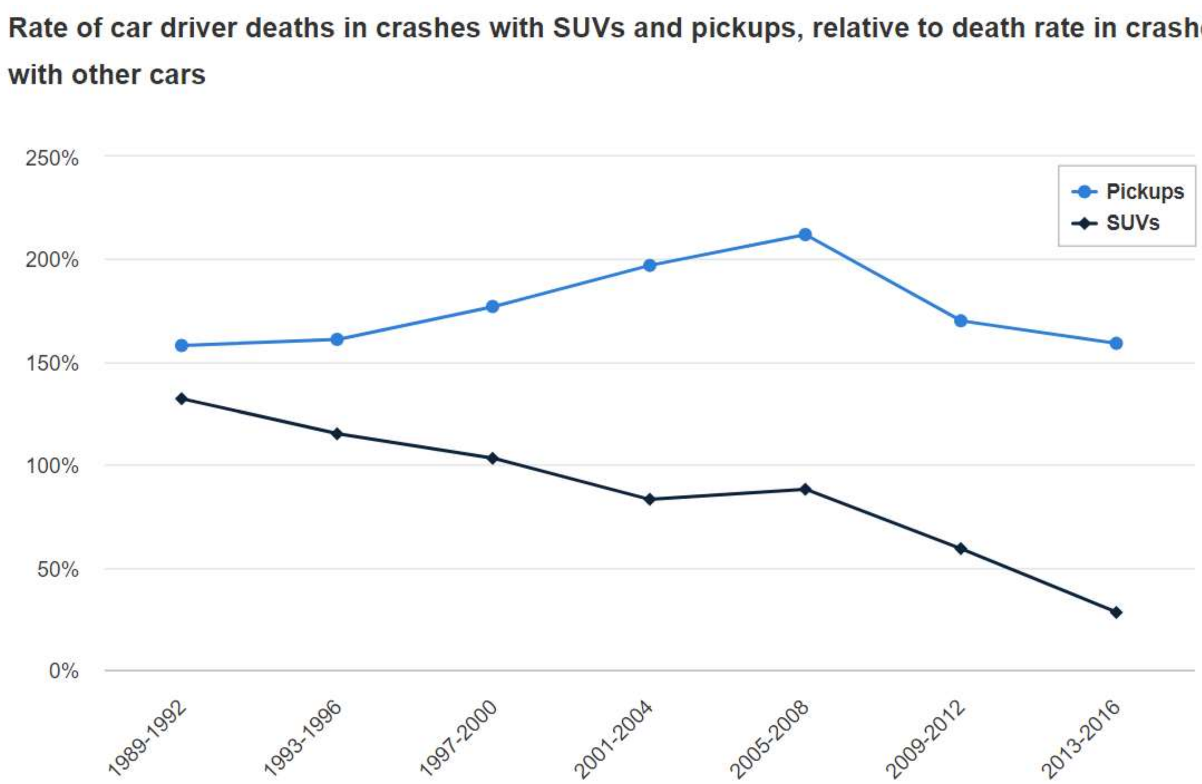
[93] Acierno et al. (2004). Vehicle mismatch: injury patterns and severity. *Accident Analysis and Prevention* 36(5): 761-772. https://doi.org/10.1016/j.aap.2003.07.001
[94] Wiacek C et al. (2015). Evaluation of frontal crash stiffness measures from the U.S. New Car Assessment Program. In Proceedings of the 24th International Technical Conference on the Enhanced Safety of Vehicles. June 2015, Gothenburg, Sweden. National Highway Traffic Safety Administration Paper No. 15-0257.
[95] Baker BC et al. (2008). Crash compatibility between cars and light trucks: Benefits of lowering front-end energy-absorbing structure in SUVs and pickups. *Accident Analysis and Prevention*, 40:116-125. https://doi.org/10.1016/j.aap.2007.04.008
Greenwell NK (2012). Evaluation of the Enhancing Vehicle-to-Vehicle Crash Compatibility Agreement: Effectiveness of the primary and secondary energy-absorbing structures on pickup trucks and SUVs. (Report No. DOT HS 811 621). Washington, DC: National Highway Traffic Safety Administration.

essentially unchanged from the 158% seen in 1989-92.[96] This study theorized that vehicle weight was a primary factor contributing to incompatibility. Lighter pickups and SUVs (weighing between 3,500 and 4,000 pounds) proved less deadly for car drivers compared with their heavier counterparts.[97]



Source: Insurance Institute for Highway Safety[98]

- In an analysis of crashes between cars and light trucks in the Seattle area, Acierno et al. (2004) found that side-impact collisions frequently caused head and upper thorax injuries to the occupants of the smaller vehicle because of the high position of the light truck's bumper.[99] In head-on collisions, those bumpers caused injuries to the car occupants by displacing the instrument panel and steering column. The occupants of the light trucks did not always emerge unscathed, because the underride of the smaller car could cause severe leg fractures. However, because crash injuries to the head, thorax, or abdomen are more likely than injuries to other parts of the body to cause severe

[96] Monfort SS and Nolan JM (2019). Trends in aggressivity and driver risk for cars, SUVs, and pickups: Vehicle incompatibility from 1989 to 2016. *Traffic Injury Prevention*, 20:sup1, S92-S96. https://doi.org/10.1080/15389588.2019.1632442
[97] Ibid.
[98] https://www.iihs.org/news/detail/suvs-no-longer-pose-outsize-risk-to-car-occupants-but-pickup-compatibility-lags
[99] Acierno et al. (2004). Vehicle mismatch: injury patterns and severity. *Accident Analysis and Prevention* 36(5): 761-772. https://doi.org/10.1016/j.aap.2003.07.001

injuries or death, and because head and neck injuries caused by the steering wheel can be particularly severe,[100] occupants of a smaller vehicle are still at a disadvantage in a collision with a light truck.

- Anderson and Auffhammer (2011) estimated that, controlling for one's own vehicle weight, being hit by a vehicle that weighs 1,000 pounds more can lead to a 47% increase in the risk of death to an occupant of the smaller vehicle, and the risk is even higher if the other vehicle is a light truck, independent of its weight.[101]

- Emphasis on performance aspects of electric vehicles, such as battery range and acceleration rates, requires larger, heavier batteries, especially for SUVs and pickups, adding considerable weight to already heavy vehicles.[102] Previous research related to crash compatibility between light trucks and cars may be unable to account for today's unprecedented weight differentials (nearly 7,000 pounds between the 2023 GMC Hummer EV light truck and 2024 Mitsubishi Mirage compact sedan), necessitating new crash-testing protocols and safety standards.

- Specifically, while EVs do not need to reserve space at the front of the vehicle for an internal combustion engine, their batteries need to be protected in the event of a crash because of the risk of catastrophic fires that can result from damage to their cells. Placing the battery underneath the vehicle or floor or beneath rear passenger seats allows for the vehicle's own structure to be used as protection in a crash.[103] The vehicle frame, therefore, must be rigid in order to avoid impact to the battery. In a crash, this stiffness will transfer energy to whatever the EV strikes.

- Increased weight and stiffness associated with EVs may impact vehicle-to-vehicle compatibility during fleet transition while ICE vehicles and EVs share road space. Publicly available data on this issue is lacking in the United States. Although a recent IIHS examination of NCAP crash-testing data in which vehicles were driven into stationary objects found no evidence battery-electric vehicles are more aggressive in crashes than their internal combustion engine counterparts,[104] it is not yet known how this may translate to crashes between different types of vehicles or the injury risk to their occupants. EuroNCAP, the European crash-testing agency, indicated that heavier EVs may have compatibility issues that endanger other drivers.[105]

[100] Concepcion J et al. (2023). Analysis of Biomechanics of Motor Vehicle Collisions for Passenger Cars: Implications for Passenger Vehicle Safety and Future Car Design Innovations. *Journal of Surgical Research* 285: 243-251. https://doi.org/10.1016/j.jss.2022.08.042

[101] Anderson M and Auffhammer M (2011). "Pounds That Kill: The External Costs of Vehicle Weight." Working Paper 17170 for the National Bureau of Economic Research: http://www.nber.org/papers/w17170

[102] See: https://www.autoweek.com/news/a39449944/problem-with-ev-battery-weight/

[103] Arora S & Kapoor A (2018). Mechanical Design and Packaging of Battery Packs for Electric Vehicles, in G Pistoia & B Liaw (Eds.) *Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost*. Springer International Publishing AG

[104] Mueller BC et al. (2024). Comparison of frontal crash compatibility metrics between battery-electric and internal-combustion-engine passenger vehicles. *Traffic Injury Prevention* 25(5): 750-756. https://doi.org/10.1080/15389588.2024.2337126

[105] European Transport Safety Council. "EuroNCAP warns on increasing car size and weight" December 7, 2023. https://etsc.eu/euro-ncap-warns-on-increasing-car-size-and-weight/

Outstanding Research Questions:

- In crashes, how compatible are EVs with ICE vehicles of different sizes and weights?
- What measures can ensure safety for ICE vehicle drivers when hit by heavier EVs, while also protecting EV batteries from damage that can cause fires?

The Compounding Impacts of Speed and Acceleration

Research Takeaway #5:

Safety issues related to increases in weight and front-end height of average new vehicles may be compounded by speeding, a perennial problem on U.S. roads. The human body has a finite tolerance for force, as recognized by the Safe System Approach. Although the likelihood of an individual pedestrian or cyclist being injured or killed will be in part influenced by factors such as one's age, size, and physical condition, very few of these road users will emerge unharmed from a crash with *any* motor vehicle traveling at speeds over 45 mph.[106] However, at lower speeds more typically observed on arterial and local roadways, small differences in speed can mean the difference between life and death. Certain design features of light trucks may inadvertently encourage drivers to speed, while their size, weight, and stiffness increase the likelihood of pedestrian fatalities in a crash. Together, these factors are a deadly combination.

Research Summary:

- Rudin-Brown (2004) showed a direct relationship between vehicle seat height and a skewed perception of speed among drivers. The higher seating position in light trucks leads drivers to go faster than they would at lower eye heights. In simulations, they drove 4 mph faster at the seating level of an SUV compared to that of a compact car, and modeling indicates they may have perceived their speeds to be 10 mph slower at the higher seated position.[107] Only one-third of participants reported noticing they drove faster at a higher seating position.

- Tefft (2011) indicated that the risk of severe injury for a pedestrian struck by a light truck is approximately equal to being struck by a car traveling 6.3 mph faster, and risk of pedestrian death by light truck is equal to being hit by a car travelling 4.1 mph faster, based on crashes that occurred between 1994 and 1998 involving vehicles from model years 1989-1999.[108] It is likely that the results of this study if conducted today would indicate an even more acute relationship between speed and death risk, as Tefft's data set reflected a time when average weight and footprint of vehicles was smaller and the mix of cars and light trucks was much different than it is today.

- At lower speeds, horsepower and acceleration can combine with factors such as front-end geometry and weight to exacerbate safety issues for larger vehicles. Between 1975 and 2021, average horsepower of new vehicles

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[106] Tefft BC (2011). *Impact Speed and a Pedestrian's Risk of Severe Injury or Death* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety. https://aaafoundation.org/impact-speed-pedestrians-risk-severe-injury-death/
[107] Rudin-Brown CM (2004). Vehicle Height Affects Drivers' Speed Perception: Implications for Rollover Risk. *Transportation Research Record*, 1899(1): 84-89. https://doi.org/10.3141/1899-11
[108] Tefft BC (2011).

increased by 85%.[109] McCartt and Hu (2017) found that drivers of high-horsepower vehicles are more likely to exceed the speed limit, particularly by 10 mph or more, compared with drivers of less-powerful vehicles.[110] A 3-unit increase in horsepower per 100 pounds of vehicle weight, which is equivalent to an increase of 90 horsepower for a midsize 3,000-pound car, was associated with a 38% increase in the likelihood of a vehicle exceeding the speed limit by more than 10 mph, as well as a 2.2% increase in mean vehicle speed.[111]

- Acceleration speeds have also increased dramatically over time due to technological advancements in electric and turbocharged internal combustion engines, which can deliver torque more rapidly while maintaining tire traction. In 1979, the average rate of acceleration from 0 to 60mph for new cars was 15.5 seconds.[112] The 2024 GMC Hummer EV, weighing in at over 9,000 pounds, now has the ability to accelerate from 0 to 60mph in about 3 seconds,[113] rivaling the acceleration capabilities of some Formula 1 race cars.[114] There is no practical need for this level of ultra-fast acceleration in everyday vehicle use, and the large battery it requires in already-heavy EVs means greater weight, longer stopping time, and greater force exerted in a crash.[115]

Outstanding Research Questions:

- With today's most common models of light truck, what is the equivalent impact speed for a sedan to cause a similar injury to a pedestrian as a light truck?
- How many lives could be saved if light trucks all came equipped with active or passive Intelligent Speed Assistance (ISA)?
- How many lives could be saved if vehicle manufacturers were held to a minimum requirement for 0-60 mph acceleration time?

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[109] "The EPA 2022 Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology Since 1975." United States Environmental Protection Agency, December 2022. EPA 420-R-22-029. https://www.epa.gov/system/files/documents/2022-12/420r22029.pdf
[110] McCartt AT and Hu W (2017). Effects of vehicle power on passenger vehicle speeds. *Traffic Injury Prevention* 18(5): 500-507. https://doi.org/10.1080/15389588.2016.1241994
[111] Ibid.
[112] Hearne DR and Clark JE (1983). Acceleration Characteristics of Late-Model Automobiles. Transportation Research Record 909: 13-19. https://onlinepubs.trb.org/Onlinepubs/trr/1983/909/909-003.pdf
[113] https://www.edmunds.com/gmc/hummer-ev/2024/features-specs/
[114] Bhatnagar UR (2014). Formula 1 Race Care Performance Improvement by Optimization of the Aerodynamic Relationship Between the Front and Rear Wings. Available https://etda.libraries.psu.edu/files/final_submissions/9695
[115] https://www.fastcompany.com/91165821/how-fast-can-a-car-go-from-0-to-60-it-really-doesnt-matter

Countermeasures That Can't Wait

The prevalence of larger, heavier vehicles with poor direct vision paints a picture of roadway safety that can seem to have reached a point of no return. Just as it took several decades to reach the situation currently seen on America's roads, it will take many years of deliberate policymaking and societal choices to create safer vehicles. But even as light trucks continue to increase their share of vehicles on America's roadways, government entities can take measures to counteract some of the increased risk to other road users, with regard to both directly addressing vehicle size and mitigating their dangers.

Financially Disincentivizing Larger Vehicles:

- To reflect the negative externalities light trucks place on the human and natural environment, state motor vehicle registration agencies could choose to charge significantly higher registration fees to their drivers. While many states already charge somewhat higher registration amounts for heavier vehicles, they are not high enough to reflect the impacts of these vehicles or disincentivize their use. Since October 2023, Washington, D.C. has experimented with the most wide-ranging weight-based fee scale to date, creating a substantial difference between the lightest and heaviest passenger vehicles: Those weighing less than 3,500 pounds are charged a $72 fee, while fees for vehicles between 3,500 and 4,999 pounds are $175, those between 5,000 and 5,999 pounds are $250, and those 6,000 pounds or above are $500 – more than triple the previous rate.[116] Exceptions are made for EVs and vehicles that must be heavier in order to accommodate persons with disabilities. Although registration revenues are directed toward the District's General Fund,[117] the City of Chicago, for example, directs revenue from its escalating fee scale towards street repair and maintenance.[118]

- Under similar reasoning, localities may choose to set parking permit rates on a scale reflecting a vehicle's size or weight. In Montreal's Rosemont-La Petite-Patrie district, a residential parking permit for a vehicle weighing more than 1,850 kilograms, or 4,079 pounds, costs C$205 (about US$150), while owners of lighter cars pay C$115 (about US$85).[119] In the Plateau Mont-Royal district, owners of the heaviest vehicles pay even more: C$482.90 (about US$360), or twice the rate for smaller vehicles.

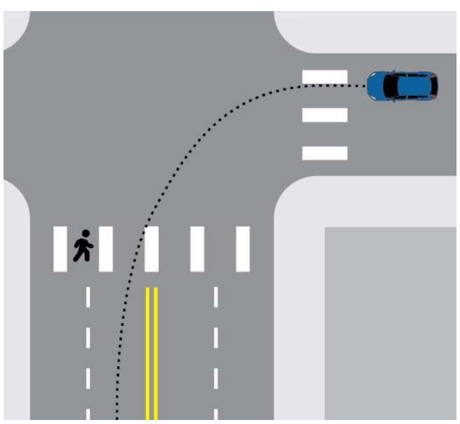
[116] https://dmv.dc.gov/node/155452
[117] Code of the District of Columbia § 50–1501.03. Fees classified and use of proceeds designated. https://code.dccouncil.gov/us/dc/council/code/sections/50-1501.03
[118] https://ezbuy.chicityclerk.com/general-pricing
[119] https://www.bloomberg.com/news/features/2024-05-15/in-montreal-suv-drivers-must-pay-hefty-new-fees-to-park

Roadway Design Improvements:

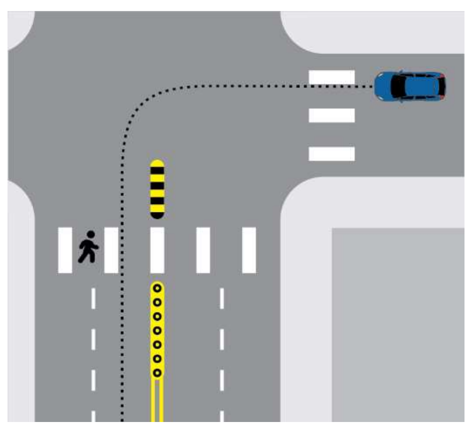
As previously mentioned, turns are of special concern for SUVs and pickup trucks because their blind zones can obscure a driver's view of a pedestrian. At an intersection, the wider the curb radius, the faster drivers tend to turn, and the longer the distance pedestrians have to travel to cross. This increases pedestrian vulnerability to crashes. Design changes that slow these turns and shorten pedestrian crossing distances can decrease the incidence of many of these crashes involving larger vehicles.

- One type of turn traffic-calming treatment is centerline hardening, which consists of installing rubber or plastic curbs and bollards along the center line at intersections (see graphics below). An analysis of centerline hardening treatments in Washington, D.C. by Hu and Cicchino (2020) revealed a "70.5% reduction in conflicts between left turning vehicles and pedestrians, a 9.8% reduction in mean left-turn speeds, and a 67.1% reduction in the odds of left turning vehicles exceeding 15 mph."[120] Another option, the slow turn wedge, involves using rubber speed bumps or plastic posts along with road markings to form squares or arcs on the inside corners of turns. This reduces pedestrian exposure and forces drivers to take the turn at closer to a 90-degree angle. An analysis in New York City (Viola et al. 2022) found that turn-calming treatments were particularly beneficial to older pedestrians, reducing deaths and serious injuries by 60% at locations where they were installed.[121]

Before Centerline Hardening



After Centerline Hardening



Source: Insurance Institute for Highway Safety[122]

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[120] Hu W and Cicchino JB (2020). The effects of left-turn traffic-calming treatments on conflicts and speeds in Washington, DC. *Journal of Safety Research* 75:233-240. https://doi.org/10.1016/j.jsr.2020.10.001

[121] Viola R et al. (2022). *New York City Senior Pedestrian Safety Study*. New York City Department of Transportation. https://www.nyc.gov/html/dot/downloads/pdf/pedestrian-safety-older-new-yorkers.pdf

[122] https://www.iihs.org/news/detail/simple-infrastructure-changes-make-left-turns-safer-for-pedestrians

Example of a slow turn wedge using plastic bumps and yellow paint

Source: New York City Department of Transportation[123]

- "Daylighting" is the practice of removing parking and other visual obstructions at crossing locations to increase visibility, which is of particular importance when pedestrians interact with vehicles that may block the driver's view of children and smaller adults trying to cross. FHWA recommends restricting parking within at least 20 feet of an intersection where speeds are 25 mph or less, and 30 feet where speeds are between 26 and 35mph.[124]

- Raised crosswalks, which are typically flush with the height of the sidewalk, can both improve pedestrian visibility to drivers and slow down traffic, potentially reducing pedestrian crashes by 45%.[125]

- Alternative design features such as widened sidewalks at intersections (also known as curb extensions or "bulb-outs") can have the dual impact of shortening crossing distances for pedestrians while also increasing visibility for those outside of the lane of travel.[126]

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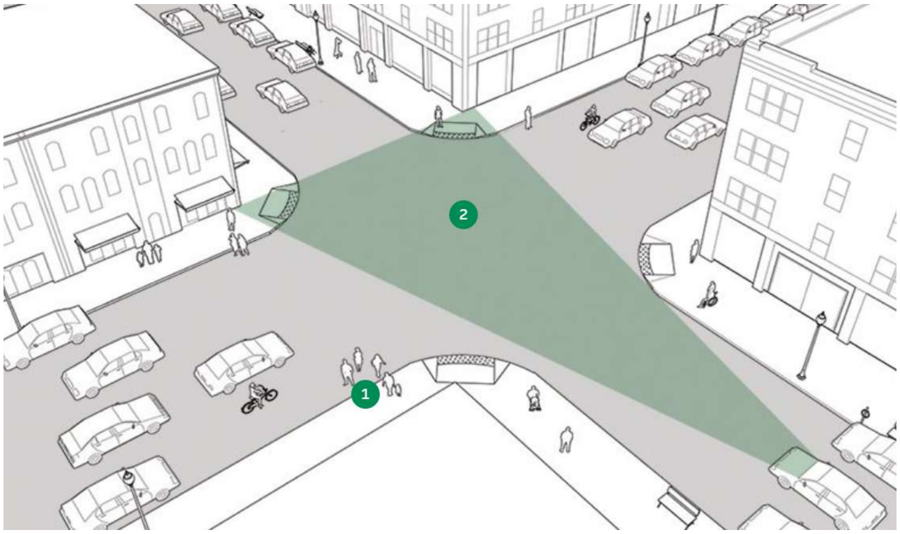
123 Viola et al (2022)

124 http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=9

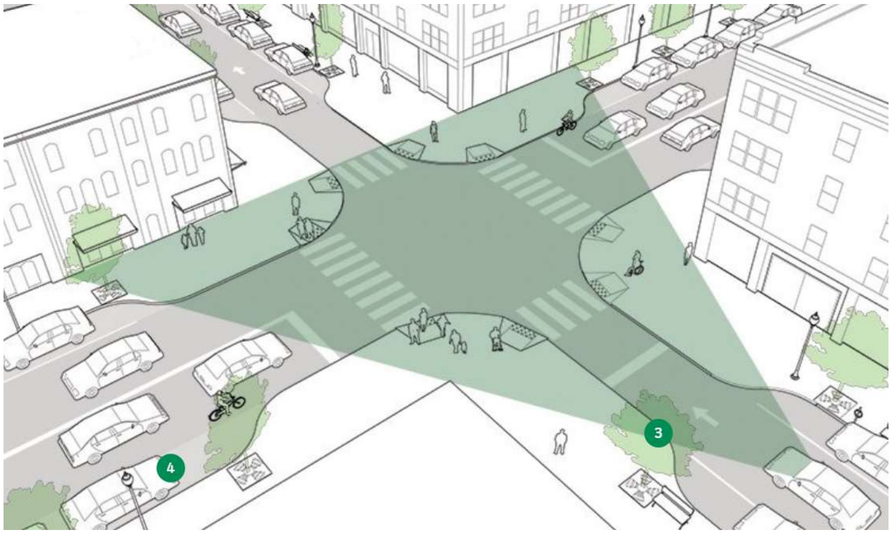
125 Federal Highway Administration. "Raised Crosswalk Countermeasure Tech Sheet" https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RaisedCW2018.pdf

126 National Association of City Transportation Officials. "Urban Street Design Guide" https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/visibility-sight-distance/

Before Bulb-Outs



After Bulb-Outs

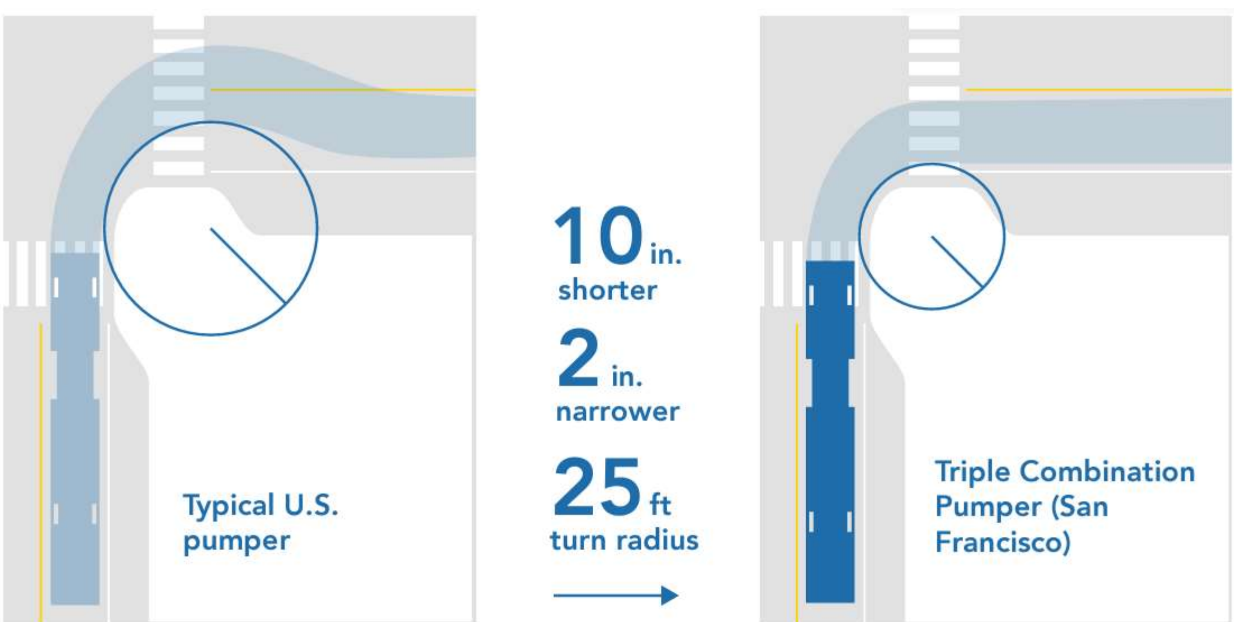


Source: National Association of City Transportation Officials (NACTO)[127]

127 Ibid.

- Leading pedestrian intervals, which allow pedestrians to enter a crosswalk before vehicles are given a green light, and before vehicles have priority to make turning movements, led to a 13% reduction in vehicle crashes at intersections, according to a 2018 FHWA study.[128] Allowing pedestrian movements to begin before those of motor vehicles can improve pedestrian visibility.

- As indicated above, reducing turning radius is an effective way to reduce speeds at intersections. For many jurisdictions, minimum turning radius is based on fire trucks and large commercial vehicles, and can restrict roadway designers' ability to narrow roadways. San Francisco, CA introduced a "triple combination pumper" fire truck that was "smaller than its predecessor by a matter of inches, but boasts a turning radius that is 25% smaller, allowing for a significant improvement in vehicle maneuverability."[129] By influencing turning speed, this improvement can arguably boost safety for all users, regardless of vehicle size or mode of travel.



Source: NACTO[130]

[128] https://highways.dot.gov/sites/fhwa.dot.gov/files/Leading_Pedestrian_Interval_1.pdf
[129] https://nacto.org/wp-content/uploads/2018/12/2018USDOTVolpe_Downsizing_FINAL_updated12-21-18.pdf, p. 7
[130] Ibid. (p. 8)

Many of these countermeasures can be implemented relatively quickly and at low cost. The City of Hoboken, New Jersey, credits intersection daylighting, curb extensions, and high-visibility crosswalks, among other quick-build and permanent safety projects, as to why the city has not experienced a traffic-related death in over seven years.[131] However, roadway design is only one component of the Safe System Approach. Legislation and regulation, as well as efforts from the private sector are also required to ensure that safer vehicles accompany these safer streets. The final sections of this report detail the measures that are needed to reduce the burden of injury and death from light trucks on America's roadways.

[131] https://www.hobokennj.gov/news/city-of-hoboken-reaches-new-vision-zero-milestone-seven-consecutive-years-without-a-traffic-death

Recommendations

Light trucks did not become the most prevalent vehicles on American roadways overnight, in a year, or even in a decade. Undoing their negative externalities will not be quick or easy, but it is possible to do so in a way that preserves what consumers enjoy about these vehicles while reducing their safety risks. The following long-term initiatives, many of which have been proposed by experts in road safety with considerable research background, require cooperation between different levels of government as well as private industry, all with a role to play in the strengthening of a Safe System.

Federal Government

Regulation and Standards

NHTSA, part of USDOT, administers the New Car Assessment Program, or NCAP, which consumers will recognize as the star rating for safety. NHTSA also issues and enforces the Federal Motor Vehicle Safety Standards, or FMVSS, a set of regulations influencing crash avoidance, crashworthiness, and post-crash survivability with which all motor vehicles sold in the United States must comply. Certain policy changes, such as those related to taxation, require acts of Congress.

- Issue final rule on incorporation of pedestrian crashworthiness in NCAP,[132] and advance efforts to further include pedestrian safety as part of a vehicle's star rating.

- Research and consider other additions to NCAP[133]:
    - Incorporate bicycle crashworthiness and bicycle Automatic Emergency Braking (AEB) testing protocols.[134]

    - NCAP testing protocols should prioritize smaller, more vulnerable road users. No vehicle should earn a five-star rating if it does not meet pedestrian crashworthiness standards.

    - NCAP ratings should consider visibility from the driver's seat (also known as "direct vision"), ensuring vehicle size and hood height do not impede the driver's ability to see in front of or around them.

    - NCAP ratings should consider hood height as a danger to others as part of pedestrian crashworthiness ratings. (The Notice of Proposed Rulemaking issued in September 2024 proposing a new FMVSS to reduce the risk of serious or fatal pedestrian head injuries acknowledges that hood height relates to the

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132 https://www.nhtsa.gov/press-releases/nhtsa-proposes-new-crashworthiness-pedestrian-protection-testing-program

133 See NCAP Comments from: NACTO and a Coalition of Safety Groups, IIHS-HLDI, Alliance for Automotive Innovation,

134 See: https://www.euroncap.com/en/car-safety/the-ratings-explained/vulnerable-road-user-vru-protection/aeb-cyclist/

angle at which a pedestrian's head impacts the front end of a vehicle, but does not propose regulations on hood height.[135])

- Advanced Driver Assistance System (ADAS) features must be evaluated based on their ability to sense and protect people outside the vehicle and in all weather and lighting conditions.

- Amend FMVSS to require Intelligent Speed Assistance (ISA)[136] technology in all new vehicles.[137]

- Amend FMVSS to cap the height of new vehicle front ends at 1.25 meters.

- Create and implement a front visibility standard for both light vehicles and heavy trucks modeled after the 2014 amendment to FMVSS No. 111 (Cameron Gulbransen Kids Transportation Safety Act of 2007), which addressed the field of view behind a vehicle. The creation of a forward visibility standard could be accomplished through several different avenues and could be an iterative process. For example:

    - An outside vehicle safety rating organization such as IIHS-HLDI, Consumer Reports, Kelley Blue Book, or J.D. Power could lead by creating a forward visibility standard and testing and evaluation protocol and ranking vehicles across classes.

    - NHTSA could evaluate testing and evaluation protocols from outside safety ratings organizations and modify as needed or create its own protocol and incorporate forward visibility in NCAP.

    - Congress could direct USDOT to issue an FMVSS creating a minimum forward visibility standard for all passenger vehicles and heavy trucks. Alternatively, NHTSA could consider moving forward with a rulemaking process based on international harmonization with UN Regulations 125 and 167.

- Regulate aftermarket modifications, including suspension and lift kits, to place caps on hood height. The American Association of Motor Vehicle Administrators (AAMVA) model legislation on excessive height modification can be used as a foundation to guide discussions.[138]

[135] https://www.govinfo.gov/content/pkg/FR-2024-09-19/pdf/2024-20653.pdf
[136] See the Road to Zero Coalition's Recommendations for Vehicle-Based Approaches to Prevent Speeding
[137] General Vehicle Safety Regulation (EU) 2019/2144 will require advisory (passive) ISA in all new MY 2024 vehicles sold within the European Union.
[138] https://www.aamva.org/getmedia/3519b0a7-ee2a-419f-8892-9707648d51d0/Model-Legislation-for-Excessively-Raised-Vehicles.pdf

- Study and revise CAFE and EPA Greenhouse Gas Emissions Standards to close loopholes and change standards that may incentivize automakers to increase vehicle footprint, weight, and size.[139] This may include moving to a single CAFE target for cars and light trucks, or amending rules to stop incentivizing larger footprints.

- Reform Section 179 of the Internal Revenue Code that provides an incentive for business owners to purchase large vehicles with a weight of over 6,000 pounds regardless of whether the size of the vehicle is necessary or related to their business purpose. Currently, Section 179 provides more than twice the tax credit if a business owner chooses to purchase a vehicle with a weight over 6,000 pounds.

- Rescind the "Chicken Tax," dating from 1964, which adds a 25% tariff on all imported light trucks, in order to diversify the model types available to American consumers. This would enable the entry of smaller models that are frequently sold in other countries.[140]

- Apply the "Gas Guzzler Tax" to all vehicles, not just passenger cars.

Research

- Study issues related to potential increased front-end stiffness associated with EVs and impacts on safety during fleet transition.

- Study persistence of crash incompatibility between cars and pickups and the role of increased curb weight, hood height, and front-end geometry.

- Research issue of potential roadway guardrail failure related to increasing vehicle weight, including financial implications for federal, state, and local governments for replacing insufficient guardrails.[141]

- Research the impact of larger vehicles on the effectiveness of various traffic-calming roadway designs, especially those that rely upon vertical deflection (e.g. speed humps, speed cushions, raised pedestrian crossings) and visual clearance (crosswalk widths, sign heights, and marking placement).

- Research and/or study the use of heads-up displays or other augmented reality in-vehicle display technology that may supplement direct vision and traditional mirrors and other vision devices, and determine their efficacy compared to direct vision.

[139] See: Whitefoot KS and Skerlos SJ (2012). Design incentives to increase vehicle size created from the U.S. footprint-based fuel economy standards. *Energy Policy* 41:402-411. https://doi.org/10.1016/j.enpol.2011.10.062
[140] See: Vision Zero Cities Journal, Cato Institute, NPR Planet Money
[141] See: https://news.unl.edu/article/nebraska-experts-weigh-highway-safety-and-electric-vehicles

- Research and quantify the differences in reaction and stopping times between direct and indirect vision in cars, SUVs, vans, and pickup trucks.

Procurement/Fleets

- Adopt vehicle purchasing standards for federal agencies that incorporate bicycle and pedestrian safety technologies, direct vision standards, Intelligent Speed Assistance (ISA), telematics, right-sizing, and other leading safety technologies.
- Incorporate ISA and telematics technologies to reduce excessive speed in publicly-owned fleet vehicles.

Funding

- Expand existing discretionary grant programs, such as Safe Streets and Roads for All, and develop new grant programs to incentivize local governments to evaluate and improve visibility for fleet vehicles, using Together for Safer Roads' 5 Star Rating Visibility Toolkit[142] or Santos Family Foundation/USDOT Volpe Center's Blind Zone Calculator[143] tool to better understand the risks to other road users. Offer incentive grants for state local governments that achieve high owned/contracted fleet visibility ratings.

- Create discretionary grant opportunities for municipalities to purchase right-sized fleet and emergency vehicles, e.g. opportunities to acquire right-sized fire trucks through the U.S. Fire Administration.

Public Education

- Create public education and messaging campaigns around the increased risks of driving larger vehicles (Examples: blind zones, increased danger to those outside the vehicle, increased danger related to vehicle speed, vehicle-to-vehicle compatibility concerns, etc.)

- Widely promote the benefits of the new FMVSS 127, issued in May 2024, which makes Automatic Emergency Braking (AEB), including pedestrian AEB, standard on all new passenger cars and light trucks by September 2029.[144]

[142] https://togetherforsaferroads.org/our-work/direct-vision-star-rating-system/
[143] https://blindzonesafety.org/
[144] https://www.nhtsa.gov/press-releases/nhtsa-fmvss-127-automatic-emergency-braking-reduce-crashes

- Develop a new point-of-sale label, or update the Monroney label (the decal that dealerships must put in windows of new cars to provide basic information about the vehicle), to convey the relative danger to others posed by a vehicle. Explain the danger through illustrations of blind zones, the number of children who can be in front of a vehicle unseen, and other illustrations.

State Governments

Regulation and Standards

- Implement weight/height-based registration and title fees and direct revenue toward safety improvements.

- Incorporate weight/height-based fees into future transportation funding systems as states move away from gas taxes.[145]

- Incorporate monitoring of suspension and lift kits into state vehicle inspection protocols.

- Advance opportunities for local governments to establish speed safety camera programs.

- Consider banning right-turn-on-red in areas where pedestrians may be present in order to account for large passenger-side blind zones on light and heavy trucks that create increased risk for nonoccupants during turning movements.

- Add physically-protected pedestrian and bicycle infrastructure along routes with high light and heavy truck traffic, as well as separate crossing phases when possible.

- Revise state statutory speed limit laws to create lower default speed limits in urban, business, and residential districts. Although global traffic safety goals call for speed limits of 20 mph in urban areas, most states set default speed limits for those areas at 25 mph or above and restrict the ability of localities to implement speed limits lower than the default.

- Revise state statutory speed limit laws to allow localities to implement lower speed limits and require transportation engineering professionals to justify how safety will be maintained or improved when suggesting higher speed limits.

- Revise state engineering guidance to promote the concept of target speeds and designing roadways to achieve natural compliance from drivers with target speeds. As states adopt the new Manual on Uniform Traffic Control Devices (MUTCD) they are now required to consider context when setting speed limits, but states may not have official guidance related to context and safe speeds for different contexts or systems to monitor whether road designs are achieving natural compliance with safe speed limits.

[145] See Aloisi J et al. (2023) "Replacing the Gas Tax: Leveraging the Electric Vehicle Transition to Build a Strong Transportation Funding System in the United States." MIT Mobility Initiative and JTL Transit Lab. https://www.mmi.mit.edu/_files/ugd/29d096_eb9d66f3b2394eb29e1a76ae9c8be156.pdf

Procurement/Fleets

- Incorporate Intelligent Speed Assistance[146] and telematics technologies to reduce excessive speed in publicly-owned fleet vehicles.
- Evaluate and improve visibility for state and local government-owned and contracted fleet vehicles, using Together for Safer Roads' 5 Star Rating Visibility Toolkit[147] or Santos Family Foundation/USDOT Volpe Center's Blind Zone Calculator[148] tool. Measure the direct vision available to drivers in specific models included in the fleet.[149]
- Develop holistic fleet safety transition plans for government owned or contracted fleets.[150]

Public Education

- Create public education and messaging campaigns around the increased risks of driving larger vehicles. (Examples: blind zones, increased danger to those outside the vehicle, increased danger related to vehicle speed, vehicle-to-vehicle compatibility concerns, etc.)

[146] See the Road to Zero Coalition's Recommendations for Vehicle-Based Approaches to Prevent Speeding
[147] https://togetherforsaferroads.org/our-work/direct-vision-star-rating-system/
[148] https://blindzonesafety.org/
[149] For example, see MassDOT's Direct Vision Study
[150] See: New York City's Safe Fleet Transition Plan

Local Governments

Regulation and Standards

- Implement weight/height-based registration fees and direct revenue toward safety improvements.
- Implement parking fee structures that charge larger vehicles a higher rate.
- Offer financial incentives[151] for micro-mobility devices and low-speed vehicles.
- Consider banning right-turn-on-red in areas where pedestrians may be present to account for large passenger-side blind zones on light and heavy trucks that create increased risk for nonoccupants during turning movements.
- Add physically-protected pedestrian and bicycle infrastructure along routes with high light and heavy truck traffic, as well as separate crossing phases when possible.
- Revise zoning and development codes to cap the size of parking spaces.
- Authorize local governments to create speed safety camera programs.

Procurement/Fleets

- Incorporate Intelligent Speed Assistance[152] and telematics technologies to reduce excessive speed in publicly-owned fleet vehicles.
- Evaluate and improve visibility for state and local government-owned fleet vehicles, using Together for Safer Roads' 5 Star Rating Visibility Toolkit[153] or Santos Family Foundation/USDOT Volpe Center's Blind Zone Calculator[154] tool.
- Reevaluate municipal fleet management, procurement, and contracting practices to promote right-sized commercial vehicles.[155] Develop holistic fleet safety transition plans for government-owned or contracted fleets.[156]

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151 For a full list of incentive programs in N. America, see Portland State University TREC- E-Bike Incentive Programs of North America
152 See the Road to Zero Coalition's Recommendations for Vehicle-Based Approaches to Prevent Speeding
153 https://togetherforsaferroads.org/our-work/direct-vision-star-rating-system/
154 https://blindzonesafety.org/
155 See: NACTO Downsizing Report, NYC Safe Fleet Transition Plan, New York City Executive Order 39 which establishes a vision standard and other requirements for city fleet and contractor vehicles, Boston Blind Zone Safety Initiative, Transport for London Direct Vision Standard and standards for heavy goods vehicles
156 See: New York City's Safe Fleet Transition Plan

Public Education

- Create public education and messaging campaigns around the increased risks of driving larger vehicles. (Examples: blind zones, increased danger to those outside the vehicle, increased danger related to vehicle speed, vehicle-to-vehicle compatibility concerns, etc.)

Private Industry

Motor Vehicle Manufacturing

- Revise the 2003 Enhancing Vehicle-to-Vehicle Crash Compatibility Agreement (EVC) to improve vehicle-to-vehicle crash compatibility for pickups and electric vehicles. The original EVC is credited with dramatically improving crash compatibility between cars and SUVs, but compatibility issues remain for pickups. A revised EVC should also consider curb-weight differences likely to be seen in the future with the proliferation of electric vehicles.

- Implement design changes that cap the front-end height for light trucks at 1.25 meters and prioritize sloping hood shape.

- Incorporate pedestrian/bicyclist crashworthiness design features and avoidance technologies into new models at all trim levels that operate effectively in all lighting and weather conditions.

- Cap vehicles' top speed at a reasonable threshold (i.e., a few miles above 85 mph, the highest US speed limit, rather than 155 mph, the current cap on many cars).

- Include ISA in new vehicles as standard.

- Implement vehicle-to-everything (V2X) technology to supplement ADAS and direct vision safety technologies.

Research

- Study implications of increased 0 to 60 mph acceleration times on driver behavior and crash outcomes, and consider limiting acceleration capabilities for new vehicles.

Procurement/Fleets

- Evaluate and improve visibility for commercial fleet vehicles, using Together for Safer Roads' 5 Star Rating Visibility Toolkit and/or the Santos Family Foundation/USDOT Volpe Center's Blind Zone Calculator tool. Create a plan to improve overall fleet visibility focusing on both short-term retrofits such as replacement of windows and removal of window tinting, as well as long-term fleet transformation to low-entry, high-vision cab-overs with maximum windshield and door glazing.

Public Education

- Avoid misleading or unrealistic automobile marketing that focuses on vehicle performance (speed, acceleration, maneuverability) in advertisements, which may influence audiences to engage in reckless driving behaviors.[157]

[157] See: IIHS and Consumer Reports

Vehicle Purchasers

- Before buying or leasing a vehicle, learn about whether it has design features that can be hazardous to other road users. Detailed specifications, such as front-end height and weight, are available on manufacturers' websites, but you can do more to learn about the vehicle's detailed safety profile. Reliable resources include:
  - Consumer Reports, which, in addition to ratings, provides explanations of what advanced vehicle technologies are, as well as a Car Safety Guide with news and advice. https://www.consumerreports.org/cars/
  - The Insurance Institute for Highway Safety, which provides detailed specifications and ratings for crash avoidance, crashworthiness, and crash mitigation, as well as explanations of which safety technologies are available on specific models. https://www.iihs.org
  - MyCarDoesWhat, a program of the National Safety Council, which offers resources to help consumers learn about the safety features offered by the top automobile brands sold in the United States, including what those features can and cannot do: https://mycardoeswhat.org.