CHAPTER 6

Transportation Safety

Highlights

- Highway deaths per 100 million vehicle-miles traveled rose from a historic low of 1.08 in 2014 to 1.18 in 2016 as deaths climbed from 32,744 to 37,461—a 14.4 percent increase in 2 years.
- Pedestrian deaths are the most since 1990. Pedestrian fatalities rose by over 1,000 between 2014 and 2016, reaching 5,987 in 2016—a 21.9 percent increase over the period and the most since 1990.
- Deaths of motorcycle riders grew from 4,594 in 2014 to 5,286 in 2016—a 15.1 percent increase. The rate of motorcyclist fatalities per vehicle mile of travel is 29 times greater than that for passenger car occupants. Also, they are 5 time more likely to be injured. Helmet use declined from 71 percent in 2000 to 65 percent in 2016.
- The estimated number of people injured in highway motor vehicle crashes increased by about 105,000 between 2014 and 2015, reaching 2.44 million.
- Alcohol use continues to be a major factor in transportation deaths and injuries. In 2016, 25 percent of motorcycle operators involved in fatal crashes were alcohol impaired, and alcohol use was the leading factor in 15 percent of fatal recreational boating accidents where the accident cause was known.
- It has been estimated that 3,258 motor vehicle occupants and motorcyclists who died in crashes in 2016 might have lived if they had used seat belts or motorcycle helmets, and 83 percent of the boaters who drowned in 2016 were not wearing a life jacket.
- Some 1,132 children aged 14 and under died, and an estimated 178,000 were injured in motor vehicle-related incidents in 2015—an average of about 3 deaths and 487 injuries a day.
- In the 2006 to 2015 period, a total of 301 school-aged children (18 and under) died in school transportation-related crashes—about 30 deaths per year on average.
- Trespassing-related fatalities accounted for 57.2 percent of the railroad deaths in 2016, and highway-rail crossing fatalities accounted for another one-third.
- Speeding continues to be the number one cited driver-related factor in highway fatal crashes. Almost half of speeding drivers in fatal crashes were found to have been drinking.

In 2016 total transportation fatalities were 39,565. Transportation fatalities are down from 44,582 in 2000, but up from 35,171 in 2010 and 37,501 in 2015 [table 6-1]. Overall, they have been consistently below 40,000 in recent years, but inching upward. This upward movement is primarily driven by highway fatalities.

Despite the 2015 and 2016 fatality increases, highway safety—and transportation safety as a whole—have improved in recent decades, resulting in a notable decline in fatalities and injuries. Even with growth in the U.S. population, more system users, and increased travel by all modes (as discussed in chapters 1 through 3), there were about 5,000 fewer total transportation fatalities in 2016 than in 2000—about 11 percent less. Still, transportation accounted for 25.2 percent of the total deaths resulting from unintentional injury in the United States in 2015 [USDHHS CDC VITALITY 2016].

As shown in box 6-A, the timeframe and definitions used to attribute a fatality to a transportation crash or accident differ among modes, reflecting different data collection methods, reporting periods, and information management systems of the various reporting agencies. For example, a death that occurs within 30 days of a crash involving highway vehicles is considered a highway fatality, while a death that occurs within 180 days of a rail

Box 6-A Fatality Definition by Mode

Mode (Source)	Definition	Citation
Air	Fatal injury means any injury which results in death within 30 days of the accident.	49 CFR 830.2
Hazardous material	Fatalities must be reported as soon as practical, but no later than 12 hours after the incident and death resulting from injury must be reported within 1 year of the date of incident.	49 CFR 171.15 and 49 CFR 171.16
Highway	Fatality means any injury which results in the death of a person at the time of the motor vehicle accident, or within 30 days of the accident.	49 CFR 390.5
Pipeline	Fatalities reported as soon as practical, but not more than 30 days after detection of an incident.	49 CFR 191.3 and 195.50
Railroad	Fatality means the death of a person within 24 hours of an accident. Also if an injured person dies within 180 days from the date of the injury.	49 CFR 840.2 and FRA Guide for Preparing Accident/Incident Reports
Rail transit	A fatality at the scene; or where an individual is confirmed dead within 30 days of a rail transit-related incident.	49 CFR 659.33
Recreational boating	Fatality means a person dies within 24 hours of the accident. Within 10 days of the occurrence or death if an earlier report is not required.	33 CFR 173 and 174

incident is considered a rail-related death. Such definitional differences pose challenges when comparing safety performance across modes of transportation.[1]

Fatalities by Mode

As shown in figure 6-1, there has been a major decrease in both the number and rate of highway fatalities over the last half century—with deaths per hundred million miles of highway vehicle travel falling from 5.50 in 1966 to a low of 1.08 in 2014, followed by a rise to 1.15 in 2015 and 1.18 in 2016.[2]

While figure 6-1 shows that the most dramatic improvement occurred in the 1970s and 1980s, progress continues despite growth in the U.S. population and number of drivers (see figure 6-2). However, highway fatalities increased by 14.4 percent between 2014 and 2016.

Despite recent increases in the number of highway fatalities, the highway mode has accounted for much of the overall reduction in transportation fatalities from 2000 to 2016. Other modes, however, including air carriers, railroads, transit, and recreational boating, also show improved safety records (Table 6-1). In 2016 more than 37,000 died in highway crashes and about 2,200 people died in accidents involving the non-highway modes. Relatively few passengers die in train or bus crashes in an average year; however, several hundred people on foot or people in motor vehicles die when struck by a train or by transit vehicles. Both general aviation and recreational boating result in the deaths of several hundred people each year—but this toll is far less than in earlier decades.

Highway

The USDOT National Highway Traffic Safety Administration (NHTSA) released preliminary 2016 and revised 2015 fatality data in October 2017. The data show two consecutive years of growth in highway fatalities. From an historic low of 32,744 fatalities in 2014, fatalities increased by over 4,700 over the next 2 years—reaching 37,461 in 2016. NHTSA noted that the last time the United States had this magnitude of back-to-back years of fatality increases was from 1963 to 1964 [USDOT NHTSA 2017a]. NHTSA found that distracted driving and drowsy driving-related fatalities declined, while deaths related to other reckless behaviors – including speeding, alcohol impairment, and not wearing seat belts—continued to increase. Motorcyclist and pedestrian deaths accounted for more than a third of the year-to-year increase [USDOT NHTSA 2017l].

Highway fatalities grew at a faster rate between 2014 and 2015 (8.3 percent) than between 2015 and 2016 (5.7 percent). Table 6-2 shows fatality change by highway component between 2014 and 2016; as shown, nearly all categories of highway fatalities increased in the two-year period.

The biggest numerical increases in fatalities between 2014 and 2016 were for occupants of passenger cars and light trucks, and pedestrians—each increasing by more than

[1] For further discussion of these different definitions, see chapter 6 of *Transportation Statistics Annual Report 2015* Box 6-B.

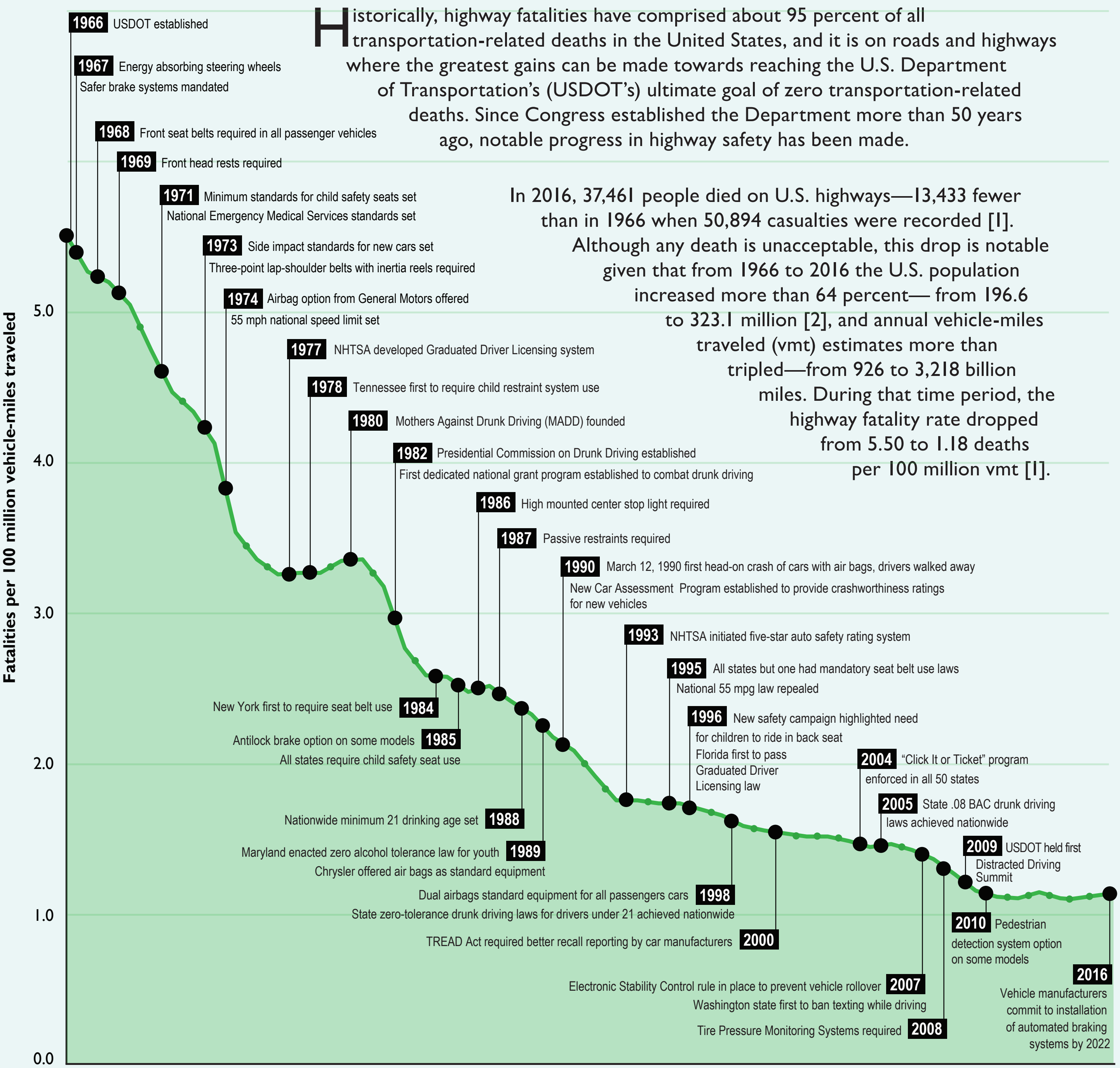
[2] The USDOT National Highway Traffic Safety Administration notes that the 2014 rate was the lowest since the agency began collecting fatality data through the Fatality Analysis Reporting System in 1975.

Figure 6-1: Highway Safety Improvements—1966 to 2016

Using 1966 as the base year, this graph plots the cumulative effect of safety innovations, over time, on annual highway fatalities per 100 million vehicle-miles traveled.

Historically, highway fatalities have comprised about 95 percent of all transportation-related deaths in the United States, and it is on roads and highways where the greatest gains can be made towards reaching the U.S. Department of Transportation's (USDOT's) ultimate goal of zero transportation-related deaths. Since Congress established the Department more than 50 years ago, notable progress in highway safety has been made.

In 2016, 37,461 people died on U.S. highways—13,433 fewer than in 1966 when 50,894 casualties were recorded [1]. Although any death is unacceptable, this drop is notable given that from 1966 to 2016 the U.S. population increased more than 64 percent— from 196.6 to 323.1 million [2], and annual vehicle-miles traveled (vmt) estimates more than tripled—from 926 to 3,218 billion miles. During that time period, the highway fatality rate dropped from 5.50 to 1.18 deaths per 100 million vmt [1].



Fatalities per 100 million vehicle-miles traveled climbed from 1.08 in 2014 to 1.18 in 2016 as fatalities increased 14.4 percent.

1966—A Pivotal Year for Highway Safety

Fifty-one years ago, on September 9, 1966, in answer to an alarming growth in annual highway-related deaths, President Lyndon Johnson signed both the National Traffic and Motor Vehicle Safety Act and the Highway Safety Act into law [3]. And on October 15, 1966, Congress established the USDOT with a multimodal mission to "Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system ..." [4]. This legislation also established the agency that 4 years later would become the National Highway Traffic Safety Administration (NHTSA).

Although these actions firmly established the Federal Government's responsibility for setting and enforcing transportation safety standards for all modes of transportation, the greatest impact would be on highway safety.

A Snowball Effect

Since 1966 there has been a dramatic drop in highway deaths. Many factors are responsible for this decrease—both regulatory and social:

• Safer vehicle designs and new safety technologies, such as seat belts, air bags, and electronic stability control, combined with programs to increase the use of seat belts and other safety equipment. NHTSA estimates that these technologies saved more than 600,000 lives from 1960 through 2012—nearly 28,000 in 2012 alone, of which more than half were saved by seat belts [5].

• Safer roads, including major new infrastructure, such as completion of the Interstate Highway System and gradual improvements to existing roads, such as guardrails, lighting, and rumble strips.

• Behavioral safety programs, such as high-visibility enforcement and child occupant protection campaigns, have encouraged more people to buckle up, use appropriate child safety seats, and to drive sober.

• More comprehensive and standardized emergency medical services, more effective transport and trauma treatment, and developments in medicine that made injuries more survivable [5].

While it is not possible to pin an exact number of lives saved to a particular safety factor, regulatory or otherwise, it is possible to show the cumulative effect of these innovations over time.

The 1960s

The decade of the 60s would see highway fatalities increase 47.1 percent, from 36,399 deaths in 1960 to 53,543 deaths in 1969. In near parallel, vehicle-miles traveled (vmt) increased 47.8 percent, from about 720 billion to more than 1 trillion miles during that same time period. The number of highway fatalities would continue to increase well into the 1970s, until the effects of new regulations and social reforms finally kicked in.

The 1970s

From 1970 through 1979, nearly a half million lives (498,356) were lost on U.S. roads. In 1972 U.S. highways would claim 54,589 lives—the highest number ever recorded. But as the decade closed, highway deaths per 100 million vmt had dropped from 4.74 in 1970 to 3.34 by 1979, even as vmt increased 37.8 percent. Still, the 51,093 lives lost in 1979 nearly matched the 52,627 lost in 1970 [6].

The 1980s

At last, the decade of the 80s would show a notable drop in highway deaths, with 5,500 fewer lives lost in 1989 than in 1980 (45,582 v. 51,091). Even more remarkable, this drop occurred in the face of a 37.6 percent increase in vmt and a population that grew by nearly 20 million, pushing down the number of lives lost from 3.35 to 2.17 per 100 million vmt.

The 1990s

At first glance the drop in the annual number of lives lost at the beginning of the decade (44,599) versus those lost at the end of the decade (41,717) might seem unremarkable. But from 1990 through 1999 the U.S. population increased by more than 23 million, while the rate of lives lost on U.S. highways continued to fall, from 2.08 to 1.55 per 100 million vmt—a nearly 72 percent drop from the 5.50 deaths per 100 million vmt recorded in 1966.

A New Century

The first years of the 21st century saw the highway fatality rate per 100 million vmt drop nearly 23 percent, falling from 1.53 deaths per 100 million vmt in 2000 to 1.18 by 2016 [1]. By 2004 the 0.08 blood alcohol limit and the "Click It or Ticket" campaign were enforced nationwide. Distracted driving emerged as a new challenge, and intelligent transportation systems, electronic stability controls, and the advent of self-driving cars ushered in a new era of innovations designed to mitigate the effects of human error.

Getting to Zero

A number of active safety systems are now available or are under development: forward collision warning, active braking, rear-view backup cameras, parking assist, lane departure, and blind spot warning—all technologies aimed at reducing or eliminating the effects of human error. In addition to these systems, connected and automated vehicle technologies are poised to play prominent roles in further reducing highway fatalities.

References

[1] U.S. Department of Transportation, National Highway Traffic Safety Administration, press release, *USDOT Releases 2016 Fatal Traffic Crash Data*, Oct. 6, 2016, www.nhtsa.gov.

[2] U.S. Department of Commerce, Bureau of the Census, Population Estimates, www.census.gov as of Nov. 20, 2017.

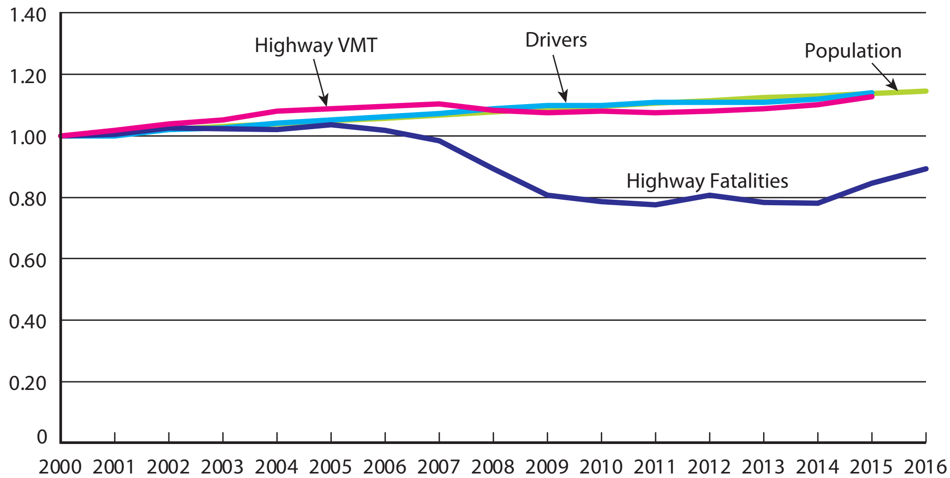
[3] U.S. Congress, Library of Congress, 112th Congress Senate Report 112-083, http://thomas.loc.gov as of May 25, 2016.

[4] U.S. Department of Transportation, mission statement, www.transportation.gov as of May 25, 2016.

[5] U.S. Department of Transportation, National Highway Traffic Safety Administration, *Lives Saved by Vehicle Safety Technologies and Associated Federal Motor Vehicle Safety Standards, 1960 to 2012*, January 2015, www.its.dot.gov as of May 25, 2016.

[6] U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, *Highway Statistics Series*, www.fhwa.dot.gov as of May 25, 2016.

FIGURE 6-2 Licensed Drivers, Resident Population, Highway Fatalities, Highway Vehicle-miles Traveled (VMT): 2000–2016



SOURCE: Drivers and Resident Population: U.S. Department of Transportation (USDOT), Federal Highway Administration, *Highway Statistics 2015*, tables DV-1C, available at http://www.fhwa.dot.gov/policyinformation/statistics/2015 as of October 2017. **Highway Fatalities and Highway VMT**: USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, tables 1-35 and 2-1, available at www.bts.gov as of October 2017

TABLE 6-1 Transportation Fatalities by Mode: Selected Years

	2000	2010	2015	2016	Change from 2015
TOTAL fatalities	**44,582**	**35,171**	**37,501**	**39,565**	↑
Air, total	764	477	404	412	↑
Highway, total	41,945	32,999	35,485	37,461	↑
Railroad, total[1]	937	735	751	791	↑
Transit rail, total[2]	197	120	151	148	↓
Water, total	701	821	700	737	↑
Pipeline, total	38	19	10	16	↑
Other counts, redundant with above					
Railroad, trespasser deaths not at highway-rail crossing	463	441	452	487	↑
Railroad, killed at public crossing with motor vehicle	306	136	127	131	↑
Rail, passenger operations	220	215	251	277	↑
Rail, freight operations	717	520	500	514	↑
Transit, non-rail	98	100	103	108	↑

[1] Includes Amtrak, Alaska Railroad, commuter railroads and freight railroads, and certain transit rail agencies reporting to the Federal Railroad Administration.

[2] Includes heavy rail transit (e.g., subway systems), light rail, streetcar rail, monorail and other track based transit operations reporting to the Federal Transit Administration.

NOTES: To reduce double counting, the following adjustments are made to **Total Fatalities**: For **Railroad**, fatalities involving motor vehicles at public highway-rail grade crossings are excluded because such fatalities are assumed to be included in Highway fatalities. For **Transit**, non-rail modes, including aerial tramway, motor bus, bus rapid transit, commuter bus, demand response, demand taxi, ferryboat, jitney, publico, trolleybus, and vanpool fatalities are excluded because they are counted as Transit, Water, and Highway fatalities. **Water** includes commerical and recreational vessels. **Other counts, redundant with above** help eliminate double-counting in the Total Fatalities.

SOURCES: **2000 and 2010**: Various sources as cited by U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics, table 2-1, available at www.bts.gov as of October 2017. **2015 and 2016**: Preliminary or revised data from the same sources cited in Table 2-1.

TABLE 6-2 Change in Highway Fatalities Between 2014, 2015, and 2016

TABLE 6-2a: 2014–2015

	2014		2015		Net increase	Percent change
Total Highway Fatalities	**32,744**	**100.0%**	**35,485**	**100.0%**	**2,741**	**8.37**
Passenger car occupants	11,947	36.5%	12,761	36.0%	814	6.81
Light truck occupants	9,103	27.8%	9,878	27.8%	775	8.51
Pedestrians	4,910	15.0%	5,495	15.5%	585	11.91
Motorcyclists	4,594	14.0%	5,029	14.2%	435	9.47
Other highway incidents[1]	761	2.3%	779	2.2%	18	2.37
Pedalcyclists	729	2.2%	829	2.3%	100	13.72
Large truck occupants	656	2.0%	665	1.9%	9	1.37
Bus occupants	44	0.1%	49	0.1%	5	11.36

TABLE 6-2b: 2015–2016

	2015		2016		Net increase	Percent change
Total Highway Fatalities	**35,485**	**100.0%**	**37,461**	**100.0%**	**1,976**	**5.57**
Passenger car occupants	12,761	36.0%	13,412	35.8%	651	5.10
Light truck occupants	9,878	27.8%	10,302	27.5%	424	4.29
Pedestrians	5,495	15.5%	5,987	16.0%	492	8.95
Motorcyclists	5,029	14.2%	5,286	14.1%	257	5.11
Other highway incidents[1]	779	2.2%	872	2.3%	93	11.94
Pedalcyclists	829	2.3%	840	2.2%	11	1.33
Large truck occupants	665	1.9%	722	1.9%	57	8.57
Bus occupants	49	0.1%	40	0.1%	-9	-18.37

TABLE 6-2c: 2014–2016

	2014		2016		Net increase	Percent change
Total Highway Fatalities	**32,744**	**100.0%**	**37,461**	**100.0%**	**4,717**	**14.41**
Passenger car occupants	11,947	36.5%	13,412	35.8%	1,465	12.26
Light truck occupants	9,103	27.8%	10,302	27.5%	1,199	13.17
Pedestrians	4,910	15.0%	5,987	16.0%	1,077	21.93
Motorcyclists	4,594	14.0%	5,286	14.1%	692	15.06
Other highway incidents[1]	761	2.3%	872	2.3%	111	14.59
Pedalcyclists	729	2.2%	840	2.2%	111	15.23
Large truck occupants	656	2.0%	722	1.9%	66	10.06
Bus occupants	44	0.1%	40	0.1%	-4	-9.09

[1]Includes occupants of other vehicle types, other nonmotorists, and unknown.

SOURCES: **2014**: U.S. Department of Transportation, Bureau of Transportation, National Transportation Statistics, table 2-1, available at www.bts.gov as of October 2017. **2015 and 2016**: Preliminary or revised data from the same sources cited in table 2-1.

1,000. The largest percentage increase was for pedestrians, up 21.9 percent in two years. Deaths of motorcyclists and pedalcyclists also increased over 15 percent [USDOT NHTSA 2017a].

In 2016 occupants of passenger cars and other light-trucks (e.g., sport utility vehicle, minivan, and pickup truck) comprised 35.8 and 27.5 percent, respectively of all highway fatalities (table 6-2). Pedestrian fatalities increased by almost 9 percent between 2015 and 2016. The share of bicyclist, motorcycle, large-truck, and bus occupant fatalities changed little, while the numbers increased.

Even with the recent spike in the highway fatalities, the overall rate of highway fatalities per 100 million VMT declined 22.6 percent from 1.53 in 2000 to 1.18 in 2016 (figure 6-3). Over time, occupant protection devices, advances in vehicle design, improved road design, graduated driver licensing for teenagers, expanded education and enforcement of drunk-driving laws, and many other preventative measures contributed to declines in highway vehicles deaths and injuries. Improvements in emergency medical response capabilities also played a role.

Not all categories of highway fatalities are lower today than in 2000, however. In 2016, 5,286 motorcyclists died—nearly 2,400 more than in 2000 and 692 more than in 2014, a 15-percent increase in 2 years. Growing ridership is a contributing factor to this increase. The rate of motorcyclist fatalities per vehicle mile of travel is 29 times greater than that for passenger car occupants in 2015 [NHTSA 2017c].

Deaths of bicyclists and other human-powered cyclists in 2016 are also higher than in 2000. More than 6,800 pedestrians and bicyclists died in highway accidents in 2016. Pedestrians and bicyclists—who often share the roads with motor vehicles—accounted for 17.2 percent of total transportation-related deaths in 2016, compared to 12.4 percent in 2000.

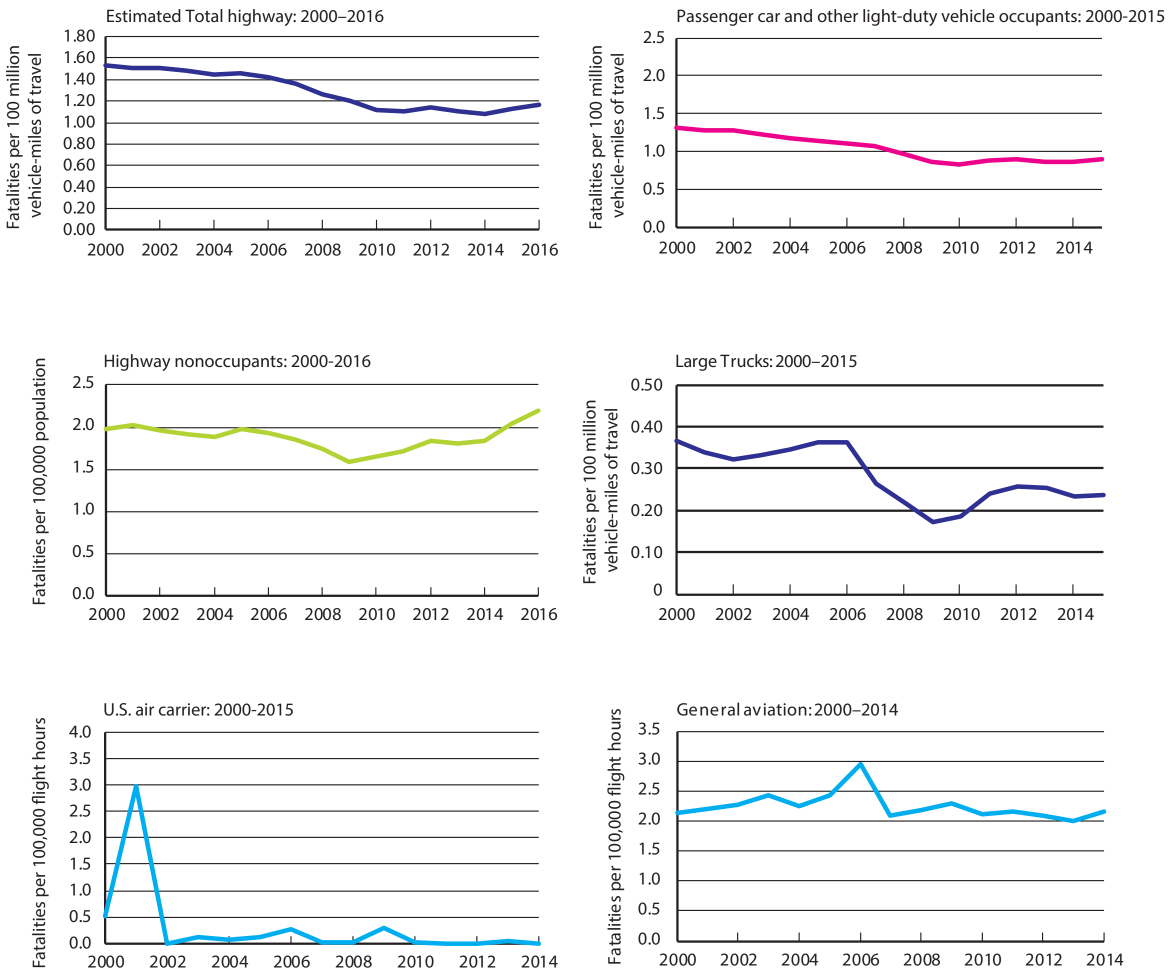
Pedestrian deaths were just under 6,000 in 2016. Figure 6-3 shows fatality rates (measured per 100,000 U.S. population) of nonoccupants[3] declined between 2000 and 2014, before rising in 2015 and again in 2016. In 2015 the fatality rate climbed above the rate reached in 2000 (2 fatalities per 100,000 population), but it remains about half the nonoccupant fatality rate of 1980, when pedestrian deaths totaled 8,070.

Per a recent National Highway Safety Administration report, pedestrians are more likely to be struck in the dark (74 percent of pedestrian fatalities) and away from intersection crosswalks. Only 18 percent of pedestrian fatalities are at intersections: the remainder were struck while crossing at non-intersections (72 percent of fatalities), on the shoulder or roadside (5 percent), or while in other locations, such as parking or bicycle lanes, median strips, or sidewalks (5 percent) [USDOT NHTSA 2017d].

An estimated 19 percent of the U.S. population lives in rural areas. However, rural fatalities disproportionally accounted for 49 percent of all traffic fatalities in 2015. In 2015 the fatality rate was 2.6 times higher in rural areas than

[3] Nonoccupants includes pedestrians, bicyclists, and others outside motor vehicles when struck.

FIGURE 6-3 Fatality Rates for Select Modes of Transportation: Most Recent Years Available



NOTE: *Light-duty vehicles* includes passenger car, vans, mini-vans, sport utility vehicles, pickup truck and other light truck occupants. *Air carrier* fatalities resulting from the Sept. 11, 2001 terrorist acts include only onboard fatalities. *Total highway fatalities* is based upon preliminary estimated.

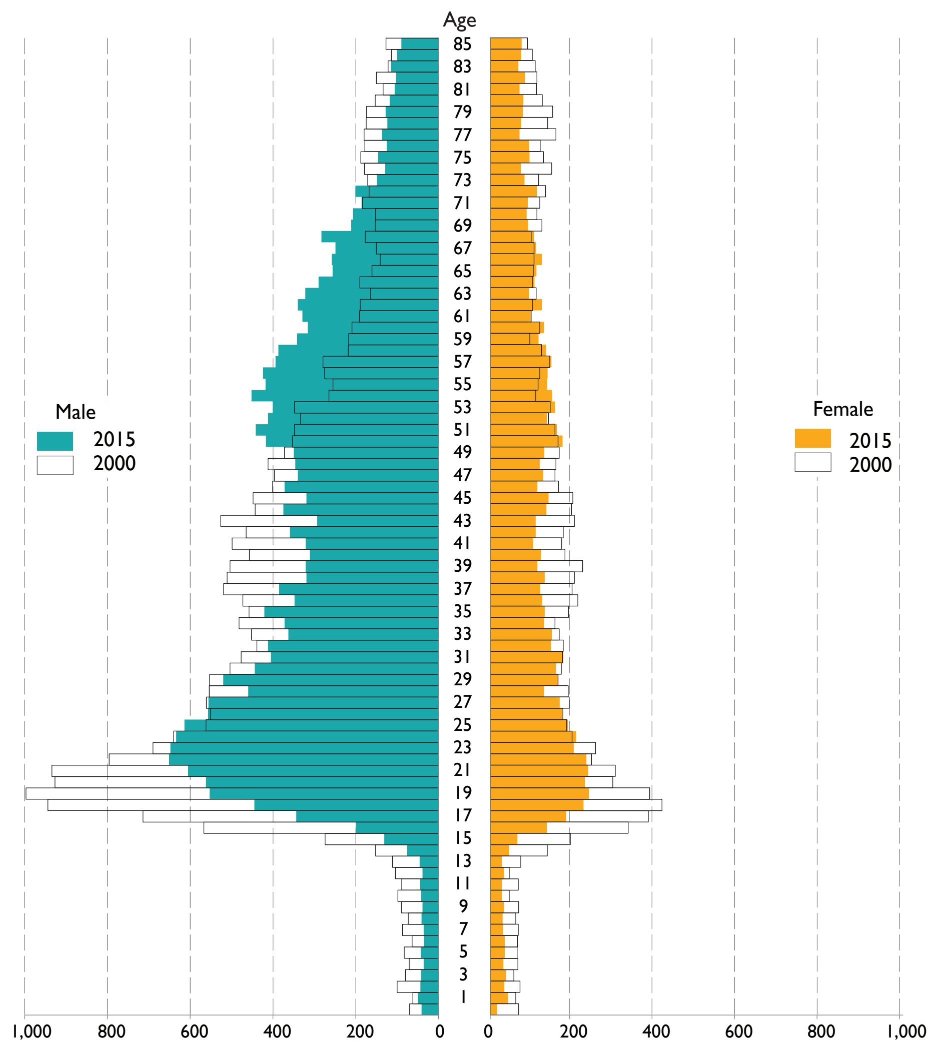
SOURCE: Calculated by U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS) based upon multiple sources as cited in USDOT, BTS, National Transportation Statistics. Tables 2-9, 2-14, 2-17, 2-19, 2-21, 2,22, and 2-23A1:P52ov as of October 2017.

in urban areas (1.84 and 0.71, respectively). Rural fatalities decreased by 28 percent between 2006 and 2015, while urban fatalities decreased by only 18 percent during this time [USDOT NHTSA 2017d].

The population ratio of males to females is 0.97 (about 5 million more females than males) in the United States [USDOC CENSUS 2016]. Yet the ratio of highway fatalities is about 2.5 males-to-females. This difference is partially because males, on average, drive more than females and thus have a higher rate of exposure to crashes. Based on the latest National Household Travel Survey data, males travel about 40.9 miles per day while females drive about 31.5 miles per day. Also, it is notable that males constitute 70 percent of pedestrian fatalities.

As in 2000, the number of males killed on U.S. highways exceeded the number of female fatalities for all age groups in 2015. Overall, males comprised 68.3 percent of highway fatalities in 2000 and 70.9 percent in 2015. Persons under the age of 30 continued to have the highest fatality numbers in 2015, although highway deaths for that age group were lower than for the same age grouping in 2000. The number of highway fatalities for males in their late 40s to late 60s was higher in 2015 than it was for the men who were in the same age group in 2000 (figure 6-4a). This cohort of males in 2015 was more numerous than their 2000 cohort and drove more miles—factors that likely contributed to the higher number of fatalities.

FIGURE 6-4a Fatalities Number by Age and Sex: 2015

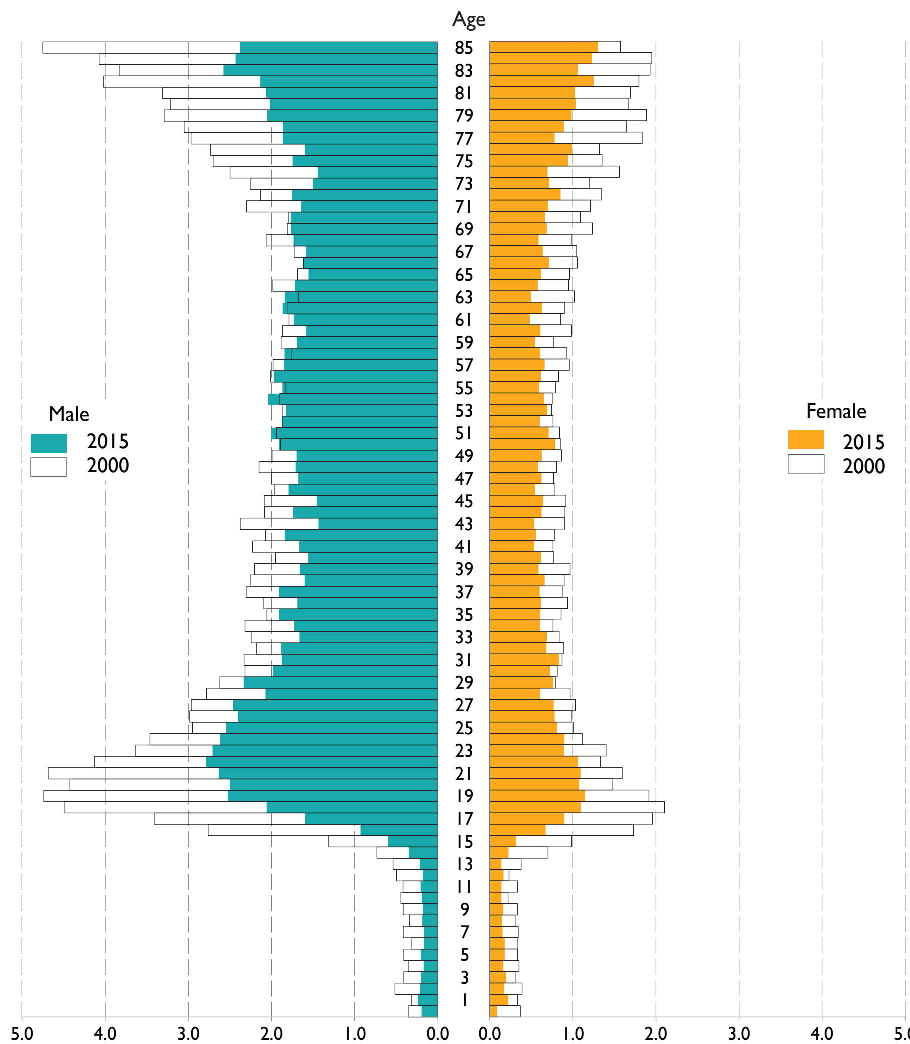


SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Fatality Analysis Reporting System, available at ftp.nhtsa.dot.gov as of March 2016.

Since 2000 there has been a considerable decrease in highway fatalities per capita across all age groups for both genders. The greatest numbers of fatalities per capita age group in both 2015 and 2000 were among males between the ages of 18 and 30, followed by males 79 and older. Female fatalities per capita in both 2015 and 2000 peaked for those between 16 and 27 years of age, followed by females over the age of 80. The 2000 rates were again higher across all age groups and both genders (figure 6-4b).

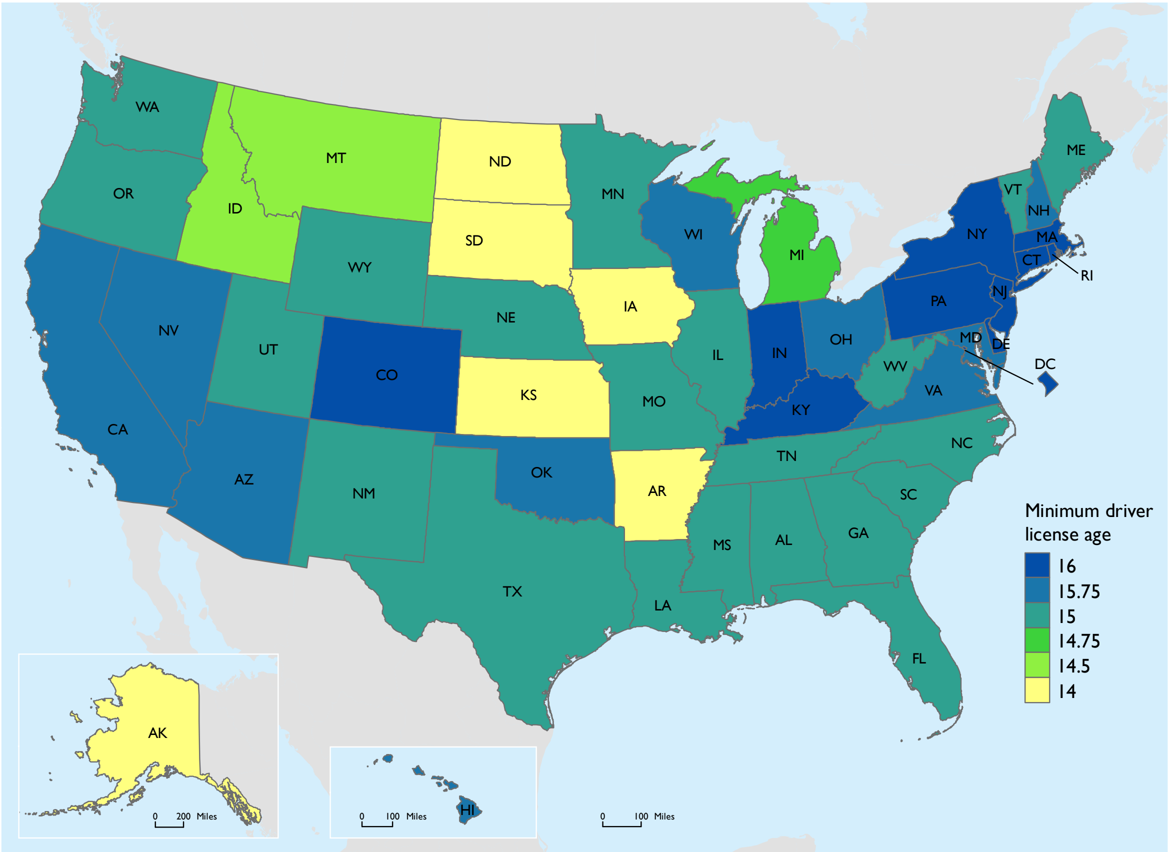
The minimum age for getting a driving license varies among states, ranging from14 to 16 years of age (figure 6-5). At least 48 states have established some form of graduated driver licensing (GDL) program to help

FIGURE 6-4b Fatalities Rate by Age and Sex: 2015



SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Fatality Analysis Reporting System, available at ftp.nhtsa.dot.gov as of March 2016.

FIGURE 6-5 Minimum Driver License Age: June 2017



NOTES: States have a wide variety of conditions that novice or teen drivers must meet as they progress to full licensure. For a listing of these requirements in a specific state, consult the source document website.

SOURCE: Governors Highway Safety Association, *Teen and Novice Drivers*, available at http://www.ghsa.org/state-laws/issues/Teen-and-Novice-Drivers as of June 2017.

inexperienced, young drivers safely gain experience while limiting their exposure to high-risk driving conditions, such as night driving and carrying teenage passengers during early months of licensure [GHSA]. A recent review of state GDL program evaluations found that the program was effective in improving 16 and 17-year-old drivers' crash outcomes by 16 and 11 percent, respectively[4] [Masten, S.V., et al.].

Motor vehicle crashes continue to be the leading cause of death for teens aged 16 to 20 years [USDHHS CDC WISQARS 2015]. Teenagers and young adults had the highest fatality numbers and fatality rates per 100,000 residents in 2015, although their deaths have declined considerably since 2000. A potential contributing factor is that those under the age of 30 in 2015 drove fewer miles than their counterparts in 2000, reducing the exposure to highway crashes.

Not surprisingly, children aged 14 and under have the lowest number and rate of fatalities—yet over 1,000 children in this age range die every year in motor vehicle crashes and incidents. In 2015 children aged 14 or younger comprised about 19 percent of the U.S. population and about 3 percent, or 1,132, of U.S. motor vehicle fatalities. This was a 5-percent increase from 2014, but a 37-percent decrease compared to 2006. Of the children killed, 824 (73 percent) were motor vehicle occupants; about 25 percent were pedestrians and bicyclists, and the remaining 2 percent were other/unknown nonoccupants. An estimated 178,000 children were also injured. [USDOT NHTSA 2017i].

Expressed daily, about 3 children died and 487 children were injured each day in motor vehicle incidents in 2015. Children who died in crashes were more likely to be unrestrained when their drivers were unrestrained; when the driver didn't wear a seat belt, 66 percent of the children were likewise unrestrained. Box 6-b discusses the challenges and risks children face traveling to and from school.

Aviation

U.S. air carriers had zero fatalities in 2015 and 2016. In fact, in 6 of the last 16 years there were no fatalities recorded for flights by U.S. air carriers. During the other years, fatalities per 100,000 flight hours ranged from 0.1 to 3.0—the larger number dating to 2001 when five passenger planes crashed, including the four hijacked by terrorists on September 11 of that year. Since 2001 the air carrier fatality rate has remained stable and low.

General aviation (GA) fatalities have numbered in the hundreds every year since at least 1960. In 2016 some 386 people were killed in GA accidents, compared to 378 in 2015, and 424 in 2014. GA fatalities have dropped appreciably from previous decades. In the 10 years spanning 1990 to 1999, an average of 716 persons per year died in GA accidents, followed by a drop to an average of 567 deaths per year in the following decade. The annual average for the 2010–2016 period was 417 fatalities.

[4] The study was unable to reach firm conclusions about the association between GDL and crash outcomes for drivers 18 to 20 years of age, finding it difficult to disentangle the mixture of people with and without GDL training. Most states do not require GDL for applicants for driver licenses who are 18 and older.

Box 6-B Student Traffic Safety

Most children go to school every school day. As was discussed in box 2-A in chapter 2, most children are transported to and from school in motor vehicles, either a personal or family vehicle (45 percent in 2009) or a school bus (39 percent). Relatively few (15 percent or less) walk or bike.

How safe are their trips to and from school? NHTSA found that, in the 10 years between 2006 and 2015, a total of 301 school-aged children (18 and under) died in school transportation-related crashes [USDOT NHTSA 2017j]. This amounts to about 30 school-children deaths per year on average. Over the 10-year period, 54 of the children who died were occupants of school buses or other school-transportation vehicles (about 5.4 fatalities per year), and 137 were school children occupying other vehicles, such as a family vehicle (13.7 fatalities per year). Children who were on foot accounted for 102 fatalities, while bicyclists and other pedalcyclists comprised 8 deaths—for a combined average of 11 fatalities per year.

About 64 percent of the school-age pedestrians that died were struck by a school bus or a vehicle functioning as a school bus, while 36 percent of pedestrian deaths of school children involved other vehicles. Over one-fifth of the school bus-child pedestrian fatalities occurred as the bus was starting up in the road, while about 11 percent of the school children pedestrian fatalities happened as another vehicle type passed or overtook a vehicle.

The above statistics indicate that some school-children fatalities happen as children approach or walk away from their transport vehicle as they go to and from school. A recent U.S. General Accountability Office study reports that, when participating school bus drivers were asked to note the number of times a vehicle illegally passed the bus when stopped to pick up or drop off students, these drivers reported 74,000 instances in a single day [USGAO 2017].

The total number of people of all ages who died in school-transportation related crashes over the 2006 to 2015 year period was 1,313—or about 131 per year on average. This was about 100 more deaths of people per year than the 30 school-aged children who died annually [NHTSA 2017i].

The GA fatality rate per 100,000 flight hours has fluctuated (figure 6-3). While the number of fatalities was fewer in 2016 (386 people) compared to 2000 (596 people), the number of flight hours in 2014 was 35 percent less, resulting in a higher fatality rate. Another metric of GA safety is the fatal accident rate per 100,000 flight hours. This rate is the same whether a plane has one or many occupants who die in a crash. According to preliminary estimates, the GA fatal accident rate for fiscal year 2016 (October 1, 2015 through September 30, 2016) was 0.91 per 100,000 flight hours, compared to a 1.08 fatal accident rate averaged over the five prior fiscal years [USDOT FAA 2017a].

Most general aviation accidents involve single-engine, piston-powered airplanes, which account for slightly more than 60 percent of general aviation aircraft and just over half of general aviation flight hours [USDOT FAA 2014]. The loss of inflight control contributes to the majority of fatalities, whereas loss of control on the ground and engine-related system malfunctions were associated with the majority of nonfatal accidents [NTSB 2014a]. General aviation accidents are widely dispersed across the country. In 2014 nearly two-thirds of fatal general aviation accidents resulted in a single fatality, another quarter resulted in two fatalities, and the remainder yielded multiple fatalities.

In addition to general aviation, many fatalities each year result from crashes involving air taxis and other commercial on-demand air services, and commuter planes with less than 10 seats. Preliminary data show 27 fatalities from these services in 2016, above the 2010-2015 annual average of 24. The safety trend in air taxi and similar services seems to be improving, averaging 43 deaths per year between 2000 and 2009 compared to nearly 64 deaths annually between 1990 and 1999.

The popularity of unmanned aircraft systems (UAS) or "drones" poses several challenges for aviation safety (box 6-C). There are now more than one million UAS in the United States, and there are increasing sightings of unauthorized drones from the air and near airports.

Recreational Boating

There were 701 recreational boating deaths in 2016. The year 2016 was the third successive year of boating fatality increases. From a historic low of 560 in 2013, boating fatalities rose to 610 deaths in 2014 and 626 deaths in 2015. While still fewer than in the 1990s when

Box 6-C Unmanned Aircraft and Aviation Safety

Estimates suggest that people in the United States now own over one million unmanned aircraft systems (UAS), commonly known as drones, with the number growing each year. Recreational and other unregulated use of drones presents safety risks to manned aircraft, their crews, airline passengers, and anyone below their flight paths. Unauthorized UAS flights reportedly interfered with aerial tankers battling wildfires, which grounded the tankers and put firefighters on the ground at greater risk [USDOT FAA 2015a].

The number of unmanned aircraft sightings by pilots while in flight have increased rapidly, from 238 in 2014, to about 1,210 in 2015, to 1,274 in just the first 8 months of 2016. The sightings come from pilots of all aircraft types, including large, commercial passenger aircraft.

The prospect of a drone damaging a commercial flight has attracted worldwide concern [The Guardian 2016]. While there have been several reports by pilots claiming a collision between UAS and their planes, FAA investigations usually found that the collisions were explained by damage from such events as a bird strike or structural failure, not a UAS [USDOT FAA 2017a]. In October 2017, however, a civilian drone collided with and damaged a military helicopter, which landed safely [USA Today].

Prior to operating unmanned aircraft, the Federal Aviation Administration (FAA) requires people to file a paper registration application for drones weighing 55 pounds or more. In December 2015, FAA also issued an interim final rule for online registration of drones weighing from 0.55 pounds up to just under 55 pounds, as an alternative to filing a paper application. Very light drones that weigh less than 0.55 pounds do not have to be registered [USDOT FAA 2015c].

As of the end of 2016, some 670,000 drones had been registered in the United States [USDOT FAA 2017b].

fatalities averaged about 800 per year, the 2016 fatality number is similar to the annual average of about 700 between 2000 and 2009. According to the U.S. Coast Guard (USCG), many boating fatalities occurred on calm protected waters, in light winds, or with good visibility. Alcohol use, operator distraction, or a lack of training continued to play key roles in fatal recreational boating accidents. Where cause of death was known, about 80 percent of people who died in recreational boating incidents drowned, and 83 percent of these people were not wearing life jackets [USDHS USCG 2017]. While most of the deaths—481 in 2016—involved motorized boats, people in kayaks and canoes accounted for 22 percent of the fatalities.

Because of a lack of reliable nationwide measures of recreational boat usage, such as operational hours, boating fatality rates have historically been based on the ratio of fatalities to the total number of registered boats, a number subject to great uncertainty. An initial 2011 survey of boating participants and boat owners estimated that there were about 2.973 billion person-hours of boating in that year. As there were 758 boating deaths in 2011, this would be about 25.5 deaths per 100 million exposure hours that year for all categories of boats [USDHS USCG 2011 undated]. A 2012 survey of boat owners and other data showed a lower overall rate of 18 deaths per 100 million exposure hours, based on 3.584 billion person hours of exposure and 648 deaths that year.[5] The USCG cautions that the methodologies used in the two surveys were different, concluding that it was confident that the 2012 survey resulted in an enhanced exposure estimate, but was not necessarily confident in the higher number derived [USDHS USCG 2012 undated].

Railroad Operations[6]

In 2016, 791 people died from railroad-related accidents (table 6-1). The FRA attributes 277 deaths to passenger train operations and 514 deaths to freight train operations, which involve far more train miles than passenger train-miles [USDOT FRA 2017a]. Unlike highway crashes, boating, or aviation accidents, most fatalities associated with train operations occur outside the train, such as people who are struck by trains while on track rights-of-way or people in cars struck at highway-rail grade crossings. Very few train passengers or crew members die in train accidents. In the 10 year period 2007 to 2016 period, the fatality count for passengers on the train was 45—less than 5 per year—but a total of 7,749 people died in railroad accidents or incidents.[7]

Several hundred people die every year when struck by trains while on railroad property or rights of way. If they were unauthorized, they are classified trespassers. Trespassers accounted for 57.2 percent of the total railroad fatalities between 2007-2016, or 443 deaths per year on average. The number of trespasser deaths fell for several years after 2007, reaching a low of 400 in 2011. However, the

[5] The 648 fatality number differs from Recreational Boating Statistics, which states that there were 651 boating fatalities in 2012.

[6] Data in this section is as reported to the Federal Railroad Administration as of February 2017. Data may change as FRA receives additional or amended reporting is received from reporting railroads.

[7] Another 29 passengers died as a result of a non-train related incident (e.g., health related deaths).

drop was of short duration; since then, the fatality toll has risen, reaching 487 in 2016—not so far below the average of 516 fatalities per year in the 1990s.

Highway-rail grade crossing fatalities averaged about 260 per year in the 2007-2016 period, or roughly one-third of the total railroad-related fatalities. The number is far fewer than in the 1990s, when the annual grade crossing fatality count averaged about 550 people per year [USDOT FRA 2017a].[8]

A recent statistical description of highway grade crossing accidents over a 10-year period found that only 5 percent of the accidents involved pedestrians; motor vehicles, led by automobiles, comprised the remainder. Male drivers were involved in over 70 percent of the accidents, and had a much higher accident risk rate than females even when their greater travel miles was taken into account. Drivers 19 years and younger and drivers 70 and older, while having relatively few accidents, had the highest accident risk rates when driving mileage by age cohort was taken into account [USDOT FRA 2017b].

Many grade crossings are the locations of repeated incidents, as shown in table 6-3. The list shows crossing locations where 10 or more incidents were reported to the Federal Railroad Administration (FRA) between 2006 and 2016. These incidents involve not only fatalities or injuries, but could also include property damage incidents. Four of the 15 crossings are in the Phoenix, Arizona, metropolitan area. Many trespassing and grade crossing fatalities are the result of suicides. According to FRA, there were 226 suicides in 2016.

[8] Counts of highway-grade crossing fatalities are reported to both rail and highway agencies. In Table 6-1, to avoid double-counting, these fatalities are included in the overall count for highways, but not for rail.

TABLE 6-3 Railroad Grade Crossings With 10 Or More Incidents: 2006–2016

Street	City	State	Total Incidents	Total Fatalities	Total Injuries
Thomas Rd	Phoenix	Arizona	24	0	2
35th Avenue	Phoenix	Arizona	21	0	4
43rd & Camelback	Glendale	Arizona	19	0	3
Front St	Ashdown	Arkansas	16	4	4
27th Avenue	Phoenix	Arizona	15	0	4
Midland Ave	Elmwood Park	New Jersey	14	1	4
Mcgalliard Rd	Muncie	Indiana	14	0	3
N Foster Dr.	Baton Rouge	Louisiana	13	0	0
Bellville Street	Evergreen	Alabama	13	5	1
Industrial Road	Pascagoula	Mississippi	12	0	7
Bessemer Ave	Cleveland	Ohio	12	0	1
Mykawa Road	Houston	Texas	12	0	5
Bethany Home Rd	Glendale	Arizona	10	0	1
Isabella/Plant St	Waycross	Georgia	10	0	1
Castilia St	Memphis	Tennessee	10	2	4

SOURCE: U.S. Department of Transportation, Federal Railroad Administration, *List of Railroad Crossings with Most Incidents over Last Decade*, available at https://www.fra.dot.gov/eLib/details/L17404 as of November 2017.

TABLE 6-4 Transportation Injuries by Mode: 2000, 2010, 2014, and 2015

	2000	2010	2014	2015
TOTAL	**3,218,900**	**2,259,731**	**2,350,490**	**2,443,175**
Air	359	278	266	284
Highway	3,189,000	2,239,000	2,338,000	2,424,000
Railroad	12,057	(R) 8,378	8,702	9,070
Transit	56,697	(R) 25,376	24,045	24,252
Water	4,355	3,770	4,090	3,231
Pipeline	81	(R) 103	95	49
Other counts, redundant with above				
Railroad, injured at public crossing with motor vehicle	1,029	718	663	812
Transit non-rail	42,713	(R) 16,705	16,532	16,839
Transit rail	13,984	(R) 8,671	7,513	7,390

NOTES: Water for the year 2000 only includes recreational boating and does not include additiional categories of water injuries that are included in the 2010 to 2014 data. The sum of the modal numbers is greater than the **TOTAL** because some injuries are counted in more than one mode. *Other counts, redundant with above* help eliminate double counting in the injury **TOTAL**, as follows: For *Railroad, injuries involving motor vehicles at public highway-rail grade crossings* are excluded because such injuries are assumed to be included in Highway injuries. For *Transit, non-rail* mode injuries, including aerial tramway, motor bus, bus rapid transit, commuter bus, demand response, demand taxi, ferryboat, jitney, publico, trolleybus, and vanpool are excluded because they are assumed to be counted as Water and Highway injuries. Please see the National Transportation Statistics table 2-2 for complete source notes and an expanded time-series.

SOURCES: Various sources as cited U.S. Department of Transportation, Bureau of Transportation, *National Transportation Statistics*, table 2-2. Available at www.bts.gov as of April 2016.

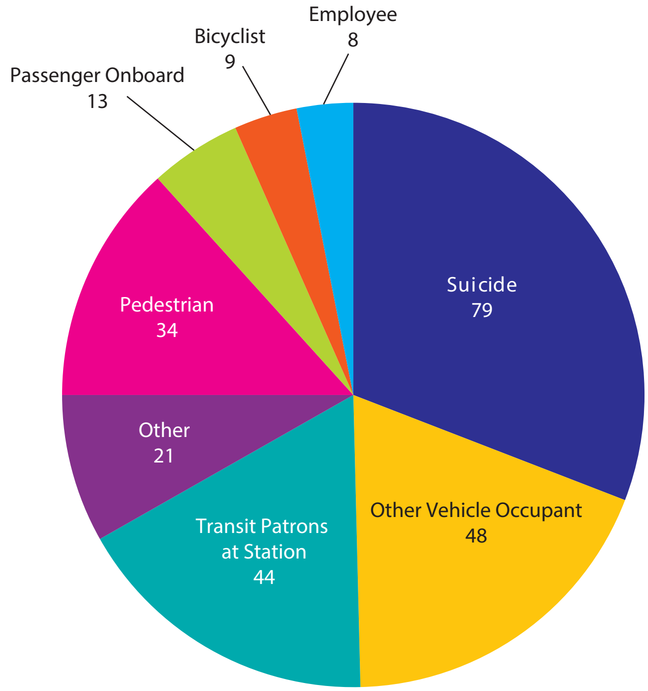
Transit

There were 256 transit fatalities in 2016, slightly above the 2010 to 2015 average of about 245 per year.[9] Like the railroad mode, most of the fatalities in transit-related accidents are not passengers or transit employees on the vehicle. According to the Federal Transit Administration (FTA), passengers on transit vehicles accounted for roughly 5.1 percent of the 2016 fatalities, and transit workers (including contractors) about 3.1 percent. Another 17.2 percent were transit patrons arriving at, waiting, or leaving transit facilities. Pedestrians and bicyclists who were not patrons accounted for 16.8 percent of the transit fatalities, and 18.8 percent of the fatalities were people in nontransit vehicles. About 30.9 percent of the transit fatalities in 2016 were considered suicides (figure 6-7).[10]

[9] Rail transit accounts for slightly more than half of the transit fatalities reported to Federal Transit Administration (FTA) (Table 6-1): however, commuter rail and Port Authority Trans Hudson heavy rail system safety data are counted in Federal Railroad Administration data, not FTA.

[10] In table 6-1 and figure 6-7, the number of transit passenger fatalities includes both passengers on the vehicle and those struck while waiting to get on or who have just gotten off the vehicle. Pedestrians killed in transit accidents on highways, such as pedestrians struck by a transit bus, are reported as highway-related pedestrian deaths in table 6-1. To avoid double counting, pedestrians killed in transit accidents are included in table 6-1 under "Other counts, redundant with above" as "transit, nonrail."

FIGURE 6-7 Transit Fatalities by Category: 2016



NOTES: Pedestrian fatalities includes in crossings, not incrossings, and walking along track.

SOURCE: U.S. Department of Transportation, Federal Transit Administration, National Transit Database, available at https://www.transit.dot.gov/ntd as of November 2017.

Other Modes

There were about 36 fatalities involving waterborne commercial vessels in 2015; this was less than the 2010–2015 average of 78 deaths per year. Pipeline-related fatalities averaged about 16 deaths per year in the 20 years between 1997 and 2016. There were 12 pipeline fatalities in 2015 and 16 fatalities in 2016 arising from all pipeline incidents.[11] Gas pipelines (especially gas transmission pipelines) account for most of the fatalities in most years [USDOT PHMSA].

Injured People by Mode

Injuries in most modes declined between 2000 and 2015. In addition to the fatality data, NHTSA also estimates highway injuries. Unlike fatalities, which are tallied from police accident reports, injuries are estimated from a sample and are subject to sampling errors. Estimated injuries in the highway modes, which account for over 99 percent of transportation injuries, fell from 3.19 million in 2000 to 2.34 million in 2014, before increasing to 2.44 million in 2015—still well below

[11] The USDOT Pipeline and Hazardous Materials Administration groups pipeline incidents under three classifications—serious, significant, and all. The fatality data above are taken from the July 2017 all incidents data pull. Data may change as PHMSA receives additional or amended reports from pipeline entities.

the 2000 level (table 6-5).[12] Not all highway vehicle categories had a decline in injuries over the 15-year period. Motorcyclist injuries rose from about 58,000 in 2000 to 92,000 in 2014, before falling to 88,000 in 2015 [USDOT BTS NTS 2017]. NHTSA estimated that about 6,700 people per day were injured in motor vehicle crashes in 2015.

In addition to the people injured on the Nation's highways, about 20,000 people were injured in nonhighway-related transportation incidents. Rail and rail transit together accounted for about 16,000 of these nonhighway injuries. These numbers do not count people injured in highway-rail crossing incidents, as they are assumed to be included in the highway mode estimate. The water modes had about 3,400 injured people—mostly from recreational boating.

The injury rate for highway crashes per vehicle mile of travel in 2015 was about one-third less than it was in 2000 (figure 6-8). According to the latest National Household Travel Survey, the average occupancy rate[13] for all vehicle types is 1.67. Motorcycles have a 1.16 occupancy rate, which is less than passenger cars (1.55). Large trucks also accounted for 4 percent of all registered vehicles and 9 percent of the total vehicle miles traveled, but only 4 percent of all vehicles involved in injury crashes. Large truck occupant injury rates were 1 to 10 compared to that of passenger car and light-duty truck occupants.

[12] NHTSA had yet to estimate 2016 injuries when this chapter was prepared.

[13] Number of persons per vehicle trip

TABLE 6-5 Fatalities by Highest Blood Alcohol Concentration (BAC) in Highway Crashes: 2000, 2010, 2015 and 2016

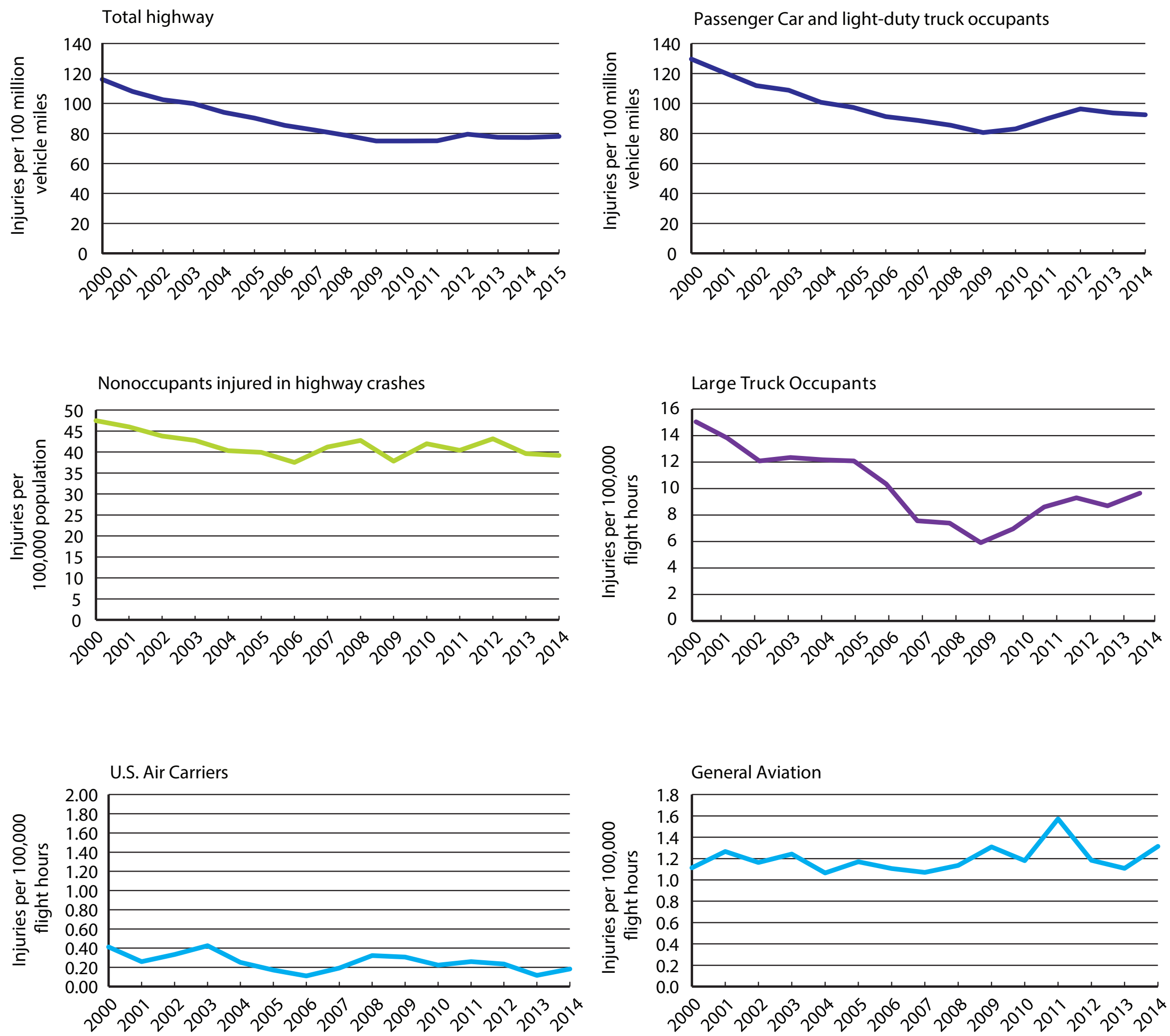
	2000	2010	2015	2016
Total fatalities	**41,945**	**32,999**	**35,485**	**37,461**
Fatalities in alcohol-related crashes (BAC = .01+)	**15,746**	**11,906**	**12,257**	**12,514**
Percent	37.5%	36.1%	34.5%	33.4%
BAC = 0.00				
Number	26,082	21,005	23,119	24,851
Percent	62.2%	63.7%	65.2%	66.3%
BAC = 0.01 - 0.07				
Number	2,422	1,771	1,937	2,017
Percent	5.8%	5.4%	5.5%	5.4%
BAC = 0.08+				
Number	13,324	10,136	10,320	10,497
Percent	31.8%	30.7%	29.1%	28.0%

KEY: BAC = blood alcohol concentration.

NOTES: *Total fatalities* include those in which there was no driver or motorcycle rider present. BAC values have been assigned by U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) when alcohol test results are unknown. *Alcohol-related crashes* pertain to the BAC of the driver and nonoccupants struck by motor vehicles. For some years, numbers for Fatalities in alcohol-related crashes (BAC = .01+) may not add to totals due to rounding.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration as cited in Bureau of Transportation Statistics, *National Transportation Statistics*,table 2-26, available at http://www.bts.gov as of November 2016.

FIGURE 6-8 Injury Rates for Select Modes: 2000–2014, 2015



NOTES: *Passenger car occupants* includes passenger car and light truck occupants. *Highway nonoccupants* includes pedestrians and bicyclists. *Air* includes serious injuries only. *Nonoccupant* includes pedestrians and riders of nonmotorized bicycles and other pedal-powered vehicles. **Total Highway, Passenger Car Occupants, and Motorcycle Operators**: When comparing highway data from 2006 and before to data from later years, it needs to be understood that a revised methodology for estimating registered vehicles and vehicle miles traveled by vehicle type for the highway modes was applied to 2007 data and beyond, and this difference in methodologies needs to be taken into account.

SOURCE: Calculated by U.S. Department of Transportation (USDOT), Bureau of Transportation Statistics (BTS) based upon multiple sources as cited in USDOT, BTS, *National Transportation Statistics*. Tables 1-35, 2-2, 2-9, and 2-14. Available at www.bts.gov as of April 2016.

Costs of Motor Vehicle Crashes

A 2014 study by the Centers for Disease Control and Prevention focused on the health burden and medical costs of both fatal and nonfatal injuries to highway motor vehicle occupants in crashes. The medical costs of fatal injuries in 2011 totaled about $266 million, the latest year for which medical cost data are available. Nonfatal injuries to motor vehicle occupants from crashes in 2012 involved an estimated 2.5 million visits to emergency rooms or other emergency departments, with an estimated 188,000 visits resulting in hospitalization and lifetime costs of $18.4 billion. Put another way, in 2012 there were about 6,900 emergency department visits and over 500 hospitalizations per day resulting from nonfatal crash injuries to motor vehicle occupants [USHSS CDC 2014].

Medical costs are only one component of the costs of crashes. A separate study of the broader economic costs of motor vehicle crashes estimated these costs as $242 billion in 2010 (the latest year for which economic estimates are available) [USDOT NHTSA 2015e]. These economic costs include the following:

- lost workplace productivity—$57.6 billion (23.8 percent of economic costs),
- lost household productivity—$19.7 billion (8.2 percent),
- property damage—$76.1 billion (31.4 percent),
- medical expenses—$23.4. billion (10 percent),
- congestion impacts—$28 billion (11.6 percent), and
- other crash-related costs—$37.0 billion (15.3 percent).

If averaged across the U.S. population in the study year, motor vehicle crashes cost nearly $784 per person in 2010. When factoring in the $594 billion in comprehensive costs from the loss of life, pain, and injuries, the cost of 2010 motor vehicle crashes totaled about $836 billion. Of this total, economic costs represent 29 percent and lost quality of life represent 71 percent [USDOT NHTSA 2015e].

Compared to other motor vehicle crashes, these costs disproportionately involve motorcycle riders who die or incur serious injuries in crashes [USDOT NHTSA 2015e]. Motorcycles provide little protective shielding to riders, compared to enclosed vehicles; also, there has been a dramatic increase in motorcycle vehicles-miles traveled. Measured by VMT, a motorcyclist in a crash was about 30 times more likely to die than a passenger car occupant and 5 times more likely to be injured, according to the study. In 2010 motorcycle crashes cost $12.9 billion in economic impacts and $66 billion in comprehensive societal costs.

Selected Contributing Factors

A multitude of human, environmental, and vehicle factors contribute to transportation crashes. The most commonly cited causes involve driver or operator errors or risky behaviors, such as speeding, and operating vehicles or carrying out transportation operations while under the influence of alcohol or drugs, while distracted, or while fatigued. Environmental factors include roadway or infrastructure design (e.g., short runway, no road shoulders), hazards (e.g., utility poles at the side of the road, hidden rocks under water), and operating conditions (e.g., fog, turbulence, choppy waters, wet roads). Vehicle factors include equipment- and maintenance-related failures (e.g., tire separations, defective brakes or landing gear, engine failure, and worn out parts) [GAO 2003]. Often it is hard to delineate among the various factors. For example, an impaired or fatigued driver may ignore dashboard alerts about potentially dangerous equipment problems (e.g., low tire pressure), or continue to operate the vehicle when unsafe weather conditions would make it prudent to stop.

Human factors are more likely than not to be recorded for fatal crashes involving passenger vehicles. In 2015 one or more driver-related human factors were recorded for two-thirds (66.6 percent) of the drivers of highway passenger vehicles (cars, vans, pickup trucks, and sport utility vehicles) involved in single-vehicle fatal crashes and 50.7 percent of drivers of passenger vehicles involved in multivehicle fatal crashes [USDOT FMCSA 2017]. For comparison, one or more (driver-related) human factors were recorded for 51.3 percent of the drivers of large trucks involved in single-vehicle fatal crashes and for one-third (33.3 percent) of the drivers of large trucks involved in multivehicle fatal crashes [USDOT FMCSA 2017a].

Speeding topped the law enforcement list for driver-related factors for drivers of both passenger vehicles and large trucks in fatal crashes. Impairment (fatigue, alcohol, illness, etc.) closely followed speeding as the second most cited factor for passenger vehicle drivers, while distracted/inattentive driving was second on the list for large-truck drivers [USDOT FMCSA 2017a]. In 2015 vehicle factors, most commonly truck tires, were recorded for 6.4 percent of the large trucks involved in fatal crashes and 2.9 percent of the passenger vehicles involved in fatal crashes [USDOT FMCSA 2017a].

Alcohol Abuse

All 50 States and the District of Columbia limit Blood Alcohol Concentration (BAC) to 0.08 percent while operating a highway vehicle [USDHHS NIH NIAAA 2014]. An average of 1 alcohol-impaired-driving fatality occurred every 50 minutes in 2016. The portion of people killed "inside the vehicle" such as passenger cars and light trucks account for about two-thirds of the fatalities, while those "outside the vehicle" including motorcyclist, pedestrians, bicyclist, and other nonoccupants account for about a third. Alcohol impairment "inside" or "outside" the vehicle may have been a contributing factor in the fatal crash [USDOT NHTSA 2017d]. Table 6-5 shows that about 10,500 people were killed in motor vehicle crashes in 2016 in which a driver or fatally struck nonoccupant or both had a BAC of 0.08 or higher.[14]

[14] According to the USDOT National Highway Traffic Safety Administration, an alcohol-impaired crash involves at least one driver or motorcycle operator with a Blood Alcohol Concentration (BAC) of at least 0.08 gram per deciliter. Crashes where the BAC of the driver or operator measures over 0.01 are considered alcohol-related or alcohol-involved crashes.

TABLE 6-6 Distraction-Affected Motor Vehicle Crashes: 2010–2015

Total crashes	2010	2011	2012	2013	2014	2015
Total	**5,419,000**	**5,338,000**	**5,615,000**	**5,687,000**	**6,064,000**	**6,296,000**
Fatal crash	30,296	29,867	31,006	30,202	30,056	32,166
Injury crash	1,542,000	1,530,000	1,634,000	1,591,000	1,648,000	1,715,000
PDO crash	3,847,000	3,778,000	3,950,000	4,066,000	4,387,000	4,548,000
Distraction-affected crashes	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total	**900,000**	**826,000**	**908,000**	**904,000**	**967,000**	**885,000**
Percent of total crashes	**16.6**	**15.5**	**16.2**	**15.9**	**15.9**	**14.1**
Fatal crash	2,993	3,047	3,098	2,923	2,972	3,196
Percent of fatal crashes	9.9	10.2	10.0	9.7	9.9	9.9
Injury Crash	279,000	260,000	286,000	284,000	297,000	265,000
Percent of injury crashes	18.1	17.0	17.5	17.9	18.0	15.5
PDO crash	618,000	563,000	619,000	616,000	667,000	617,000
Percent of PDO crashes	16.1	14.9	15.7	15.2	15.2	13.6

KEY: PDO = property damage only.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration (NHTSA). *Distracted Driving 2014* (April 2016), Table 6. Available at http://www-nrd.nhtsa.dot.gov/ as of October 2017.

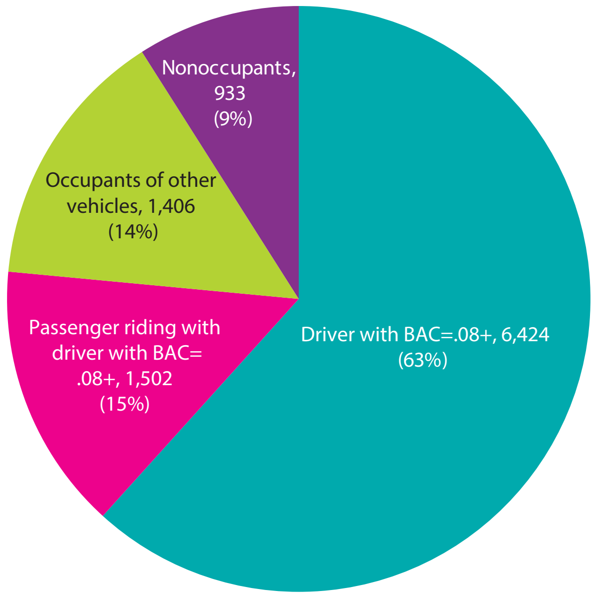
Figure 6-9 displays who died in fatal crashes when the driver had a BAC of 0.08 or higher. Drivers accounted for over 6,400 (63 percent) of the fatalities; about 2,900 were either passengers in the vehicle with an impaired driver or occupants of other vehicles (29 percent), and more than 900 were pedestrians or other nonoccupants (9 percent). Some 25 percent of motorcycle operators in fatal crashes are alcohol-impaired, the highest share of any highway motor vehicle drivers.

As for recreational boating, alcohol use is perennially listed by the USCG as the leading contributing factor in fatal boating accidents. The USCG found alcohol use to be the primary cause in 15 percent of fatal boating accidents in 2016, resulting in 87 deaths. Alcohol presence was noted in the deaths of an additional 46 people, but was not determined to be an accident cause [USDHS USCG 2017]. As of January 1, 2016, 47 States and the District of Columbia limit BAC to 0.08 percent for operators of recreational boats. The remaining three States—North Dakota, South Carolina, and Wyoming—have a 0.10 percent standard. In 2015 Michigan lowered its BAC from 0.10 to 0.08 percent [USDHHS NIH NIAAA 2017].

Speeding coupled with drinking are common factors in many highway crashes. Some 27 percent of traffic fatalities in 2015 were in crashes in which one or more drivers were speeding. Younger male drivers are especially prone to speeding, with nearly one-third (32 percent) of 15 to 24 year old males in fatal crashes found to have been speeding. Some

FIGURE 6-9 Fatalities, by Role, in Crashes Involving at Least One Driver with a BAC of .08 or Higher: 2016

Total fatalitiesinvolving BAC ≥ 0.08 % = 10,497



NOTES: Nonoccupants includes pedestrians, pedalcyclists, and others not listed above.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, *Traffic Safety Facts: Alcohol-Impaired Driving* (Annual Issues), available at http://www-nrd.nhtsa.dot.gov/ as of November 2017.

45 percent of speeding drivers in fatal crashes were found to have been drinking compared to 20 percent among non-speeding drivers in fatal crashes [USDOT NHTSA 2017e]

Substance Abuse

A recent study by the National Transportation Safety Board (NTSB) analyzed toxicology reports on about 6,700 pilots who died in crashes between 1990 and 2012 to attempt to establish baseline data. About 96 percent of the crashes were in general aviation because there were few commercial aviation crashes during that period. The toxicology information was available because the Federal Aviation Administration is able to conduct this testing in follow-up fatal crash investigations.

The NTSB examined illegal drugs (which were assumed to be impairing) and certain legally obtained over-the-counter (OTC) drugs that were considered potentially impairing. These legal pharmaceuticals were considered potentially impairing if the packaging contained a Food and Drug Administration label warning of possible effects from routine usage (e.g., cautions about driving or operating machinery, or possible side effects such as sedation, hallucinations, or behavior changes.) The toxicology results showed increased "use of all drugs, potentially impairing drugs, drugs used to treat potentially impairing conditions, drugs designated as controlled substances, and illicit drugs" during the 23-year period. Diphenhydramine, an antihistamine with sedating properties, was the most common drug found in the toxicology reports that was thought to be potentially impairing. Diphenhydramine is found in many over-the-counter allergy formulations, cold medications, and sleep aids. NTSB found few cases of illicit drug use, but noted that there was an increase in positive tests for marijuana usage during the last 10 years of the study (2002 to 2012).

The NTSB examined whether pilots who had used potentially impairing drugs had increased risk of involvement in certain accident types. However, it found no statistically significant difference in the distribution of accident events from 2008 through 2012 in crashes involving pilots with and without evidence of potentially impairing drugs [NTSB 2014b].

In recent years, several States have legalized or are considering legalizing the use of marijuana. This trend has raised concerns about the effects of marijuana use on driver performance and traffic safety. The American Automobile Association (AAA) Foundation for Traffic Safety conducted several studies to quantify the prevalence of driving under the influence of marijuana. The AAA's annual online sample survey on traffic safety culture reported that 4.6 percent of respondents reported that they drove within 1 hour of using marijuana. (The annual survey was conducted from 2013 to 2015 and included 6,612 respondents.) Male drivers, 18 to 24 years of age, and those who lived in the Midwest were most likely to report having driven within 1 hour of using marijuana. Moreover, drivers who reported using marijuana within 1 hour of driving were less likely to believe that using marijuana increased the risk of crashing and more likely to believe that such usage does not affect or decreases the risk of crashing [AAA 2016a].

Another AAA study focused on marijuana involvement in fatal crashes in Washington State from 2010 to 2014. Using toxicology test data from the Washington State Safety Commission, AAA found that the number of drivers in marijuana-involved fatal crashes more than doubled from 49 (8.3 percent) in 2013 to 106 (17.0 percent) in 2014. Prior to legalization in December 2012, the number and proportion of drivers testing positive for marijuana were fairly stable, but then began to rise about 9 months after the law was passed [AAA 2016b].

Distraction and Fatigue

Distracted and fatigued vehicle operators are found in all modes of transportation, including airline pilots, bus drivers, train engineers, and tugboat operators [NTSB 2014c]. In 2015, 3,196 fatal highway crashes and an estimated 265,000 injury crashes involved distracted drivers. This was about 10 percent of fatal crashes, 15 percent of injury crashes, and 14 percent of property-damage-only crashes involving a motor vehicle (table 6-6). Drivers under the age of 30 are disproportionately represented in distraction-affected fatal crashes, and especially drivers aged 15 to 19 years [USDOT NHTSA 2017f]. Figures 6-10a and 6-10b show the trend on the percent of distracted driving-related highway fatalities and injuries (the fatality data begin with 2010

FIGURE 6-10a Distracted Driving Fatalities: 2010-2015

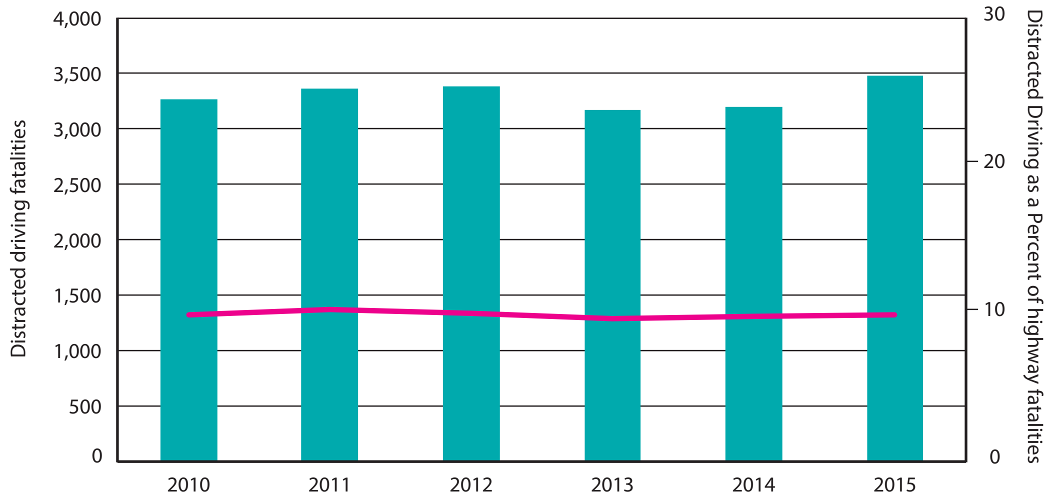
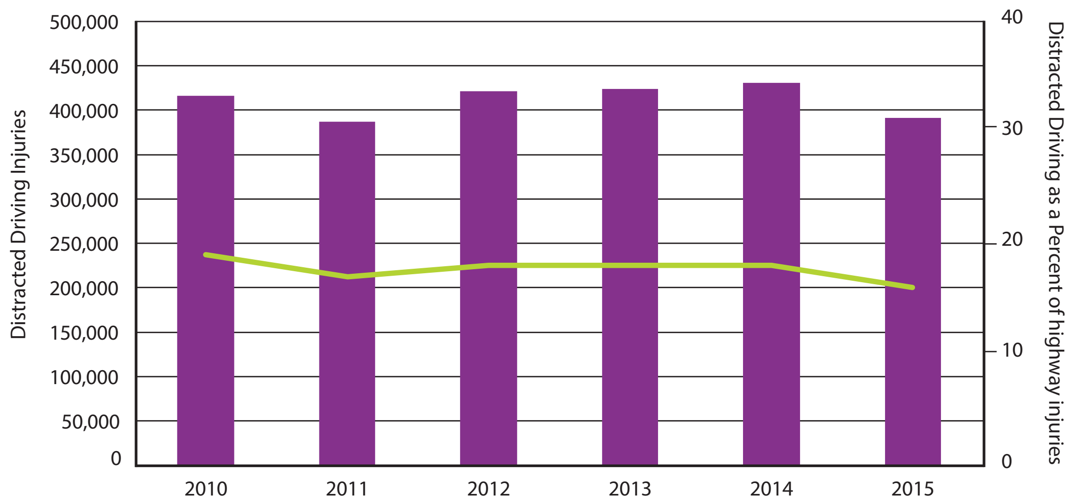


FIGURE 6-10b Distracted Driving Injuries: 2010-2015



NOTES: Distracted driving involves any activity that could divert a person's attention away from the primary task of driving, such as texting, using a cell phone, eating and drinking, grooming, using a navigation system, adjusting a radio, etc. Distracted driving fatality data for 2010 and on are not comparable with previous years due to changes in methodology.

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, Traffic Safety Facts, Research Note, *Distracted Driving 2014*, available at www.nhtsa.gov as of April 2016.

due to a change in methodology, making earlier data not comparable).

Some 3,477 people died in distraction-affected crashes in 2015, and about 391,000 were injured. Vehicle occupants comprised 84 percent of the fatalities. There were 551 nonoccupants who died, mostly pedestrians in distraction-affected crashes. It is not known how many nonoccupants were also distracted when struck (e.g., walkers absorbed in a cell phone conversation).

Although many other activities (e.g., eating, sipping coffee, smoking, grooming, tending to a child, adjusting a radio) are distracting to drivers, bicyclists, and pedestrians, cell phone use and texting have received the most attention as these devices have attained nearly universal usage in the last few years. Cellphones were in use in about 14 percent of fatal crashes involving a distracted driver in 2015, comprising about 1.4 percent of all fatal crashes [USDOT NHTSA 2017f]. Figure 6-11 shows that 14 States, the District of Columbia, and Puerto Rico prohibit drivers' use of handheld cellphones; and 47 states plus the District of Columbia and Puerto Rico ban texting while driving.

In 2014[15] drowsy and fatigued driving was considered a related factor in 846 highway fatalities (2.6 percent). However, it is likely that fatigue-related crashes are underestimated [AAA 2014]. Measuring the exact number of drowsing-related fatalities is difficult, although research is underway to improve methods. Drowsy-driving crashes often occur in rural areas, with the vehicle going off the road at high speed without braking and with no other vehicle occupant besides the driver [USDOT NHTSA 2016e]. About 57 percent of fatal crashes in rural areas involve a single-vehicle [IIHS].

Distracted or inattentive driving by commercial motor vehicle drivers was a contributing factor in 6.1percent of fatal crashes involving large trucks in 2015 [USDOT FMCSA 2017a]. In addition, truck driver impairment (e.g., fatigue, drugs/alcohol, illness, etc.) was a factor in 3.3 percent of fatal crashes [USDOT FMCSA 2017a].

Lives Saved by Occupant Protection Equipment

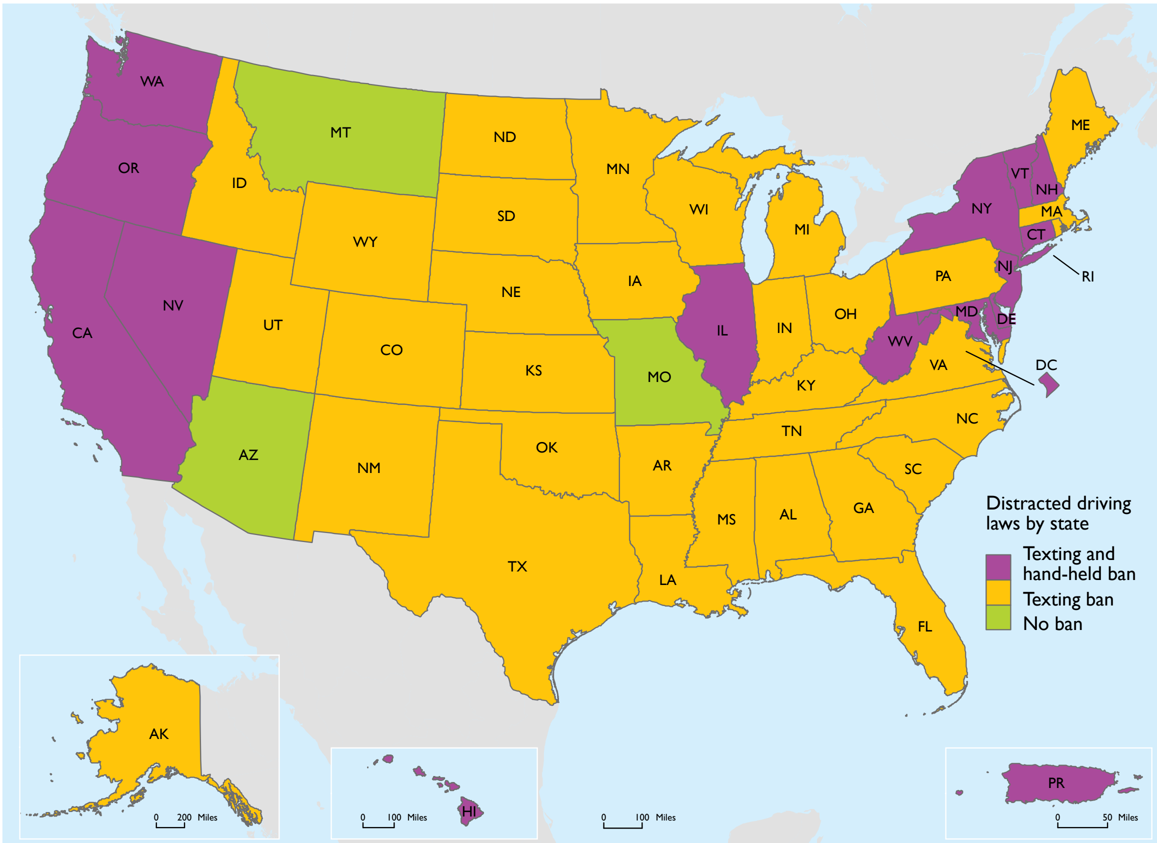
When properly used, safety devices significantly reduce the risk of death or serious injury. The NHTSA estimated that more than 20,000 lives were saved on the highways in 2016—up from more than 17,000 in 2010—by occupant protection devices, including seat belts, frontal air bags, child restraints, and motorcycle helmets, as shown in table 6-8. Seat belts saved over 14,000 lives, frontal air bags about 2,800, child restraints about 300, and DOT-compliant motorcycle helmets nearly 1,900 lives in 2016 (table 6-7).

Seat Belt Use

About 90.1 percent of occupants of cars, vans, and sport utility vehicles (SUVs) used safety belts in 2016, up from 70.7 percent in 2000 and 85.1 percent in 2010, and 88.5 percent in 2015 [USDOT NHTSA 2017g, 2016g]. Pickup truck occupants had the lowest usage at 83 percent in 2015, up from 81percent in 2014 (Table 6-8).

[15] 2015 data are not available.

FIGURE 6-11 State Laws on Distracted Driving: July 2017



NOTES: A primary law means that an officer can ticket the driver for the offense without any other traffic violation taking place. A secondary law means an officer can only issue a ticket if a driver has been pulled over for another violation (like speeding). Hand-held Cell Phone Use: 14 states, D.C., Puerto Rico, Guam and the U.S. Virgin Islands prohibit all drivers from using hand-held cell phones while driving. All are primary enforcement laws—an officer may cite a driver for using a hand-held cell phone without any other traffic offense taking place. Text Messaging: Washington was the first state to pass a texting ban in 2007. Currently, 47 states, D.C., Puerto Rico, Guam and the U.S. Virgin Islands ban text messaging for all drivers.

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, *State Laws on Distracted Driving*, available at http://www.distraction.gov/stats-research-laws/state-laws.html as of November 2017.

TABLE 6-7 Estimated Lives Saved by Selected Safety Features: 2000, 2010, 2015, and 2016

	2000	2010	2015	2016
Child Restraints, Age 4 and Younger	479	303	272	328
Seat Belts, Age 5 and Older	12,882	12,670	14,067	14,668
Frontal Air Bags, Age 13 and Older	1,716	2,403	2,596	2,756
Motorcycle Helmets, All Ages	872	1,551	1,800	1,859
Minimum Drinking Age Law	922	560	542	552

SOURCE: U.S. Department of Transportation, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts* (Washington, DC: Annual Issues). Available at http://www-nrd.nhtsa.dot.gov/ as of October 2017 as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-31. Available at http://www.bts.gov as of November 2017.

TABLE 6-8 Safety Belt and Motorcycle Helmet Use: 2000, 2010, 2015, and 2016
Percent

	2000	2010	2015	2016
Overall safety belt use	**71**	**85**	**89**	**90**
Drivers	72	86	89	91
Right-Front Passengers	68	83	87	89
Passenger cars	74	86	90	91
Vans and sport utility vehicles	U	88	90	92
Pickup trucks	U	75	81	83
Motorcycle helmet use[b]	**71**	**54**	**61**	**65**
Operators	72	55	64	68
Passengers	62	51	46	53

KEY: U = data are unavailable.

[a] Seat belt use is as of the Fall each year. Motorcycle helmet use is as of the Fall each year.

[b] Only those operators and riders wearing safety helmets that met U.S. Department of Transportation (DOT) standards are counted. Those safety helmets that do not meet DOT standards are treated as if the operator/rider were not wearing a helmet.

NOTE: Occupants of commercial and emergency vehicles are excluded.

SOURCE: U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration, Traffic Safety Facts: Research Notes, *Seat Belt Use* (Annual issues); and *Motorcycle Helmet Use—Overall Results* (Annual issues). Available at http://www-nrd.nhtsa.dot.gov as of October 2017 as cited in USDOT, Bureau of Transportation Statistics, *National Transportation Statistics*, table 2-30, available at http://www.bts.gov as of November 2017.

Regionally, in 2015, seat belt use is highest in the western United States (about 95 percent) and lowest in the Midwestern states (82 percent). States with primary enforcement laws, allowing police to ticket vehicle occupants solely for not wearing seat belts, have higher belt usage (91 percent in 2015) than states with weaker enforcement (79 percent) [USDOT NHTSA 2016e].

Seat belt use is most effective in conjunction with air bags, which deploy automatically in crashes. Recalls to replace defective airbags and other occupant protection equipment sometimes are undertaken, most dramatically in the ongoing case of airbags outlined in box 6-d.

Helmet Use

DOT-compliant motorcycle helmets reduce the risk of dying in a motorcycle crash and also reduce emergency medical care, hospitalization, intensive care, rehabilitation, and long-term care following crashes [NTSB 2010]. Overall usage of DOT-compliant helmets has declined from 71.0 percent in 2000 to 65.3 percent in 2016 (table 6-8). Only 19 states and the District of Columbia have a universal helmet law, 28 states have a partial law covering certain riders and passengers (e.g., those under the age of 18), and 3 states (Illinois, Iowa, and New Hampshire) have no motorcycle helmet law (figure 6-12). Helmet use seems partially correlated to state

Box 6-D Air Bag Recall

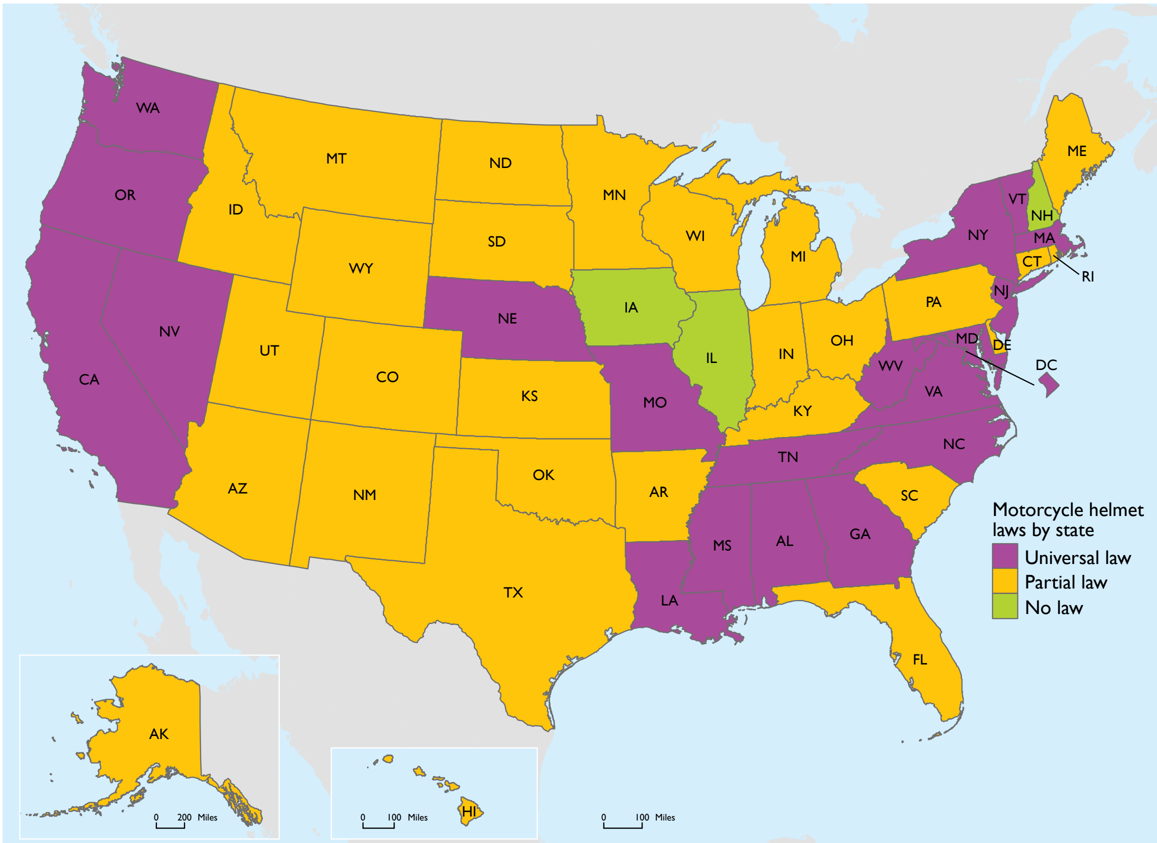
According to the National Highway Transportation Safety Administration (NHTSA), Takata air bags have been installed in tens of millions of U.S. vehicles. As of early October, 2016, 11 U.S. fatalities and more than 100 injuries have been linked to a defect in the airbag inflator and propellant devices, causing them to rupture and send metal shards into vehicle occupants during a crash [USDOT NHTSA 2016c and 2016h]. The root cause of the ruptures is the degradation of the ammonia nitrate propellant over time and when exposed to high humidity and fluctuating high temperatures, which in turn causes the propellant to burn too quickly and rupture.

NHTSA, which is charged with ensuring the safety of motor vehicles in the United States, initiated a formal defect investigation of the Takata air bag inflators in June 2014 [USDOT NHTSA 2015f], which resulted in a recall of 28.8 million airbags. Of that total, nearly 11.4 million have been repaired (5.1 million passenger-side air bags and 6.3 million driver side air bag) as of October 7, 2016 [USDOT NHTSA 2016b].

On May 4, 2016, NHTSA expanded the recall to include an additional 35–40 million air bag inflators to the already recalled 28.8 million. The expanded recall of inflators means that all Takata ammonium nitrate-based propellant air bag inflators that do not have a chemical drying agent, also known as a desiccant, will be recalled. The expanded recall will be handled in five phases over the May 2016 to December 2019 period, and based on risk factors, such as an inflator's age and its exposure to high humidity and fluctuating high temperatures [USDOT NHTSA 2016c].

The Takata air bag recall is the largest safety recall in U.S. history. Takata reached an agreement with NHTSA to pay $200 million in civil penalties and to phase out supplying ammonium nitrate inflators to fulfill existing contracts by no later than December 31, 2018 [USDOT NHTSA 2015a]. In January 2017, Takata agreed to plead guilty to wire fraud and to pay $1 billion in criminal penalties for fraudulent conduct in selling the defective inflators [USDOJ 2017]. In June, 2017, Takata filed for bankruptcy. Federal law (Section 3012A of Title 49 of the U.S. Code) specifies recall obligations in the event of bankruptcy, indicating that filing a bankruptcy petition does not negate the manufacturers recall duties [USDOT NHTSA 2013].

FIGURE 6-12 State Laws on Motorcycle Helmet Use: August 2017



SOURCE: Insurance Institute for Highway Safety, *Motorcycle Helmet Use*, available at www.iihs.org as of August 2017.

requirements. In 2016, 79.6 percent of riders wore DOT-compliant helmets in states that required helmet use, while 53.5 percent of riders wore DOT-compliant helmets in states that do not require their use [USDOT NHTSA 2017h]. Noncompliant helmets were worn by 14.9 percent of riders in states requiring helmet use and 3.6 percent in states not requiring helmet use. In 1975, 47 states and the District of Columbia had adopted universal helmet use laws that required motorcycle helmets for all riders, but many states have subsequently made their helmet laws less restrictive [COSGROVE 2007].

Life Jackets and Boat Safety Training

About 8 out of 10 people who died in boating accidents in 2016 drowned, and about 83 percent of those who drowned were not wearing a life jacket [USDHS USCG 2017]. Even if not legally required, operators of boats can insist that their passengers wear life jackets. Most states require mandatory recreational boating education and safety training courses, but eight states do not (Alaska, Arizona, California, Idaho, Maine, South Dakota, Utah, and Wyoming). Boater education helps reduce the risk of boating accidents and death [NTSB

2013], and about 42.6 percent of U.S. boat owners have taken a boating safety course. Most boating fatalities occur on vessels in which the operator had no formal instruction in boating safety. Only 13 percent of deaths in fatal boating accidents in 2016 occurred in boats operated by a person known to have received a certificate for boating safety from such providers—an improvement from 23 percent in 2014 [USDHS USCG 2017].

Traffic Safety Enforcement

Traffic safety enforcement promotes good driving habits (e.g., wearing a safety belt) and discourages unsafe behaviors (e.g., impaired driving) [USDOT NHTSA 2014b]. According to the Bureau of Justice Statistics, in 2011 about 10.2 percent of the Nation's 212.3 million drivers were stopped by police while operating a motor vehicle, 5.3 percent of these drivers were ticketed, 3.4 percent were given a verbal or written warning, and 1.4 percent were allowed to proceed with no enforcement action taken [USDOJ BJS 2013].

Speeding was cited as the leading reason for a traffic stop, accounting for 46.5 percent, followed by vehicle defects (e.g., broken tail light) with 14.1 percent. Males were more likely to be stopped and ticketed than females, accounting for 58.8 percent of ticketed drivers. Drivers who were 25 to 34 years of age accounted for about 22.4 percent of stopped drivers, which is the highest percentage among all age groups [USDOJ BJS 2013]. However, this age group accounted for only 13.7 percent of VMT [USDOT FHWA 2011].

In 2015, according to the Federal Bureau of Investigation, law enforcement agencies across the country made an estimated 1.1 million arrests for driving under the influence [USDOJ FBI 2017]. Males accounted for three out of four DUI arrests [USDOJ FBI 2017]. Studies have shown sobriety checkpoints are an effective countermeasure to reduce alcohol-impaired driving, reducing alcohol-related crashes by roughly 20 percent [USDHHS CDC NCI 2015].

The Federal Motor Carrier Safety Administration (FMCSA) is responsible for reducing crashes, injuries, and fatalities involving the Nation's approximately 521,200 interstate freight carriers, 13,300 interstate passenger carriers, and 16,600 interstate hazardous material carriers [USDOT FMCSA 2017b]. In fiscal year 2016, over 3.4 million roadside inspections were conducted (table 6-9). Over 34,670 warning letters were issued to carriers whose safety data showed a lack of compliance with motor carrier safety regulations and whose safety performance had fallen to an unacceptable level [USDOT FMCSA 2017c]. Table 6-9 shows the number of inspection, which may result in out-of-service (OOS) violations that must be corrected before the driver or vehicle can return to service. Vehicle violations, such as defective lights, worn tires, or brake defects put 27.7 percent of inspected vehicles out-of-service.

To comply with Federal hours of service regulations, truck drivers are required to take 10 consecutive hours off after driving a maximum of 11 hours and to take 30-minute rest periods after 8 hours of driving [USDOT FMCSA 2011]. Consequently, drivers need to find parking facilities that will give drivers

TABLE 6-9 Inspection Summary: 2010 and 2016

	2010	2016
Roadside inspections	**3,569,373**	**3,418,886**
With no violations	1,225,324	1,418,401
With violations	2,344,049	2,000,485
Driver inspections	**3,470,871**	**3,300,964**
With OOS Violations	183,350	187,597
Driver OOS Rate	5.3%	5.7%
Vehicle inspections	**2,413,094**	**2,348,391**
With OOS Violations	480,416	650,909
Vehicle OOS Rate	19.9%	27.7%
Hazardous material inspections	**211,154**	**200,479**
With OOS Violation	9,210	10,373
Hazmat OOS Rate	4.4%	5.2%

KEY: OOS = out-of-service.

NOTES: *Driver Inspections* were computed based on inspection levels I, II, III, and VI. *Vehicle Inspections* were computed based on inspection levels I, II, V, and VI. *Hazmat Inspections* were computed based on inspection levels I, II, III, IV, V, and VI when hazardous materials were present. *Roadside inspection* OOS rates depicted in this table include both large trucks and buses. For more information on roadside inspections and inspection levels, please refer to https://csa.fmcsa.dot.gov.

SOURCE: U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Motor Carrier Management Information System (MCMIS), *Roadside Inspection Activity Summary for Fiscal Years*, October 2017.

off-road places to stop to rest while not posing a safety hazard to others on the road.

A 2015 FHWA survey showed a shortage of truck parking facilities, especially along major freight corridors, such as I-95, I-40, and I-10, and in metropolitan areas [USDOT FHWA 2015]. Also, many states do not allow overnight or extended parking at public rest areas [USDOT FHWA 2012]. The shortage of truck parking facilities poses a safety risk not only to truck drivers but also other motorists, as some commercial drivers could decide to drive on while tired or to park in unsafe locations along road shoulders and highway entrance and exit ramps [USDOT FHWA 2015]. Driver violations put 5.7 percent out-of-service, often due to noncompliance with hours-of-service regulations. As was discussed earlier, fatigue is a factor in many crashes.

Hazardous Materials Transportation

Transporting hazardous materials requires special precautions, handling, and packaging. There are specialized safety regulations, standards, and reporting systems in place for pipelines, rail, highway, air, and marine vehicles that transport hazardous materials.

These special requirements recognize that incidents involving the transportation of hazardous materials can affect the environment in addition to potentially risking injury and death. Table 6-10 shows that, in 2016, more than 18,200 hazardous materials incidents (excluding pipeline incidents) were reported to the USDOT Pipeline and Hazardous Materials Administration (PHMSA)—up from about 16,500 in 2015 [USDOT PHMSA 2017b].

About 1.4 percent of hazardous materials transportation incidents in 2016 were the result of an accident (e.g., vehicular crash or train derailment). About 90 percent of these incidents related to the movement of hazardous materials occurred on highways or in truck terminals. Most hazardous materials incidents occur because of human error or package failure, particularly during loading and unloading.

The above incidents do not include pipelines which are reported separately to PHMSA. Table 6-11 provides a summary of all 635 hazardous liquid-related and gas-related pipeline incidents reported in 2016, which resulted in 17 fatalities, 82 injuries, and $308 million in property damage (down from $1.7 billion in 2010, reflecting the incident specific nature of property damage). Hazardous liquids accounted for well over half the incidents and property damage. Gas distribution and transmission accounted for all but one of the fatalities and all of the injuries in 2015 (table 6-11).

TABLE 6-10 Hazardous Materials Transportation Incidents: 2010 and 2014–2016

	2010	2014	2015	2016
Total incidents	**14,795**	**17,401**	**16,588**	**18,238**
Total vehicular accident / derailment incidents	**358**	**351**	**286**	**263**
Vehicular accident-related percent of total incidents	**2.4**	**2.0**	**1.7**	**1.4**
Air	1,295	1,327	1,074	1,198
Vehicular accident-related	2	3	2	3
Highway	12,648	15,310	14,923	16,485
Vehicular accident-related	320	330	251	235
Rail	747	717	567	544
Vehicular accident-related / derailment incidents	35	18	32	24
Water[1]	105	47	24	11
Vehicular accident-related	1	0	1	1

[1] Water include only packages (nonbulk) marine. Non-packaged (bulk) marine hazardous material incidents are reported to the U.S. Coast Guard and are not included.

NOTES: *Incidents* are defined in the Code of Federal Regulations (CFR): 49 CFR 171.15 and 171.16 (Form F 5800.1). Each modal total also includes fatalities caused by human error, package failure, and causes not elsewhere classified. *Accident-related* are the result of a vehicular crash or accident damage (e.g., a train derailment).

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, *HAZMAT Intelligence Portal* (as of April 17, 2016), available at https://hip.phmsa.dot.gov/ as of April 2017.

TABLE 6-11 All Reported Hazardous Liquid and Gas Incidents: 2010–2016

	TOTAL - all reported					
	Number	Fatalities	Injuries	Property damage as reported	Barrels spilled (Haz Liq)	Net barrels lost (Haz Liq)
2010	586	22	108	$1,692,500,877	100,558	49,452
2011	592	14	56	$426,551,870	89,110	57,375
2012	573	12	57	$229,613,337	45,884	29,247
2013	619	9	44	$349,961,947	117,467	85,598
2014	707	19	95	$310,257,400	47,083	21,686
2015	715	12	49	$344,188,043	103,607	81,953
2016	635	17	82	$308,344,675	86,154	53,083

KEY: *Haz Liq* = Hazardous Liquid, *LNG* = Liquefied Natural Gas, R = revised, U = Data unavailable.

NOTES: *Hazardous Liquid* includes crude oil; refined petroleum products (e.g., gasoline, diesel, kerosene); highly volatile, flammable, and toxic liquids (e.g., propane); liquid carbon dioxide; and biodiesel. *Gross Barrels Spilled* is the amount before clean-up, whereas *Net Barrels Lost* is the amount after clean-up is attempted.

Incident means any of the following events: 1) An event that involves a release of gas from a pipeline, or of liquefied natural gas, liquefied petroleum gas, refrigerant gas, or gas from an LNG facility, and that results in one or more of the following consequences: i) A death, or personal injury necessitating in-patient hospitalization; ii) Estimated property damage of $50,000 or more. *Accident* is a failure in a pipeline system in which there is a release of the hazardous liquid or carbon dioxide transported resulting in any of the following: a) Explosion or fire not intentionally set by the operator. b) Release of 5 gallons (19 liters) or more of hazardous liquid or carbon dioxide.

Please see the Pipeline and Hazardous Materials Safety Administration's Incident Report Criteria History for a complete definition of past and present reporting requirements, which is available at https://hip.phmsa.dot.gov/Hip_Help/pdmpublic_incident_page_allrpt.pdf as of April 2016.

SOURCE: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, *HAZMAT Intelligence Portal*. Available at https://hip.phmsa.dot.gov/ as of April 2017.

A new challenge for freight transportation safety relates to accidents involving tanker trucks and trains carrying hazardous materials. Chapter 3 discusses the rapid growth in domestic transportation, some of which involves hazardous materials. According to the Commodity Flow Survey (CFS), liquid hazardous materials tonnage increased 15.6 percent between 2007 and 2012; part of the increase could be a result of increased CFS coverage [USDOT BTS 2015]. Some 58.7 percent of hazardous liquid tonnage was moved by truck and 2.1 percent by rail in 2012. As for flammable solids, rail moved 32.9 percent of the tonnage and trucks transported 59.7 percent. Liquid hazardous materials include gasoline, fuel oils, and ethanol, while flammable solids include metal powders, shavings, and cuttings; rubber scrap; and molten sulfur, among other spontaneous combustible materials.

There has been a dramatic increase in hazardous liquid train traffic, as discussed in chapter 3, and several derailments resulting in explosions and fireballs have occurred in this country, resulting in evacuations of several communities. In Canada, the rail catastrophe in Lac-Mégantic, Quebec, resulted in 47 deaths in 2013. See box 6-E for more on rail tank car safety.

Box 6-E Rail Tank Car Safety

Section 7308 of the *Fixing America's Surface Transportation Act* (FAST Act; P. L. 114-94; December 4, 2015) requires the U.S. Department of Transportation (DOT) to assemble and collect data on rail tank cars transporting Class 3 flammable liquids. The objective of this legislation is to track the progress in upgrading the rail tank car fleet to new safety requirements. By the end of 2029, rail tank cars carrying class 3 flammable liquids must meet the DOT-117 or DOT-117R specification or equivalent.

According to the recent BTS report, 81,027 tank cars were used in 2016 to transport Class 3 flammable liquids, accounting for 20 percent of all tank cars. Most of these tank cars were non-jacketed DOT-111 specification (53 percent of the fleet), followed by the non-jacketed CPC-1232 (15 percent) and the jacketed CPC-1232 (10 percent).[1] The newer DOT-117 and 117R tank cars grew from less than 100 cars in 2013 (76 cars) to 7,181 tank cars, or approximately 9 percent of the fleet used to transport Class 3 flammable liquids in 2016.

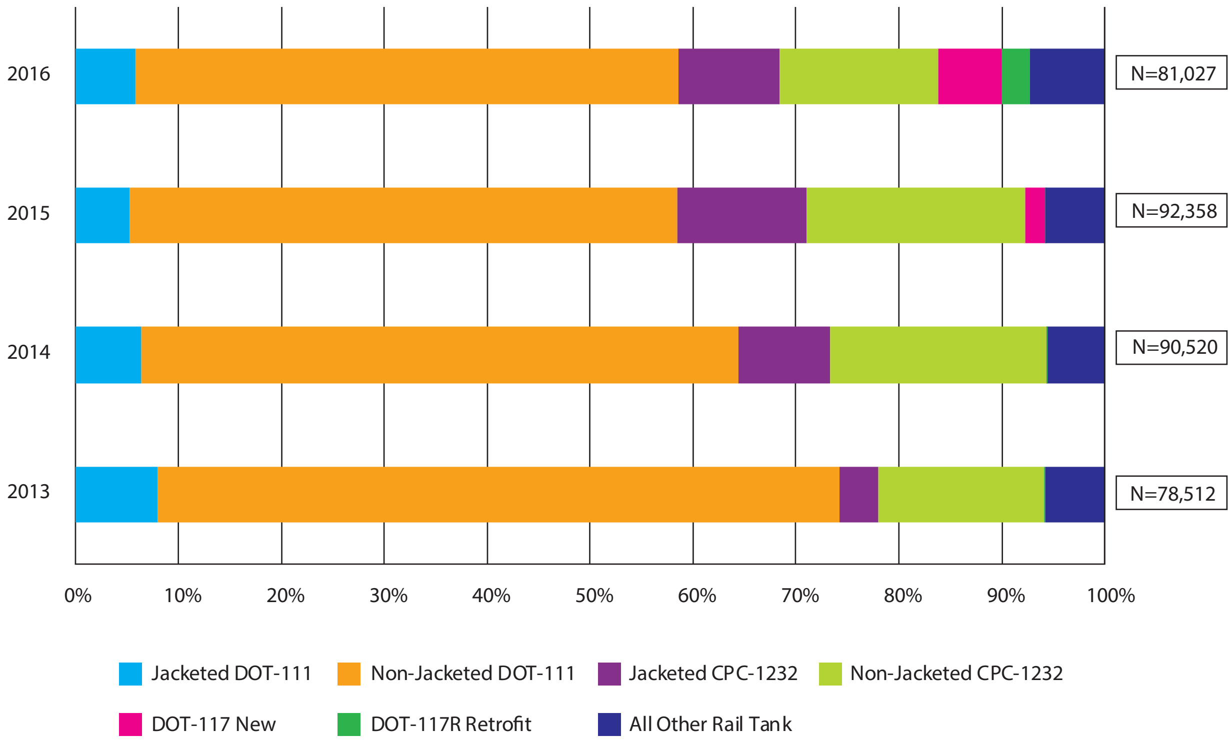
[1] Jacketed tank cars have a layer of insulation/thermal protection between the tank shell and jacket that stabilizes the temperature of the liquid contained in the tank car, and reduce the conductivity of heat from outside sources to the contents of the tank car.

As of the end of 2016, 9 percent of the tank cars used to carry Class 3 flammable liquids met the new safety requirements, a dramatic increase from the 2 percent in 2015. Among the fleet of rail tank cars that meet the DOT- 117 specification, 70 percent (4,966 tank cars) are new and 30 percent (2,215 tank cars) have been retrofitted. While the DOT-117 and DOT-117R tank cars carry a variety of flammable liquids, nearly 9 out of 10 of these tank cars carry crude oil or ethanol (41 percent and 46 percent, respectively).

While the non-jacketed DOT-111 tank cars still represent most of the fleet used to transport flammable liquids, with 42,714 tank cars in operation in 2016, their numbers have declined since 2013 when 52,021 DOT-111 tank cars (66 percent of the fleet) were reported carrying flammable liquids on the railroads. In addition, the percentage of non-jacketed DOT-111 cars carrying crude oil has also shown a noticeable decline. In 2013, 25 percent of these cars transported crude oil as compared to less than 1 percent in 2016.

For the complete *Fleet Composition of Rail Tank Cars That Transport Flammable Liquids: 2013–2016* report, please visit the BTS website at http://www.bts.gov.

FIGURE 6-13 Fleet Composition of Rail Tank Cars Carrying Class 3 Flammable Liquids: 2013–2016



NOTE: All Other Rail Tank Cars includes DOT-105, DOT-112, DOT-114, DOT-115, DOT-120, and DOT-211.

SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics. Special analysis based on data provided by the Association of American Railroads: *UMLER® and TRAIN II® rail tank car and annualized rail tank car movements, 2013-2016*, as of June 7, 2017.

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