EFFECT OF SUBARU EYESIGHT ON PEDESTRIAN-RELATED BODILY INJURY LIABILITY CLAIM FREQUENCIES

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ABSTRACT

Research Question/Objective
Subaru's EyeSight is a camera-based driver assistance system that includes the ability to brake automatically when it detects a crash-imminent situation involving a pedestrian. The objective of this study was to evaluate whether Eyesight was preventing vehicles from striking pedestrians. Insurance claims under bodily injury (BI) liability coverage without associated first-party (collision) or third-party (property damage liability [PDL]) claims for vehicle damage were used as a surrogate measure of pedestrian crashes.

Methods and Data Sources
EyeSight is an option on various 2013–17 Subaru series. The presence or absence of EyeSight is discernible from information encoded in the vehicle identification numbers (VINs). The number of BI-only claims per insured vehicle year was compared for Subaru vehicles with and without EyeSight, using regression analysis to account for other factors also known to affect insurance claim frequency. A Poisson distribution was used to model claim frequency. Covariates included calendar year, garaging state, vehicle density, age group, gender, marital status, risk classification, and vehicle model year and series. Twenty percent of the insured-vehicle-year exposure came from vehicles equipped with EyeSight. Prior investigation has shown that injury-only BI claims are consistent with pedestrian or other nonoccupant injuries. Even so, these may include some nonpedestrian crashes, and some pedestrian crashes that were severe enough to also cause vehicle damage may be excluded. This study was based on vehicles with overlapping BI liability, collision, and PDL insurance in U.S. states with traditional tort liability insurance laws.

Results
When all series were combined, Subaru vehicles with EyeSight showed a statistically significant 35% reduction in BI-only claim frequency. When the Subaru Forester, Legacy, and Outback were separated by generation, results also showed statistically significant reductions of 33% for the first generation and 41% for the second generation. When the vehicle series were modeled individually, claim frequency reductions ranged from 18 to 57%, although only the Legacy (57%) and Outback (34%) results were statistically significant.

Discussion and Limitations
Claim frequency reductions for the EyeSight generations are similar, but it is promising that the second generation is showing a larger reduction. There are limitations to the data used in this analysis. Covariates describing driver characteristics are generally those of the primary driver of each vehicle and not necessarily the driver involved in the crash claim. Likewise, geographic covariates describe where the owner of the insured vehicle lives and not necessarily where crashes occurred. Nevertheless, these variables are consistently predictive in explainable ways.

Conclusions and Relevance to Session Submitted
Subaru's Eyesight system is associated with a lower BI-only claim frequency than the same Subaru vehicles without EyeSight. In 2016, there were nearly 6,000 pedestrian fatalities in the United States, up 9% from 2015, and an 11% increase in bicyclist deaths. Pedestrian detection systems like Subaru EyeSight have the potential to effectively reduce these numbers, and efforts to promote similar systems will help protect vulnerable road users.

INTRODUCTION

In 2017, there were 5,977 pedestrians and 783 bicyclists killed in traffic crashes in the United States. This is slightly less than in 2016, when there were 6,080 pedestrian fatalities and 852 bicyclist fatalities [1]. However, 2016 pedestrian fatalities were 9% higher than 2015 [2]. In addition, in 2015, an estimated 70,000 pedestrians were injured in traffic crashes [3]. Along with the growth of the number of pedestrian fatalities in recent years, there has also been an increase in the number of pedestrian deaths as a proportion of total motor vehicle crash deaths. Pedestrian deaths represented 11% of motor vehicle crash deaths in 2007 and 16% of motor vehicle crash deaths in 2016 [4].

From 2009 to 2016, the largest increases in pedestrian deaths occurred under these conditions: in urban areas (a 54% increase from 2009 to 2016); on arterials (a 67% increase); at nonintersections (a 50% increase); and in dark conditions (a 56% increase) [5]. Pedestrian detection systems, like the Subaru EyeSight system, have the potential to effectively reduce the number of crashes involving pedestrians by as much as 39,000, which includes 2,932 fatal crashes [6].

Previous Highway Loss Data Institute (HLDI) studies have examined the effectiveness of the Subaru EyeSight system at reducing collision, property damage liability (PDL), and bodily injury (BI) liability claim frequencies [7–11]. In the most recent study, EyeSight showed a 1.1% reduction in collision claim frequency, a 14.8% reduction in PDL claim frequency, and a 28.3% reduction in BI liability claim frequency. However, information about the types of crashes in those studies is unavailable.

The current study evaluates whether the EyeSight system is preventing vehicles from striking pedestrians. Insurance claims under BI liability coverage without associated first-party (collision) or third-party (PDL) claims for vehicle damage were used as a surrogate measure of pedestrian crashes for 2013–17 Subaru vehicles with and without the EyeSight system.

METHODS

Vehicle Data

Subaru's EyeSight is a camera-based driver assistance system that includes the ability to brake automatically when it detects a crash-imminent situation involving a pedestrian. 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 can respond to pedestrians in the vehicle's path or about to cross the vehicle's path. When the system determines that a collision with a pedestrian is imminent, it will activate braking to mitigate or avoid the collision. Because it is camera based, Eyesight cannot detect pedestrians in all conditions, especially those characterized by low visibility.

EyeSight is an option on various 2013–17 Subaru series. The presence or absence of EyeSight is discernible from the information encoded in the vehicle identification numbers (VINs).

Insurance Data

Automobile insurance covers damages to vehicles and property, as well as 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. The current study is based on BI liability coverage, collision coverage, and PDL coverage. Collision coverage insures against vehicle damage to an at-fault driver's vehicle sustained in a crash. PDL coverage insures against vehicle damage that at-fault drivers cause to other people's vehicle and property in crashes. 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.

HLDI has data on the individual vehicles insured by its member companies, including the length of time those vehicles were insured and any claims filed for those vehicles under BI liability, collision, or PDL coverage. Using this information, HLDI calculates BI liability, collision, and PDL claim frequency as the number of claims divided by exposure, where exposure is defined as the number of insured vehicle years. One insured vehicle year can

represent one vehicle insured for one year, two vehicles insured for six months, etc. Vehicles in the HLDI database are identified by full 17-digit VINs.

This study was based on vehicles with overlapping BI liability, collision, and PDL insurance in U.S. states with traditional tort liability laws. In forming the data for this study, exposure and claim data for BI liability 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 could be explored to identify whether a BI claim occurs in an injury-only crash that has no associated vehicle damage. Only BI liability claims with no same-day collision or PDL claims are included in this study. Prior investigation has shown that injury-only BI claims are consistent with pedestrian- or cyclist-related claims. Hereafter, these claims will be referred to as BI-only or pedestrian-related claims.

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, deductible range, risk, and vehicle series. 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. EyeSight was included as a binary variable, indicating whether this safety feature was present or not. Claim frequency was modeled using a Poisson distribution with a logarithmic link function.

RESULTS

Figure 1 shows the estimated change in BI-only claim frequency for EyeSight vehicles versus non-EyeSight vehicles. All the series combined show a 35% reduction in claim frequency. When the vehicle series are modeled individually, all the series show reductions, although only the results for the Legacy (57%) and Outback (34%) are statistically significant. The reductions in claim frequency range from 18 to 57%. Two generations of the EyeSight system were fitted to Forester, Legacy, and Outback vehicles depending on model year. When the results for these models are separated by generation, the results also show significant reductions of 33% for the first generation and 41% for the second.

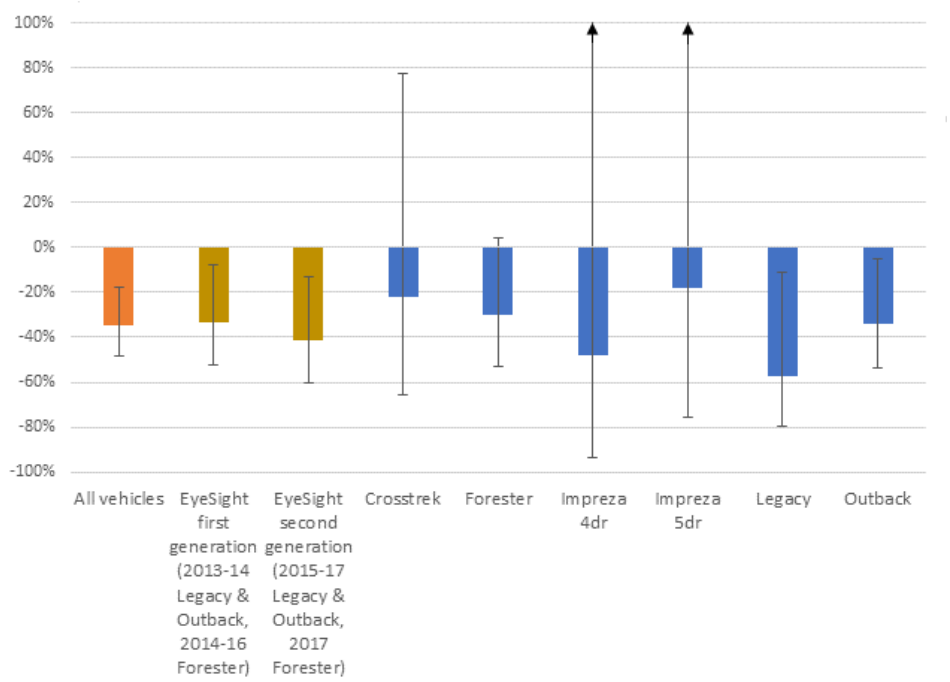

Figure 1. Estimated change in BI-only claim frequency for EyeSight vehicles versus non-EyeSight vehicles

DISCUSSION

Subaru vehicles with EyeSight, which includes pedestrian detection, show a statistically significant 35% reduction in pedestrian-related claim frequency. Reductions were observed for every Subaru model on which Eyesight is available, although at the individual vehicle level, only results for the Legacy and Outback were statistically significant. The lack of statistical significance for the other models is not surprising given their much lower exposure in the HLDI data. In any case, these results provide strong evidence that Eyesight is helping Subaru drivers avoid collisions with pedestrians.

Two generations of the EyeSight system were represented in the data for this study. The first generation was available as an option on 2013–14 Subaru 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. The second generation shifted 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. Claim frequency reductions for the EyeSight generations are similar, with a 33% reduction in the first generation and a 41% reduction in the second generation. Both reductions were statistically significant. While the different reductions are not significantly different from one another, the larger reduction for the newer generation may indicate an increase in effectiveness over the original EyeSight.

Based partly on the apparent efficacy of Subaru's pedestrian detection system, in February 2019 the Insurance Institute for Highway Safety launched a consumer information program to promote and rate pedestrian-detecting automatic emergency braking (AEB) systems. The ratings – no credit, basic, advanced and superior – are based on measured AEB speed reductions in three different simulated pedestrian crash scenarios, each at two different speeds. The Subaru Eyesight system is the benchmark for a superior rating. Systems providing lower speed reductions in fewer tests are rated advanced, basic, or no credit. In a test series covering 11 small sport utility vehicles, four including the 2019 Subaru Forester were rated superior, five were rated advanced, one was rated basic, and one received no credit because it did not provide meaningful speed reductions in any of the tests [12].

IIHS is not the first to recognize the potential for pedestrian-detecting AEB to address the problem of collisions between vehicles and pedestrians. The European New Car Assessment Program (EuroNCAP) has been rating these systems since 2016. Already, two thirds of front crash prevention systems available in the U.S. in 2019 include a pedestrian detection feature [12]. The United Nations Economic Commission for Europe (UNECE) in February 2019 adopted a draft regulation that would specify AEB performance including pedestrian detection and would go into force in 2020 [13].

These results suggest great promise for pedestrian-detecting AEB for preventing or mitigating collisions between vehicles and pedestrians. However, other HLDI research [14] suggests it will take 35 years or more for 95% of vehicles on U.S. roads to be equipped with AEB, and not all AEB systems on the road have pedestrian detection functionality. Consequently, it will require other efforts such as separating pedestrians from vehicles by time or space, making pedestrians easier to spot, and reducing vehicle speeds [15]. Recent moves by cities to lower speed limits in areas where pedestrians are present have been shown as an effective way to reduce vehicle speeds, which gives drivers more time to react to an encroaching pedestrian as well as mitigate the consequences of the collisions that do occur [16].

CONCLUSION

Vehicles with Subaru's Eyesight system are associated with a lower BI-only claim frequency than the same Subaru vehicles without EyeSight. In 2016, there were nearly 6,000 pedestrian fatalities in the United States, up 9% from 2015, and an 11% increase in bicyclist deaths [2]. Pedestrian detection systems like Subaru EyeSight have the potential to effectively reduce these numbers, and efforts to promote similar systems will help protect vulnerable road users.

LIMITATIONS

There are limitations to the data used in this analysis. Although injury-only BI claims are consistent with pedestrian or other nonoccupant 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 nonoccupants. 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 BI liability claim and also damaged the vehicle would have been excluded, because a collision claim would have been filed for the same day for the damaged vehicle.

Additionally, the data supplied to HLDI do not include detailed crash information such as point of impact or transmission status. The EyeSight system studied for this report targets certain crash types. For example, EyeSight is not expected to mitigate pedestrian crashes that occur when the vehicle is backing up. All crashes, regardless of the ability of a feature to prevent or mitigate them, are included in the analysis.

The EyeSight system is optional and associated with increased costs. The type of person who selects EyeSight may be different from the person who declines it. While the analysis controls for several driver characteristics, there may be other uncontrolled attributes among people who selected EyeSight.

REFERENCES

[1] National Highway Traffic Safety Administration, National Center for Statistics and Analysis. (2018). *2017 Fatal motor vehicle crashes: Overview* (Traffic Safety Facts Research Note. Report No. DOT HS 812 603). Washington, DC. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603

[2] National Highway Traffic Safety Administration, National Center for Statistics and Analysis. (2017). *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

[3] National Highway Traffic Safety Administration, National Center for Statistics and Analysis. (2017). *Pedestrians: 2015 data* (Traffic Safety Facts. Report No. DOT HS 812 375). Washington, DC. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812375

[4] Retting, R. (2018). *Pedestrian traffic fatalities by state, 2017 preliminary data*. Washington, DC: Governors Highway Safety Association.

[5] Hu, W., & Cicchino, J.B. (2018). An examination of the increases in pedestrian motor-vehicle crash fatalities during 2009–2016. *Journal of Safety Research, 68*, 37–44. doi:/10.1016/j.jsr.2018.09.009

[6] Jermakian, J.S., Zuby, D.S. (2011). *Primary pedestrian crash scenarios: factors relevant to the design of pedestrian detection systems*. Arlington, VA: Insurance Institute for Highway Safety.

[7] Highway Loss Data Institute. (2014). Subaru collision avoidance features: initial results. *Loss Bulletin, 31*(24). Arlington, VA.

[8] Highway Loss Data Institute. (2015). Subaru collision avoidance features: an update. *Loss Bulletin, 32*(8). Arlington, VA.

[9] Highway Loss Data Institute. (2016). 2013–15 Subaru collision avoidance features. *Loss Bulletin, 33*(6). Arlington, VA.

[10] Highway Loss Data Institute. (2017). 2013–16 Subaru collision avoidance features. *Loss Bulletin, 34*(10). Arlington, VA.

[11] Highway Loss Data Institute. (2018). 2013–17 Subaru collision avoidance features. *Loss Bulletin, 35*(2). Arlington, VA.

[12] Insurance Institute for Highway Safety. (2019). Safe passage: New ratings address pedestrian crashes. *Status Report, 54*(2). Retrieved from https://www.iihs.org/iihs/sr/statusreport/article/54/2/1

[13] United Nations Economic Commission for Europe. (2019, February 12). *UN regulation on advanced emergency braking systems for cars to significantly reduce crashes* [Press release]. Retrieved from http://www.unece.org/?id=51189

[14] Highway Loss Data Institute. (2018). Predicted availability and fitment of safety features on registered vehicles — a 2018 update. *Loss Bulletin, 35*(27). Arlington, VA.

[15] Retting, R.A., Ferguson, S.A., & McCartt, A.T. (2003). A review of evidence-based traffic engineering measures to reduce pedestrian-motor vehicle crashes. *American Journal of Public Health, 93*(9), 1456–1463. doi: 10.2105/AJPH.93.9.1456

[16] Hu, W., & Cicchino, J.B. (2019). Lowering the speed limit from 30 to 25 mph in Boston: effects on vehicle speeds. *Injury Prevention* (published online, 13 January 2019). doi: 10.1136/injuryprev-2018-043025