HLDI
Highway Loss Data Institute

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Effect of Subaru EyeSight on pedestrian-related bodily injury liability claim frequencies

Summary

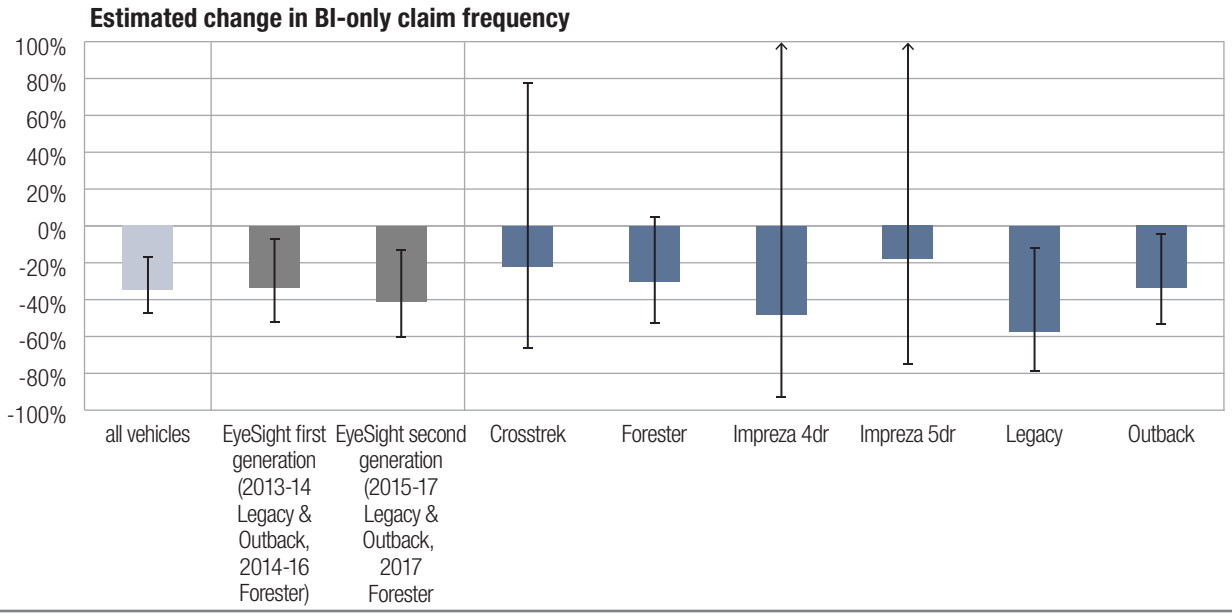
This Highway Loss Data Institute (HLDI) bulletin examines the effects of Subaru EyeSight® on pedestrian-related bodily injury (BI) liability claim frequencies. EyeSight includes a pedestrian detection feature that will brake to avoid or mitigate a collision with a pedestrian. The data in this report were limited to injury-only BI claims. These consist of BI claims without associated collison or property damage liability (PDL) claims. It is expected that many of the BI claims without associated collision or PDL claims are pedestrian- or bicycle-related. The purpose of this study is to determine if the injury-only BI claim frequency for EyeSight-equipped vehicles differs from the frequency for non-EyeSight versions of the same vehicles.

There were nearly 6,000 pedestrian fatalities in the United States in 2016, up 9 percent from 2015, and an 11 percent increase in bicyclist deaths (National Highway Traffic Safety Administration [NHTSA], 2017a). In addition, in 2015, an estimated 70,000 pedestrians were injured in traffic crashes (NHTSA, 2017b). Pedestrian detection systems in vehicles have the potential to reduce these numbers. This is HLDI's first study examining the impact of pedestrian detection systems on pedestrian-related claims.

This analysis found that Subaru vehicles equipped with EyeSight reduced pedestrian-related claim frequency by 35 percent compared to Subaru vehicles without EyeSight. When the vehicle series are modeled individually, all the series show reductions ranging from 18 to 57 percent, although only the Legacy and Outback are statistically significant.

The first generation of the EyeSight system was available on 2013–14 Legacy and Outback vehicles and the 2014-16 Forester. In model year 2015, Subaru introduced a second generation of the EyeSight system on the Legacy and Outback. The second generation was introduced on the Forester in model year 2017. The first generation utilized dual black-and-white cameras while the second generation made a shift to color cameras along with longer and wider detection ranges, an increased ability to handle the speed differential with leading vehicles, and brake light detection. When evaluated separately, the first generation was associated with a 33 percent reduction in BI-only claim frequency, while the second generation was associated with a 41 percent reduction. Both results were statistically significant and it is promising that the second generation is showing a larger reduction.

Subaru is continuing to upgrade the EyeSight system, and as exposure and claims build, HLDI will continue to examine the impacts of the EyeSight system on pedestrian-related claim frequencies and expand to look at systems available from other manufacturers.



Introduction

Previous HLDI studies have shown Subaru EyeSight to be effective at reducing collision, PDL, and BI liability claim frequency (Highway Loss Data Institute [HLDI], 2017). This HLDI bulletin examines the effects of the EyeSight system on BI-only claim frequency. HLDI expects that a large proportion of the BI claims without associated collision or PDL claims are pedestrian- or bicyclist-related. There were nearly 6,000 pedestrian fatalities in the United States in 2016, up 9 percent from 2015 (NHTSA, 2017a). In addition, in 2015, an estimated 70,000 pedestrians were injured in traffic crashes (NHTSA, 2017b). Pedestrian detection systems in vehicles have the potential to reduce these numbers.

Subaru EyeSight uses a dual-camera system located behind the windshield to assess the risk of a collision with leading traffic. The first generation of the EyeSight system was available on 2013–14 Legacy and Outback vehicles and the 2014-16 Forester. In model year 2015, Subaru introduced a second generation of the EyeSight system on the Legacy and Outback. It also appeared for the first time on the Crosstrek and Impreza four-door and five-door in 2015. The second generation was introduced on the Forester in model year 2017. The first generation utilized dual black-and-white cameras while the second generation made a shift to color cameras along with longer and wider detection ranges, an increased ability to handle the speed differential with leading vehicles, and brake light detection.

An important enhancement to the second generation of the EyeSight system is the increased speed differential. The first generation of EyeSight was fully functional when the speed difference between the EyeSight-equipped vehicle and another vehicle was up to 19 mph. On the second generation, Subaru increased the speed differential to 30 mph.

Both EyeSight generations include a pedestrian detection feature. The system detects pedestrians from their size, shape, and movement. The system detects a pedestrian when the contour of the head and shoulders are clear. EyeSight's Pre-Collision Braking function treats pedestrians as obstacles. Traveling at low speed, EyeSight is capable of detecting pedestrians in the path of the vehicle and if detected, the system will activate to mitigate or avoid a collision. However, depending on the conditions, there may be cases when the system cannot detect a pedestrian.

Methods

Vehicles

EyeSight is offered as an option on various 2013–17 Subaru models. The presence or absence of these features is discernible from the information encoded in the vehicle identification numbers (VINs). Subaru vehicles in the same model years without EyeSight served as the control vehicles.

Insurance data

Automobile insurance covers damages to vehicles and property in crashes plus injuries to people involved in crashes. Different insurance coverages pay for vehicle damage versus injuries, and different coverages may apply depending on who is at fault.

BI liability coverage insures against medical, hospital, and other expenses for injuries that at-fault drivers inflict on occupants of other vehicles or others on the road. PDL coverage insures against physical damage that at-fault drivers cause to other people's vehicles and property in crashes. Collision coverage insures against physical damage to an at-fault driver's vehicle sustained in a crash with an object or other vehicle.

The current study is based on BI liability, collision, and PDL coverages. BI liability losses are restricted to data from traditional tort states.

Concurrent coverage and injury-only BI claims

Concurrent coverage means a vehicle is insured under two or more relevant coverage types at the time of a loss: in this study BI, collision, and PDL. In forming the data for this study, exposure and claim data for BI coverage were joined with those for collision and PDL coverages at the VIN level, so that during the overlapped exposure period, the association between claims can be explored to identify whether a BI claim occurs in an injury-only crash that has associated vehicle damage.

The current study is based on BI claims with no same-day collision or PDL claims. HLDI expects that many of the BI claims without associated collision or PDL claims are pedestrian- or bicycle-related. Hereafter, these claims will be referred to as BI-only or pedestrian-related claims. Exposure is measured in insured vehicle years. An insured vehicle year is equivalent to one vehicle insured for 1 year, two vehicles insured for 6 months, etc.

Table 1 shows the exposure and claim counts for the various Subaru vehicles in the study. It also includes the percent of BI claims that are BI-only, BI-only claim frequency, and the percent difference in BI-only claim frequency for EyeSight versus non-EyeSight vehicles by series.

Table 1: Feature exposure, claim counts, and observed BI-only claim frequency by vehicle series

Series	Exposure (years)	BI claims	BI-only claims	Percent of BI claims that are BI-only	Observed BI-only claim frequency	Difference between non-EyeSight and EyeSight BI-only claim frequencies
Crosstrek	61,197	478	32	7%	0.52	
Crosstrek with EyeSight	16,924	99	7	7%	0.41	-21%
Forester	382,466	2,391	191	8%	0.50	
Forester with EyeSight	82,050	363	29	8%	0.35	-29%
Legacy	138,558	1,034	91	9%	0.66	
Legacy with EyeSight	31,853	172	9	5%	0.28	-57%
Impreza 4dr	15,735	161	15	9%	0.95	
Impreza 4dr with EyeSight	1,618	18	1	6%	0.62	-35%
Impreza 5dr	39,137	339	24	7%	0.61	
Impreza 5dr with EyeSight	5,395	28	3	11%	0.56	-9%
Outback	430,361	2,521	211	8%	0.49	
Outback with EyeSight	142,525	552	46	8%	0.32	-34%
Total	**1,347,818**	**8,156**	**659**	**8%**	**0.49**	
Non-EyeSight	1,067,454	6,924	564	8%	0.53	
EyeSight	280,364	1,232	95	8%	0.34	-36%

Analysis methods

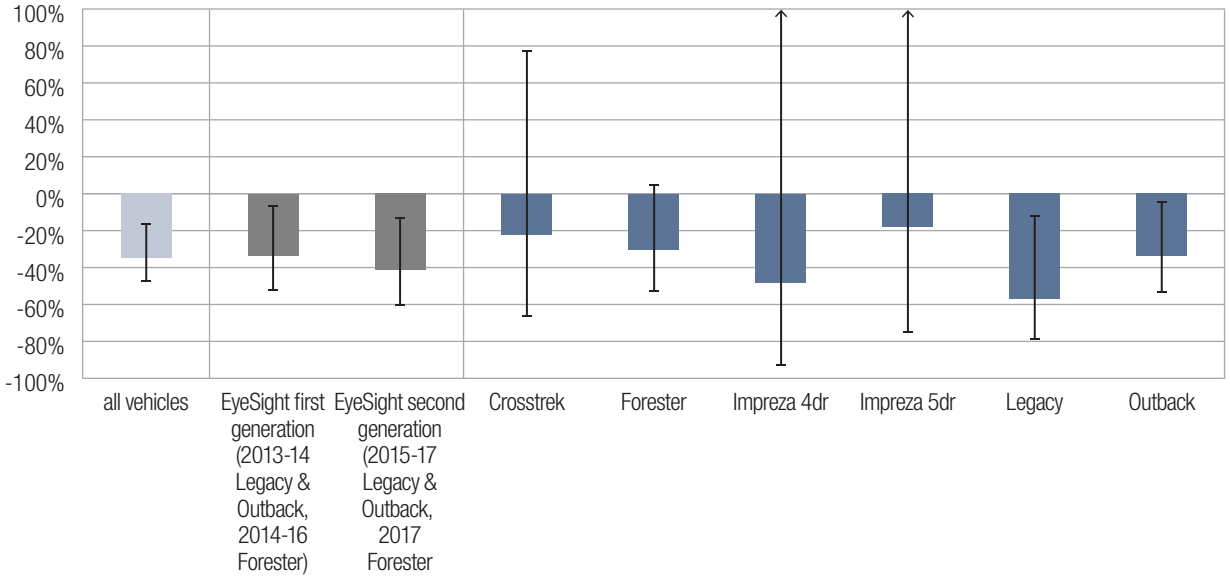
Regression analysis was used to quantify the effect of EyeSight while controlling for other covariates. The covariates included calendar year, garaging state, vehicle density (number of registered vehicles per square mile), rated driver age group, rated driver gender, rated driver marital status, and risk. Based on the model year and vehicle series, a single variable called vehicle model year and series was created for inclusion in the regression model. Effectively, this variable controlled for the variation caused by vehicle design changes that occur from model year to model year. This is a relatively small dataset which yielded unexpected estimates for some covariates. As a result, other models were evaluated in which covariates such as marital status and gender were not included. This did not change the primary effect of EyeSight on BI-only claim frequency and marital status and gender were included in the final model. Reference categories were assigned as follows: rated driver age group = 40–49, risk = standard, state = California, rated driver gender = female, rated driver marital status = married, density = 1,000+, calendar year = 2016, vehicle model year and series = 2013 Subaru Outback, and EyeSight = not available.

Claim frequency was modeled using a Poisson distribution and a logarithmic link function. For space reasons, illustrative full regression results for BI-only claim frequency are shown in the Appendix. To further simplify the presentation here, the exponent of the parameter estimate was calculated, 1 was subtracted, and the results multiplied by 100. The resulting number corresponds to the effect of a given model variable on a loss measure. For example, the estimate of BI-only claim frequency for vehicles with EyeSight was -0.4267; thus, BI-only claim frequency is expected to be 35 percent lower than that of their conventional counterparts ((exp(-0.4267)-1)*100 = -35).

Results

Figure 1 shows the estimated change in pedestrian-related claim frequency for EyeSight vehicles versus non-EyeSight vehicles. All the series combined show a 35 percent reduction in claim frequency. When the Forester, Legacy and Outback are separated by generation, results are also showing significant reductions, ranging from 33 to 41 percent. When the vehicle series are modeled individually, all the series show reductions, although only the Legacy and Outback results are statistically significant. The reductions in claim frequency range from 18 to 57 percent.

Figure 1: Estimated change in BI-only claim frequency



Discussion

Subaru vehicles with EyeSight show a statistically significant 35 percent reduction in pedestrian-related claim frequency. EyeSight vehicles have pedestrian detection and the results suggest that the EyeSight system is effective. In preliminary IIHS testing of pedestrian detection systems, Subaru vehicles with EyeSight performed well in several testing scenarios. It is encouraging that even though the BI-only claim counts are relatively small, there is still a large and statistically significant reduction in BI-only claim frequency.

Claim frequency reductions for the EyeSight generations are very similar, with a 33 percent reduction in the first generation and a 41 percent reduction in the second generation. Both reductions were statistically significant and it is promising that the second generation is showing a larger reduction. At the individual vehicle level, only results for the Legacy and Outback were statistically significant, as those vehicles have had EyeSight available since 2013 or 2014. EyeSight was available on the Crosstrek and Impreza beginning in 2015, so there is much less exposure for these vehicles.

Next Steps

Subaru EyeSight is the first crash avoidance system with pedestrian detection that HLDI has analyzed. Subaru is continuing to upgrade their EyeSight system. As exposure and claims build, HLDI will continue to examine the impacts of the EyeSight system on pedestrian-related claim frequencies and expand to look at systems available from other manufacturers.

Limitations

There are limitations to the data used in this analysis. Although injury-only BI claims are consistent with pedestrian or other non-occupant injuries, our data do not allow us to know definitively if a crash involved a pedestrian, however prior checks on this assumption verify that injury-only BI claims in fact involve non-occupants. Even so, there may be some crashes included that are not pedestrian-related. Likewise, some pedestrian crashes may have been excluded unintentionally. For example, a crash in which a person was struck that resulted in a bodily injury claim and also damaged the vehicle would have been excluded, because a collision claim would have been filed for the damaged vehicle.

References

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National Highway Traffic Safety Administration, National Center for Statistics and Analysis. (2017a). 2016 Fatal motor vehicle crashes: Overview. (Traffic Safety Facts Research Note. Report No. DOT HS 812 456). Washington, DC. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812456

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Appendix: Illustrative regression results - claim frequency

Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
Intercept		1	-13.0679		0.1798	-13.4203	-12.7154	5280.75	<0.0001
Calendar years	2012	1	-1.3334	-73.6%	1.0065	-3.3062	0.6394	1.75	0.1853
	2013	1	-0.3887	-32.2%	0.2112	-0.8027	0.0252	3.39	0.0657
	2014	1	-0.0688	-6.6%	0.1326	-0.3287	0.1911	0.27	0.6041
	2015	1	0.0492	5.0%	0.0985	-0.1438	0.2422	0.25	0.6170
	2017	1	-0.3767	-31.4%	0.1754	-0.7204	-0.0330	4.61	0.0317
	2016	0	0	0	0	0	0		
Vehicle model year and series	2013 Legacy	1	0.3220	38.0%	0.1814	-0.0334	0.6775	3.15	0.0758
	2014 Forester	1	-0.1258	-11.8%	0.1446	-0.4092	0.1575	0.76	0.3840
	2014 Legacy	1	0.0825	8.6%	0.2431	-0.3939	0.5589	0.12	0.7344
	2014 Outback	1	-0.1756	-16.1%	0.1585	-0.4862	0.1349	1.23	0.2677
	2015 Forester	1	-0.1602	-14.8%	0.1534	-0.4608	0.1405	1.09	0.2964
	2015 Impreza 4dr	1	0.4821	61.9%	0.3131	-0.1316	1.0957	2.37	0.1236
	2015 Impreza 5dr	1	0.1074	11.3%	0.2473	-0.3773	0.5920	0.19	0.6641
	2015 Legacy	1	-0.3448	-29.2%	0.2617	-0.8576	0.1681	1.74	0.1876
	2015 Outback	1	-0.1370	-12.8%	0.1769	-0.4837	0.2096	0.60	0.4385
	2015 Crosstrek	1	-0.0146	-1.4%	0.2277	-0.4608	0.4316	0.00	0.9490
	2016 Crosstrek	1	-0.2734	-23.9%	0.3261	-0.9126	0.3659	0.70	0.4020
	2016 Forester	1	0.0885	9.3%	0.2071	-0.3175	0.4945	0.18	0.6692
	2016 Impreza 4dr	1	0.3123	36.7%	0.5165	-0.7000	1.3247	0.37	0.5454
	2016 Impreza 5dr	1	-0.1296	-12.2%	0.4271	-0.9667	0.7074	0.09	0.7615
	2016 Legacy	1	0.4098	50.7%	0.2960	-0.1702	0.9899	1.92	0.1661
	2016 Outback	1	0.1056	11.1%	0.2254	-0.3362	0.5474	0.22	0.6394
	2017 Crosstrek	1	1.0240	178.4%	0.7246	-0.3961	2.4442	2.00	0.1576

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Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	2017 Forester	1	-0.5229	-40.7%	0.5166	-1.5354	0.4896	1.02	0.3114
	2017 Impreza 4dr	1	-5.4319	-99.6%	56.1169	-115.4190	104.5553	0.01	0.9229
	2017 Impreza 5dr	1	-5.6622	-99.7%	37.7484	-79.6478	68.3234	0.02	0.8808
	2017 Legacy	1	0.2782	32.1%	0.7210	-1.1349	1.6912	0.15	0.6996
	2017 Outback	1	-1.0660	-65.6%	0.7218	-2.4806	0.3487	2.18	0.1397
	2013 Outback	0	0	0	0	0	0		
Rated driver age group	< 20	1	0.4285	53.5%	0.3254	-0.2093	1.0662	1.73	0.1879
	20–24	1	0.2156	24.1%	0.2138	-0.2035	0.6347	1.02	0.3134
	25–29	1	-0.1320	-12.4%	0.1811	-0.4869	0.2229	0.53	0.4659
	30–39	1	-0.1580	-14.6%	0.1419	-0.4361	0.1201	1.24	0.2655
	50–59	1	-0.0836	-8.0%	0.1388	-0.3556	0.1883	0.36	0.5468
	60–64	1	0.0434	4.4%	0.1563	-0.2629	0.3497	0.08	0.7812
	65–69	1	-0.1607	-14.8%	0.1739	-0.5014	0.1801	0.85	0.3554
	70–74	1	-0.1599	-14.8%	0.2049	-0.5615	0.2416	0.61	0.4351
	75+	1	0.2348	26.5%	0.1819	-0.1218	0.5913	1.67	0.1969
	Unknown	1	-0.2562	-22.6%	0.2006	-0.6494	0.1370	1.63	0.2016
	40–49	0	0	0	0	0	0		
Rated driver gender	Male	1	-0.0491	-4.8%	0.0886	-0.2227	0.1245	0.31	0.5791
	Unknown	1	0.6989	101.2%	0.4499	-0.1829	1.5807	2.41	0.1203
	Female	0	0	0	0	0	0		
Rated driver marital status	Single	1	0.1990	22.0%	0.0968	0.0094	0.3887	4.23	0.0397
	Unknown	1	-0.2043	-18.5%	0.4392	-1.0650	0.6564	0.22	0.6418
	Married	0	0	0	0	0	0		
Risk	Nonstandard	1	0.5483	73.0%	0.1945	0.1671	0.9294	7.95	0.0048
	Standard	0	0	0	0	0	0		
State	Alabama	1	0.0180	1.8%	0.4599	-0.8834	0.9195	0.00	0.9687
	Alaska	1	0.3761	45.7%	0.3293	-0.2693	1.0215	1.30	0.2533
	Arizona	1	-0.1415	-13.2%	0.2843	-0.6986	0.4157	0.25	0.6187
	Arkansas	1	0.3465	41.4%	0.3719	-0.3824	1.0754	0.87	0.3515
	Colorado	1	0.1067	11.3%	0.1460	-0.1794	0.3928	0.53	0.4648
	Connecticut	1	0.0857	8.9%	0.1588	-0.2256	0.3969	0.29	0.5895
	Georgia	1	0.2724	31.3%	0.2153	-0.1495	0.6944	1.60	0.2057
	Idaho	1	-0.5199	-40.5%	0.3965	-1.2970	0.2571	1.72	0.1897
	Illinois	1	-0.2077	-18.8%	0.1732	-0.5471	0.1317	1.44	0.2303
	Indiana	1	-0.9603	-61.7%	0.3909	-1.7265	-0.1942	6.04	0.0140
	Iowa	1	-0.7705	-53.7%	0.5113	-1.7726	0.2315	2.27	0.1318
	Louisiana	1	0.6794	97.3%	0.3302	0.0321	1.3266	4.23	0.0397
	Maine	1	-0.0715	-6.9%	0.3001	-0.6596	0.5166	0.06	0.8116
	Mississippi	1	-0.3875	-32.1%	1.0064	-2.3600	1.5851	0.15	0.7003
	Missouri	1	-0.9981	-63.1%	0.4186	-1.8184	-0.1777	5.69	0.0171
	Montana	1	-1.4100	-75.6%	0.7280	-2.8369	0.0168	3.75	0.0528
	Nebraska	1	-0.7085	-50.8%	0.4566	-1.6034	0.1864	2.41	0.1207
	Nevada	1	0.0430	4.4%	0.3142	-0.5729	0.6589	0.02	0.8913
	New Hampshire	1	-0.1620	-15.0%	0.2705	-0.6922	0.3681	0.36	0.5491

Appendix: Illustrative regression results - claim frequency									
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald 95% confidence limits		Chi-square	P-value
	New Mexico	1	-0.2259	-20.2%	0.3957	-1.0015	0.5497	0.33	0.5681
	North Carolina	1	-0.0527	-5.1%	0.2087	-0.4618	0.3564	0.06	0.8007
	Ohio	1	-0.3397	-28.8%	0.1846	-0.7015	0.0221	3.39	0.0658
	Oklahoma	1	-0.3497	-29.5%	0.4623	-1.2557	0.5563	0.57	0.4493
	Rhode Island	1	-0.0629	-6.1%	0.3660	-0.7802	0.6543	0.03	0.8635
	South Carolina	1	-0.2253	-20.2%	0.3703	-0.9511	0.5006	0.37	0.5430
	South Dakota	1	-0.4984	-39.2%	0.7203	-1.9101	0.9134	0.48	0.4890
	Tennessee	1	-0.5157	-40.3%	0.3508	-1.2032	0.1718	2.16	0.1415
	Vermont	1	-0.7377	-52.2%	0.4641	-1.6473	0.1719	2.53	0.1119
	Virginia	1	-0.4112	-33.7%	0.1909	-0.7853	-0.0372	4.64	0.0312
	West Virginia	1	0.1806	19.8%	0.2585	-0.3262	0.6873	0.49	0.4849
	Wisconsin	1	-0.8433	-57.0%	0.2853	-1.4025	-0.2841	8.74	0.0031
	Wyoming	1	-0.1404	-13.1%	0.6079	-1.3318	1.0510	0.05	0.8174
	California	0	0	0	0	0	0		
Registered vehicle density	<50	1	-0.7123	-50.9%	0.1883	-1.0813	-0.3432	14.31	0.0002
	50–99	1	-0.4194	-34.3%	0.1596	-0.7322	-0.1067	6.91	0.0086
	100–249	1	-0.3045	-26.3%	0.1336	-0.5663	-0.0427	5.20	0.0226
	250–499	1	-0.1941	-17.6%	0.1273	-0.4436	0.0555	2.32	0.1274
	500–999	1	-0.2967	-25.7%	0.1341	-0.5596	-0.0339	4.89	0.0269
	1,000+	0	0	0	0	0	0		
EyeSight		1	-0.4267	-34.7%	0.1202	-0.6624	-0.1911	12.60	0.0004

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The Highway Loss Data Institute is a nonprofit public service organization that gathers, processes, and publishes insurance data on the human and economic losses associated with owning and operating motor vehicles. DW201712 KW