HLDI
Highway Loss Data Institute

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IIHS crashworthiness evaluation programs and the U.S. vehicle fleet — a 2019 update

The Insurance Institute for Highway Safety (IIHS) conducts several different vehicle crashworthiness evaluation programs to assess the risk of serious injury in automobile crashes. The purpose of this analysis is to quantify how the crashworthiness ratings for vehicles in the U.S. fleet have changed over time. This is the fifth report by the Highway Loss Data Institute (HLDI, 2013, 2016, 2017, 2018) on this topic.

IIHS first began crash testing in 1995 with the moderate overlap frontal test. By 2018, 77 percent of registered vehicles could be assigned front crash ratings. As of the end of this study period, good-rated vehicles represented 64 percent of registered vehicles and 83 percent of the rated vehicle population.

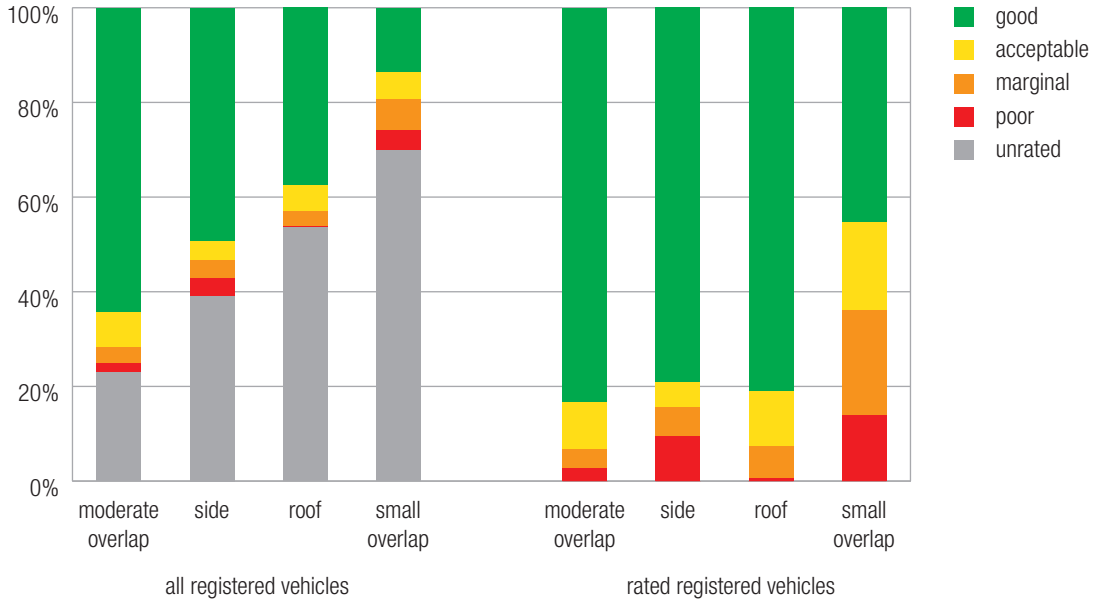
IIHS began conducting side impact crash tests in 2003, and by 2018, ratings could be assigned to 61 percent of the registered fleet. Forty-nine percent of the fleet and 79 percent of rated vehicles had achieved a good rating.

In 2009, IIHS began roof strength testing, and by 2018, 46 percent of the fleet could be assigned ratings. Thirty-eight percent of the fleet and 81 percent of the rated vehicle population had earned a good rating.

Most recently in 2012, IIHS began small overlap frontal crash testing, and by 2018, 30 percent of the fleet could be assigned ratings. Fourteen percent of the fleet and 45 percent of the rated vehicle population earned a good rating.

Test ratings for the 2018 calendar year are shown below for all registered vehicles and rated vehicles.

Test ratings for all registered vehicles and rated vehicles, 2018 calendar year



Introduction

The Insurance Institute for Highway Safety (IIHS) currently conducts four vehicle crashworthiness evaluation programs aimed at improving occupant protection in severe crashes, including the moderate overlap frontal, side impact, roof strength, and small overlap frontal test programs. The crash modes these tests address represent a large portion of serious injury and fatal crashes.

Annual fatal crash rates for automobiles have been dropping steadily since the early 1980s with recent increases in deaths for 2015 and 2016. The purpose of this Highway Loss Data Institute (HLDI) study is to quantify crashworthiness improvements that have been made to the U.S. vehicle fleet as measured by the IIHS testing programs.

IIHS crashworthiness evaluation programs and research on occupant death and injury risk

In the moderate overlap frontal test, a vehicle travels at 40 mph toward a barrier with a deformable face made of aluminum honeycomb. A Hybrid III dummy representing an average-size man is positioned in the driver seat. Forty percent of the total width of the vehicle strikes the barrier on the driver side. The forces in the test are similar to those that would result from a frontal offset crash between two vehicles of the same weight, each going just less than 40 mph.

An analysis of 14 years' worth of crash data involving IIHS-rated vehicles shows that a driver of a vehicle rated good in the moderate overlap frontal test is 46 percent less likely to die in a frontal crash, compared with a driver of a vehicle rated poor. A driver of a vehicle rated acceptable or marginal is 33 percent less likely to die than a driver of a poor-rated one (IIHS, 2006).

In the IIHS side test, a 3,300-pound SUV-like barrier hits the driver side of the vehicle at 31 mph. Two SID-II dummies representing a small (5th percentile) woman and a 12-year-old child are positioned in the driver seat and the rear seat behind the driver.

IIHS side crash ratings encourage automakers to equip vehicles with side airbags with head protection, which reduce a car driver's risk of death in driver-side crashes by 37 percent and an SUV driver's risk by 52 percent. In contrast, side airbags designed to protect only the torso reduce fatality risk by 26 percent for car drivers and by 30 percent for SUV drivers (McCartt & Kyrychenko, 2007). Above and beyond this benefit, a driver of a vehicle rated good is 70 percent less likely to die in a left-side crash, compared with a driver of a vehicle rated poor. A driver of a vehicle rated acceptable is 64 percent less likely to die, and a driver of a vehicle rated marginal is 49 percent less likely to die (Teoh & Lund, 2011).

In the IIHS roof strength test, a metal plate is pushed against one side of the vehicle's roof at a constant speed. To earn a good rating, the roof must have a strength-to-weight ratio of at least 4. In other words, it must be able to withstand a force of 4 times the vehicle's weight before reaching 5 inches of crush. For an acceptable rating, the minimum required strength-to-weight ratio is 3.25. A marginal rating value is 2.5. Anything lower than that is poor.

Real-world rollover crashes of 11 midsize SUVs and 12 small cars were studied to establish injury risk given various roof strengths. Results showed that increased vehicle roof strength reduces the risk of occupant injury in a rollover crash (Brumbelow, Teoh, Zuby, & McCartt, 2009; Brumbelow & Teoh, 2009).

In the IIHS small overlap frontal test, a vehicle travels at 40 mph toward a 5-foot-tall rigid barrier. A Hybrid III dummy representing an average-size man is positioned in the driver seat. Twenty-five percent of the total width of the vehicle strikes the barrier on the driver side. The test is designed to replicate what happens when the front corner of a vehicle collides with another vehicle or an object like a tree or utility pole.

Methods

This study combined information on IIHS crash test ratings and vehicle registration data from IHS Automotive (formerly R.L. Polk and Company). The test programs studied include the four vehicle crashworthiness tests (moderate overlap frontal test, side impact test, roof strength test, and small overlap frontal test).

Registration data

The most recent IHS Automotive data available to HLDI went through calendar year 2018. For each calendar year included in the study, a number of recent model years were available, ranging from 23 model years for calendar year 1995 to 40 model years for calendar year 2018. The number of model years available per calendar year has increased over time. In order to have a consistent data set over all of the calendar years in this study, data were restricted to the 23 most current model years per calendar year. In calendar year 2018, the most current 23 model years comprised more than 90 percent of the available data. In earlier years with fewer model years, the 23 most recent accounted for even more of the available data. Because the unused data were comprised entirely of older/unrated vehicles, using the most current 23 model years per calendar year understated the size of the unrated vehicle population.

Some vehicles have multiple ratings for the same model year. This is particularly common for the side impact test program. When side airbags are optional, vehicles are first tested without the optional airbags. Manufacturers can remunerate IIHS for a second test vehicle so that the vehicle with optional side airbags can be assessed. For example, the model year 2005 Toyota RAV4 has two ratings. The RAV4 without optional side airbags earns a poor rating, while the RAV4 with side airbags earns a good rating.

Registration data are not available based on side airbag availability. Additionally, take rates for side airbags during the time period when the side impact test was introduced were relatively low. Using data from Ward's Automotive, an audit of 26 vehicles with multiple ratings was conducted. For 20 of the audited vehicles, the take rates for side airbags were lower than 50 percent. For the 2005 Toyota RAV4 mentioned previously, Ward's reports that just 34 percent of these vehicles were purchased with side airbags. Consequently, it was decided to use the lowest rating for vehicles that have more than one rating. Using this methodology to handle multiple ratings understates the number of vehicles with favorable ratings. However, given the low take rates, it is likely more accurate than using the highest rating.

For each crash test program evaluated, two graphs are presented. The first graph illustrates the percentage of the registered vehicle fleet that has not been rated along with the percentage rated by IIHS. The second graph excludes the unrated vehicle population and illustrates registration counts of just the rated vehicle population.

Results

Figure 1 shows the distribution of vehicle ratings for the moderate overlap frontal test for all registered vehicles. In 1995, 97 percent of registered vehicles were unrated, and just 1 percent of the registered vehicle population was rated good. By 2018, the unrated percentage was down to 23 percent, and 64 percent of the registered vehicles had attained a good rating.

Figure 1: Moderate overlap front crash test ratings for all registered vehicles by calendar year

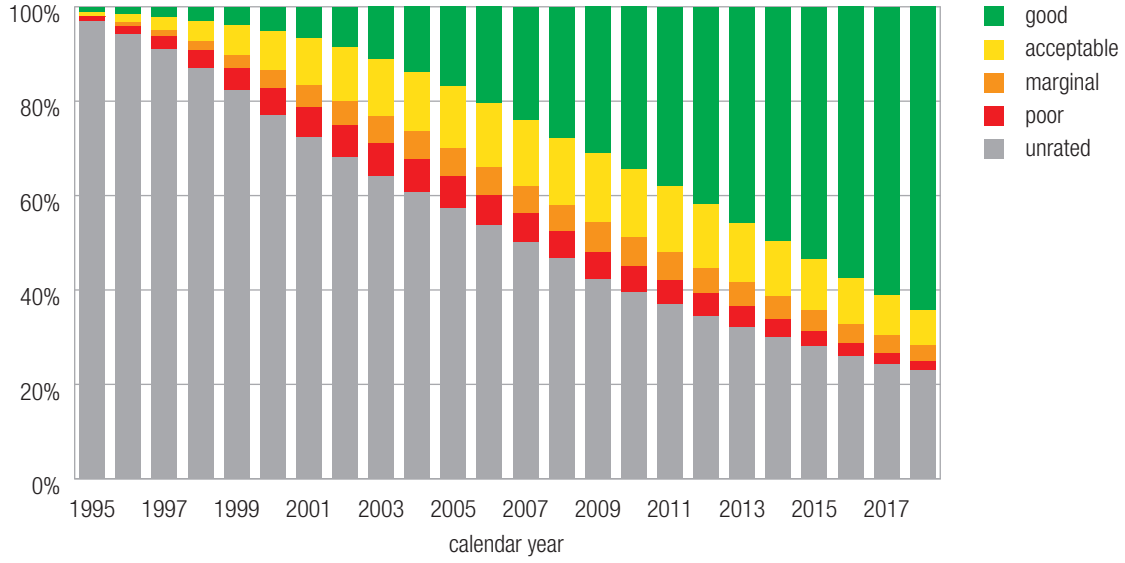


Figure 2 shows the distribution of vehicle ratings for the moderate overlap frontal test for rated vehicles. Registration data for unrated vehicles were not included. In 1995, just 39 percent of rated vehicles earned a good rating. By 2018, vehicles rated good represented 83 percent of the rated vehicle population.

Figure 2: Moderate overlap front crash test ratings for registered vehicles by calendar year, rated vehicles only

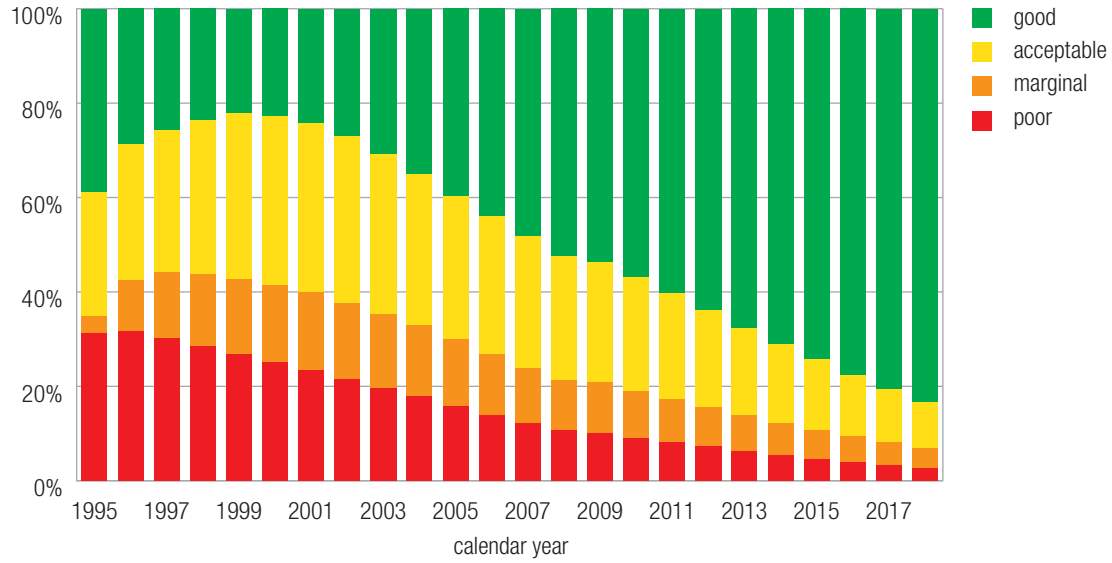


Figure 3 shows the distribution of vehicle ratings for the side impact crash test for all registered vehicles. In 2003, when the test program was introduced, 96 percent of registered vehicles were unrated, and less than 1 percent of the registered vehicle population was rated good. By 2018, the unrated percentage was down to 39 percent, and 49 percent of the registered vehicles had attained a good rating. As previously mentioned, some vehicles have multiple ratings, and when this occurred, the lowest rating was used.

Figure 3: Side impact crash test ratings for all registered vehicles by calendar year

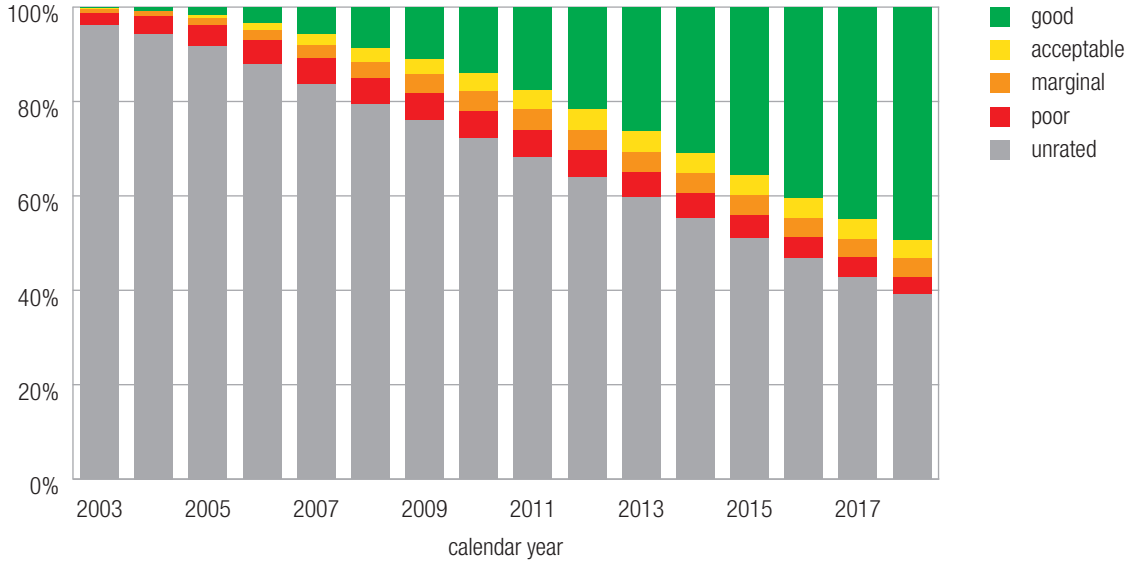
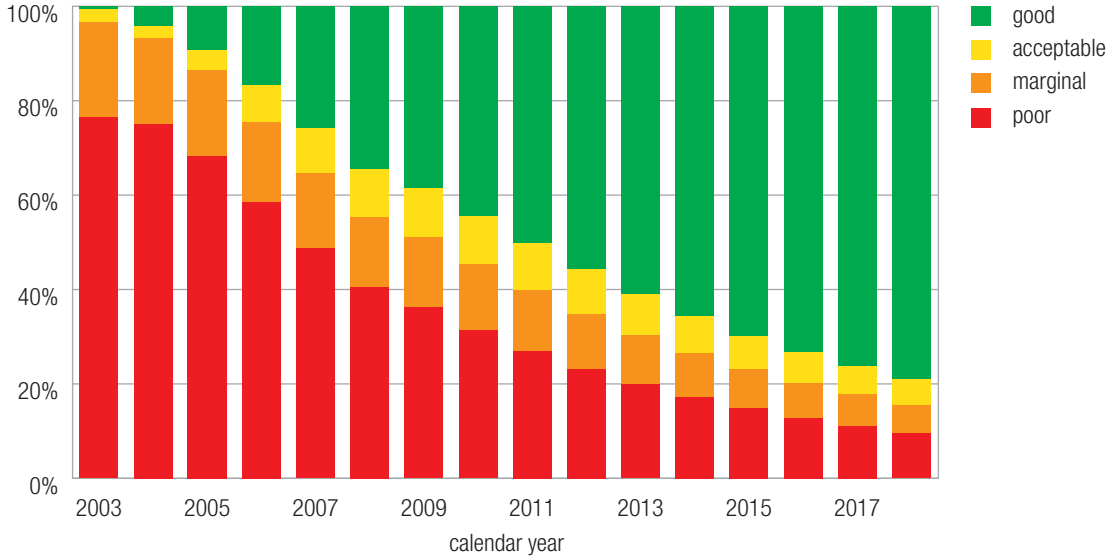


Figure 4 shows the distribution of vehicle ratings for the side impact crash test for rated vehicles. Registration data for unrated vehicles were not included. In the first year of the program, less than 1 percent of rated vehicles earned a good rating. In 2018, vehicles rated good represented 79 percent of the rated vehicle population. The fast improvement in ratings for the side crash test is particularly impressive, given that the methods used in this study understate the number of good-performing vehicles due to the large number that have two ratings because they have optional side airbags.

Figure 4: Side impact crash test ratings for registered vehicles by calendar year, rated vehicles only



For vehicles with multiple ratings for the same model year, using the lowest rating understates the improvements in side crashworthiness over time. The alternative is to use the highest rating, but given the low side airbag take rates, this would considerably overestimate the improvements in side crashworthiness. The true measure of improvements in side crashworthiness lies somewhere between the two approaches. Figure 5 illustrates how the percentage of vehicles with good ratings would be different if the highest ratings for vehicles with multiple ratings were used instead of the lowest. Note that the graph shows ratings for all vehicles rated good and not just the ones with multiple ratings. The differences in the results of the two methodologies decrease over time primarily because the number of vehicles with multiple ratings has decreased, with side airbags becoming standard in the vast majority of models.

Figure 5: Registered vehicles with good side crash test ratings by calendar year, rated vehicles only

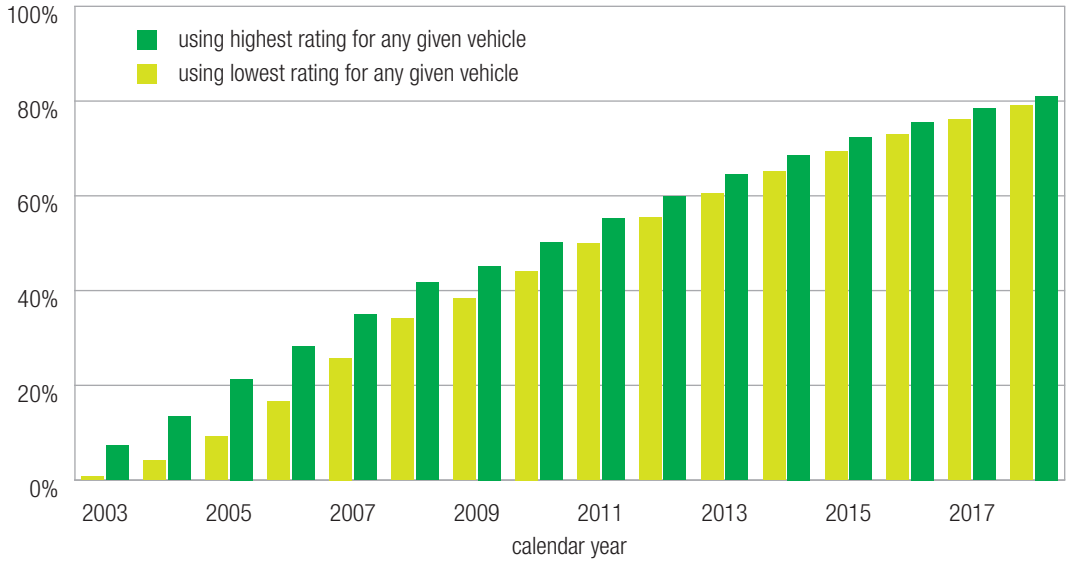


Figure 6 illustrates how the percentage of vehicles rated poor would be different if the highest ratings for vehicles with multiple ratings were used instead of the lowest. Note that the graph shows ratings for all vehicles rated poor and not just the ones with multiple ratings. As with Figure 5, the differences between the two methodologies decrease over time, primarily because the number of vehicles with multiple ratings has decreased over time.

Figure 6: Registered vehicles with poor side crash test ratings by calendar year, rated vehicles only

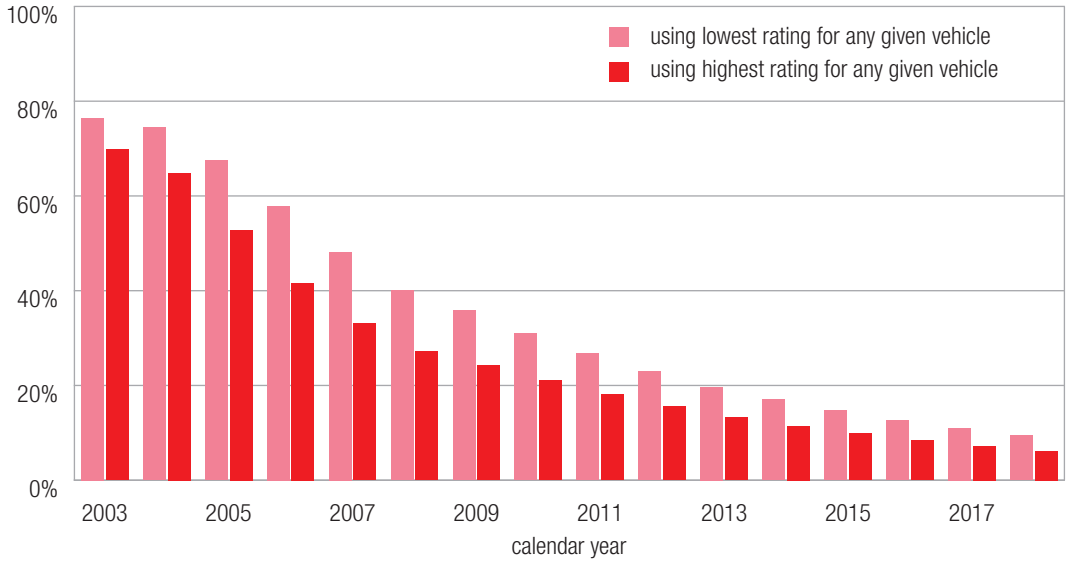


Figure 7 shows the distribution of vehicle ratings for the roof strength test for all registered vehicles. In 2009, 92 percent of registered vehicles were unrated, while about 3 percent of the registered vehicle population was rated good. By 2018, the unrated percentage was down to 54 percent, and 38 percent of the registered vehicles had attained a good rating. For comparison, it took about 17 years for a comparable percentage of vehicles to achieve a good rating in the moderate overlap frontal test.

Figure 7: Roof strength ratings for all registered vehicles by calendar year

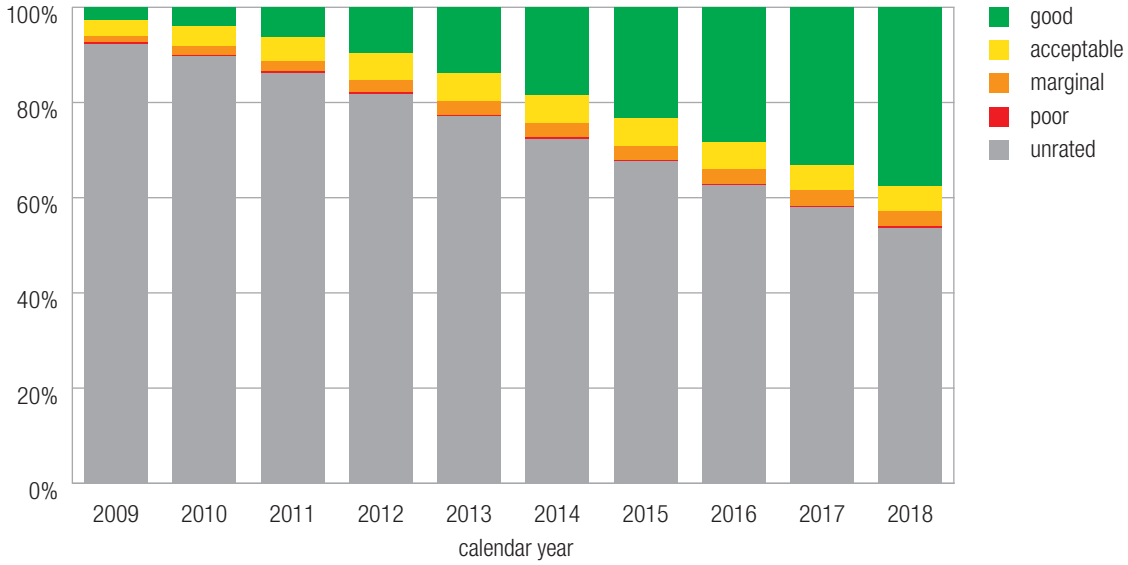


Figure 8 shows the distribution of vehicle ratings for the roof strength test for rated vehicles. Registration data for unrated vehicles were not included. In 2009, 35 percent of rated vehicles earned a good rating. By 2018, vehicles rated good represented 81 percent of the rated vehicle population.

Figure 8: Roof strength ratings for registered vehicles by calendar year, rated vehicles only

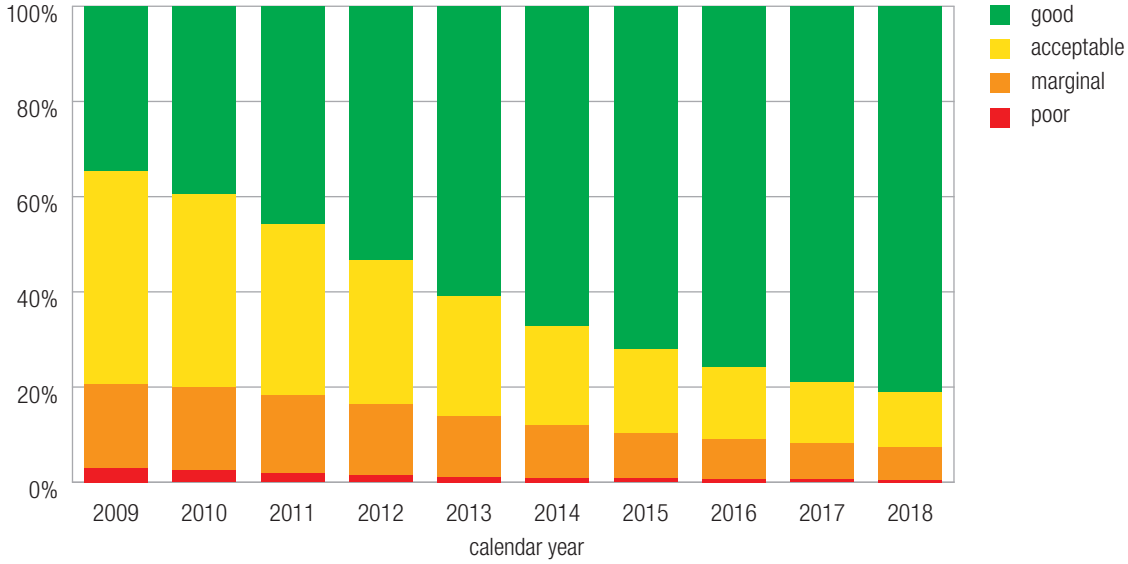


Figure 9 shows the distribution of vehicle ratings for the small overlap frontal test for all registered vehicles. In 2012, 96 percent of registered vehicles were unrated, and less than 1 percent of the registered vehicle population was rated good. By 2018, 30 percent of the vehicle fleet had been rated, and 14 percent of the registered vehicles had attained a good rating.

Figure 9: Small overlap front crash test ratings for all registered vehicles by calendar year

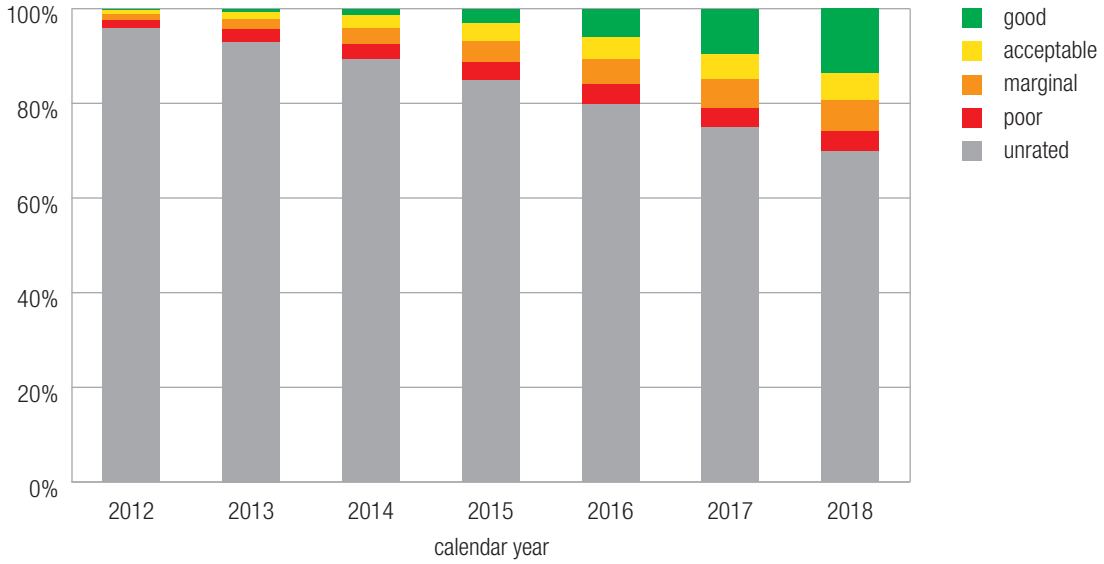


Figure 10 shows the distribution of vehicle ratings for the small overlap frontal test for rated vehicles. Registration data for unrated vehicles were not included. In 2012, just 8 percent of rated vehicles earned a good rating. By 2018, vehicles rated good represented 45 percent of the rated vehicle population. The small overlap test was first included in the Top Safety Pick (TSP) designation in 2013. From 2013 through 2015, an acceptable rating in this test could qualify a vehicle for a TSP. Since 2016, a good-rated small overlap test was required to receive the TSP. In 2013, about one third of the rated vehicle population was rated good or acceptable. By 2018, nearly two thirds of the rated vehicle population was rated good or acceptable. Good-rated registered vehicles alone increased five-fold since the test began in 2012.

Figure 10: Small overlap front crash test ratings for all registered vehicles by calendar year, rated vehicles only

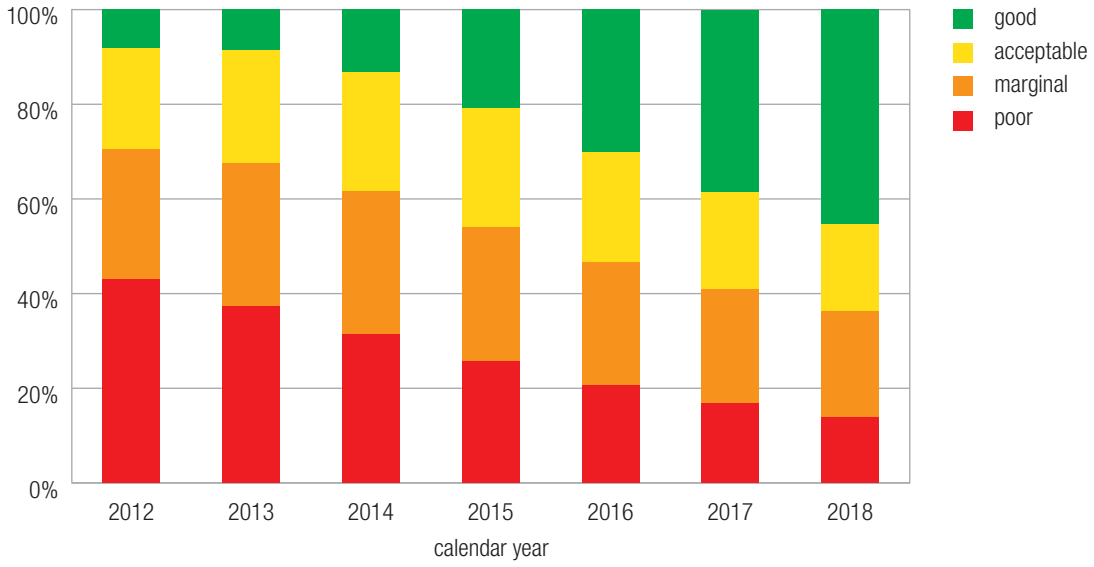


Figure 11 shows rated versus unrated vehicles in the moderate overlap frontal test by size and class groups for model year 2018 vehicles in calendar year 2018. In some size and class groups, such as small and large two-door cars; micro, mini, and large four-door cars; mini, midsize, and large station wagons; small luxury cars; and mini SUVs; 100 percent of registered vehicles have been rated. In other size and class groups, such as mini and small sports cars and very large pickups, no vehicles have been evaluated. In total, 84 percent of model year 2018 vehicles in calendar year 2018 have been rated.

Figure 11: Rated versus unrated vehicles in the moderate overlap front crash test for model year 2018 in calendar year 2018, by vehicle size and class

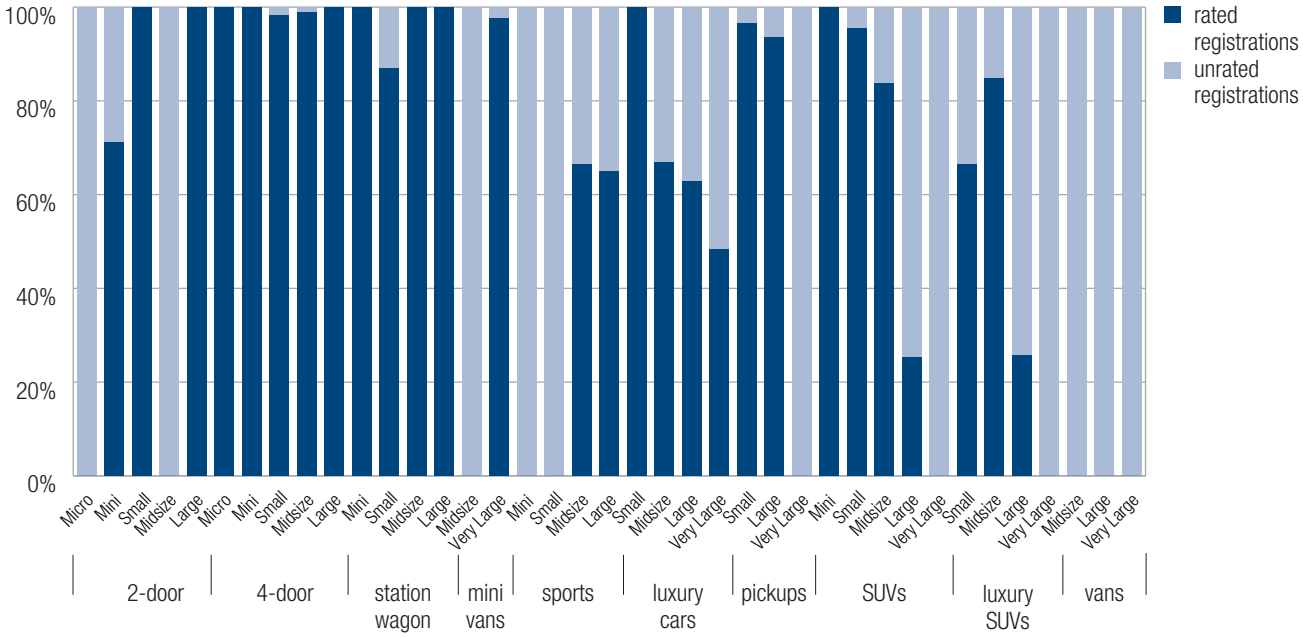


Figure 12 illustrates the unrated vehicle population for model year 2018 vehicles in calendar year 2018 by vehicle size and class group. Very large pickups represent the largest group of vehicles without moderate overlap frontal ratings, followed by the midsize SUV group.

Figure 12: Registered vehicles without moderate overlap front crash test ratings by size and class group for model year 2018 in calendar year 2018

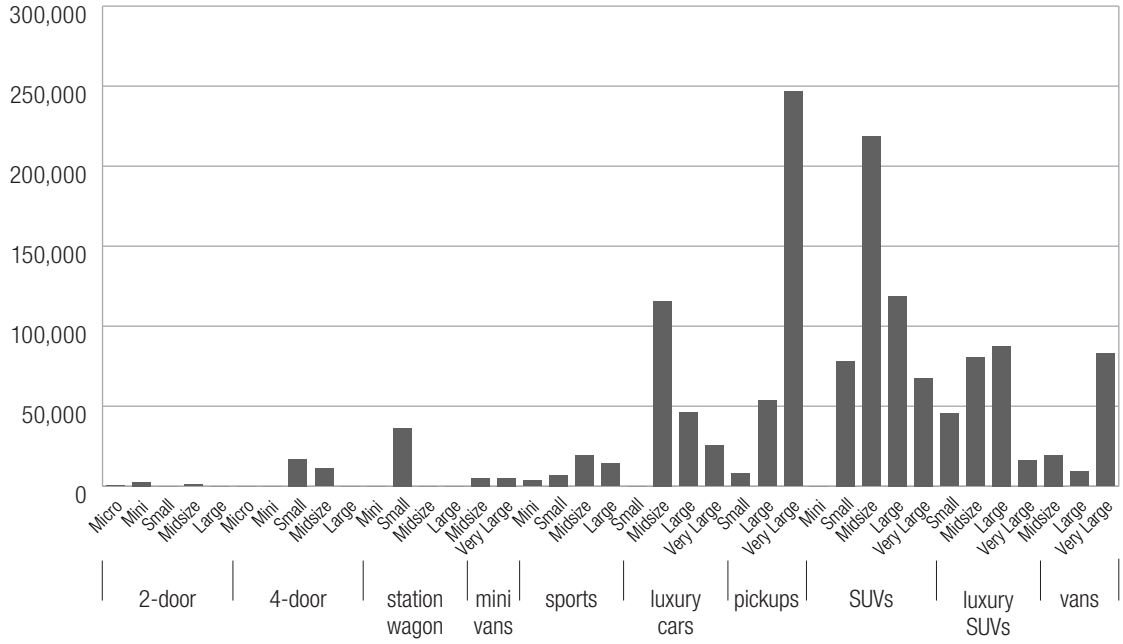


Table 1 provides additional information about the unrated vehicle population for each of the four programs in this study. The denominator for each percentage in the table is the number of registered vehicles. The numerator for each percentage is the number of registered vehicles from the rated size/classes that were not tested. For the moderate overlap frontal program in 2018, 23 percent of the registered vehicles were unrated. For the side impact crash test, the percentage of unrated vehicles has declined by more than half, from 96.1 to 39.1 percent.

Table 1: Unrated, out-of-scope vehicles by crashworthiness program

Calendar year	Moderate overlap frontal	Side	Roof	Small overlap frontal
1995	97.7%	—	—	—
1996	94.8%	—	—	—
1997	91.7%	—	—	—
1998	87.6%	—	—	—
1999	82.8%	—	—	—
2000	77.6%	—	—	—
2001	72.9%	—	—	—
2002	68.5%	—	—	—
2003	64.5%	96.1%	—	—
2004	61.1%	94.3%	—	—
2005	57.7%	91.7%	—	—
2006	54.0%	87.9%	—	—
2007	50.4%	83.7%	—	—
2008	46.9%	79.3%	—	—
2009	42.4%	76.0%	92.4%	—
2010	39.7%	72.2%	89.7%	98.3%
2011	37.1%	68.2%	86.2%	97.3%
2012	34.6%	64.0%	81.8%	95.7%
2013	32.2%	59.6%	77.1%	93.0%
2014	30.1%	55.3%	72.4%	89.3%
2015	28.0%	51.0%	67.6%	84.9%
2016	25.9%	46.7%	62.6%	79.9%
2017	24.2%	42.8%	58.0%	74.9%
2018	23.0%	39.1%	53.6%	69.9%

Discussion

Vehicle ratings are steadily improving. In all four crash test programs evaluated, there were dramatic increases in the percentage of good-rated vehicles. The moderate overlap frontal program went from having 39 percent of vehicles rated good in the first year to having 83 percent in the most current year. This is an annual average increase of 1.9 percentage points per year. For the side impact and roof strength programs, the annual average increase was about 5.2 percentage points per year. For the newest rating program, the small overlap frontal test, improvements closely mirror the roof and side tests, with an average annual increase in good-rated vehicles of 6.2 percentage points per year.

Given the number of older vehicles in the registered vehicle fleet, it takes a long time for changes to new vehicles to impact the fleet. Although 83 percent of vehicles rated in the moderate overlap frontal test are rated good, these vehicles only represent 64 percent of the registered fleet. For the side impact crash test program, just 49 percent of the registered fleet is rated good. For the roof strength program, just 38 percent of the registered fleet is rated good. And for the small overlap frontal test program, 14 percent of the registered fleet is rated good. Given that studies conducted by IIHS of the moderate overlap frontal test and side impact test indicate occupants in good-rated vehicles are much safer than occupants in poor-rated vehicles, fatal crash risk should decrease as the percentage of good-rated vehicles in the registered fleet grows.

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HLDI
Highway Loss Data Institute

4121 Wilson Blvd, 6th floor
Arlington, VA 22203
+1 703 247 1500
iihs-hldi.org