

ALCOHOL-IMPAIRED DRIVING IN THE UNITED STATES Results from the 2019 TIRF USA Road Safety Monitor

By: Ward G.M. Vanlaar¹, Craig Lyon¹, Carl Wicklund² and Robyn D. Robertson¹

Financial support provided by: Anheuser-Busch Foundation



This fact sheet summarizes the national results of the 2019 USA Road Safety Monitor (USA RSM) on alcohol-impaired driving. This USA RSM is the fifth annual public opinion survey conducted by the Traffic Injury Research Foundation USA, Inc. (TIRF USA) with sponsorship from Anheuser-Busch Foundation. The survey takes the pulse of the nation regarding the alcohol-impaired driving issue by means of an online survey of a random, representative sample of U.S. drivers aged 21 years or older. A total of 2,526 drivers in the U.S. completed the poll in September 2019 (results can be considered accurate within plus or minus 2%, 19 times out of 20).

This fact sheet provides a general overview of key results related to the prevalence of alcohol-impaired driving, reasons for engaging in this behavior and characteristics of drivers, as well as concern about this and other road safety topics. These survey results are compared to data from previous years. For the first time, the survey also included some questions about drug- and marijuana-impaired driving. With the increasing number of states passing some form of legal marijuana sales and the potential impairing effects of both legal and illegal drugs, there has been growing concern from highway safety professionals, policymakers and the general public about the impact of impairing substances other than alcohol on drivers. To provide context, alcohol-impaired driving and drug- and marijuana-impaired driving are compared to other unsafe driving behaviors such as speeding, red-light running, fatigued driving and distracted driving.

THE TRAFFIC INJURY RESEARCH FOUNDATION USA, Inc.

The mission of the Traffic Injury Research Foundation USA, Inc. (TIRF USA) is to develop and share the knowledge that saves – preventing injuries and loss of life on American roads, reducing related social, health and insurance costs, and safeguarding productivity. TIRF USA is an independent road safety research institute that obtained 501(c)3 non-profit status in the US in 2014.

¹ TIRF, Ottawa, Ontario, Canada

² Traffic Injury Research Foundation USA, Inc. (TIRF USA)



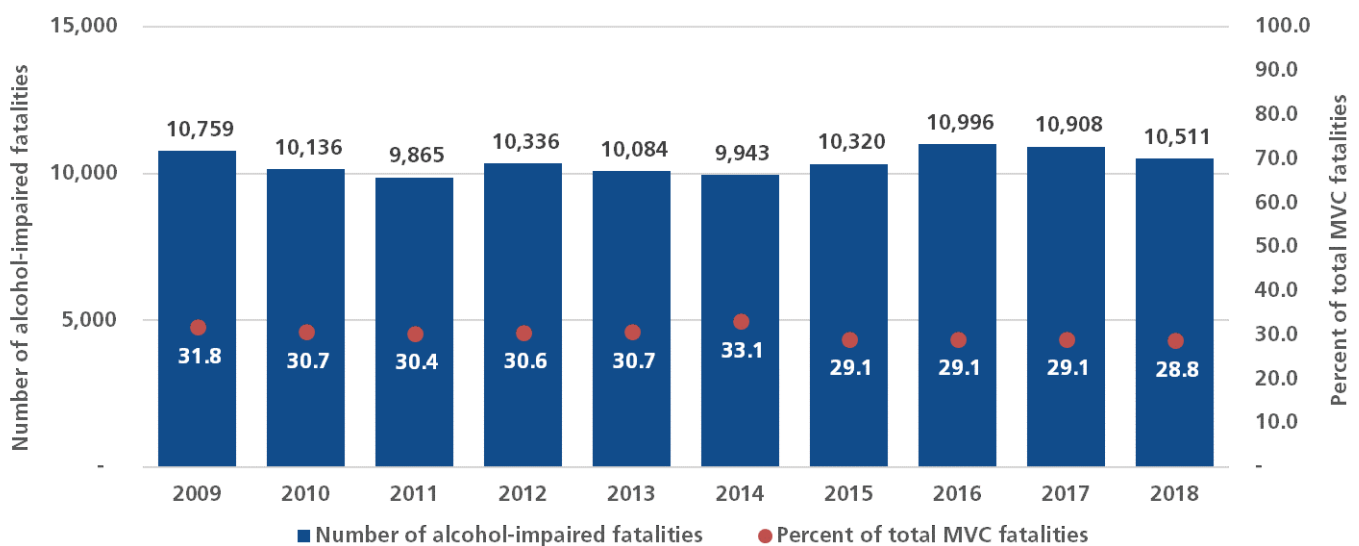
The knowledge source for safe driving

Background

What is the context of alcohol-impaired driving in the U.S.? According to the National Highway Traffic Safety Administration (NHTSA), alcohol-impaired driving fatalities involving a driver with a blood alcohol concentration (BAC) of .08 or greater accounted for 28.8% of total motor vehicle crash (MVC) fatalities in 2018, or 10,511 lives lost (see Figure 1). This corresponds to a 3.6% decrease compared to 2017 when the number of fatalities was 10,908 (NHTSA October 2019)³. During the same time span vehicle miles traveled (VMT) increased by 0.3% from 2017 to



Figure 1: Alcohol-impaired driving fatalities from 2009 to 2018



Source: NHTSA Traffic Safety Fact Sheets

2018 and the overall fatality rate per 100 million VMT decreased by 3.4 percent from 1.17 in 2017 to 1.13 in 2018. Although the percent of alcohol-impaired driving fatalities of all total driving fatalities remained constant at approximately 29% during 2016, 2017 and 2018, the total VMT increase coupled with 3.6% fewer alcohol-impaired driving fatalities indicates a decreasing trend of fewer fatalities per VMT (NHTSA October 2019). In other words, proportionately speaking, compared to all fatalities, the situation in 2018 was similar to 2016 and 2017, but in absolute numbers and in fatalities per VMT, there is a decrease.

³ Note that in last year's 2018 TIRF USA RSM fact sheet (Wicklund et al. 2018), the 2017 number of fatalities involving a driver with a BAC of 0.08 or greater was reported to be 10,874. This was based on official data available at that time. Since then, an adjustment was made to this number and published in the most recent NHTSA fact sheet (NHTSA October 2019), hence the change from 10,874 to 10,908 in our 2019 TIRF USA RSM fact sheet for the 2017 number of alcohol-impaired driving fatalities.

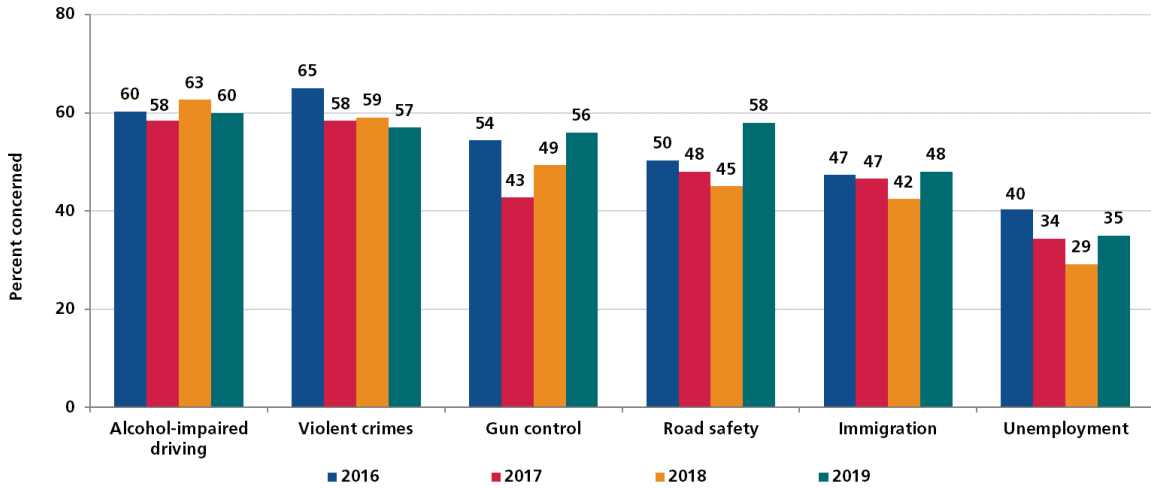
Where does the issue of alcohol-impaired driving sit on the public agenda?

Figure 2 shows the percentage of U.S. drivers who were very or extremely concerned about six societal issues. Like the previous three years, almost two-thirds (60%) of U.S. drivers reported that they were very or extremely concerned about alcohol-impaired driving in 2019. There was slightly less concern about violent crimes (57%), gun control (56%) and road safety (58%). Notably, concerns about gun control rose significantly in the last three years (from 43% to 49%, and to 56%) and road safety saw a significant increase in concern from 2018 (from 45% to 58%). Respondents reported that they were very or extremely concerned about other issues to a lesser extent such as immigration (48%) and unemployment (35%). Concern about unemployment has fluctuated each of the past four years.

Is alcohol-impaired driving a major road safety problem for U.S. Drivers?

Figure 3 shows the

Figure 2: Percent of U.S. drivers who are very or extremely concerned about different societal issues in 2016-2019



percentage of U.S. drivers who think various road safety issues are a serious or very serious problem. The most serious problems identified by drivers continued to be texting and driving at 84% (a significant decrease from 88% in 2018) followed by alcohol-impaired driving at 78% (a significant increase from 74% in 2018) and drug-impaired driving at 71% (a significant increase from 62% in 2018). Other road safety issues are also a concern for most U.S. drivers such as talking on hand-held devices (67%), excessive speed (67%), marijuana or THC impaired drivers (58%), driving after vaping marijuana or THC (57%), driving under the influence of CBD/cannabidiol (53%) and driving after vaping CBD/cannabidiol (51%). The questions related to marijuana/THC and CBD/cannabidiol were asked for the first time in 2019.

Figure 3: Percent of U.S. drivers who think various road safety issues are a serious or very serious problem in 2016-2019

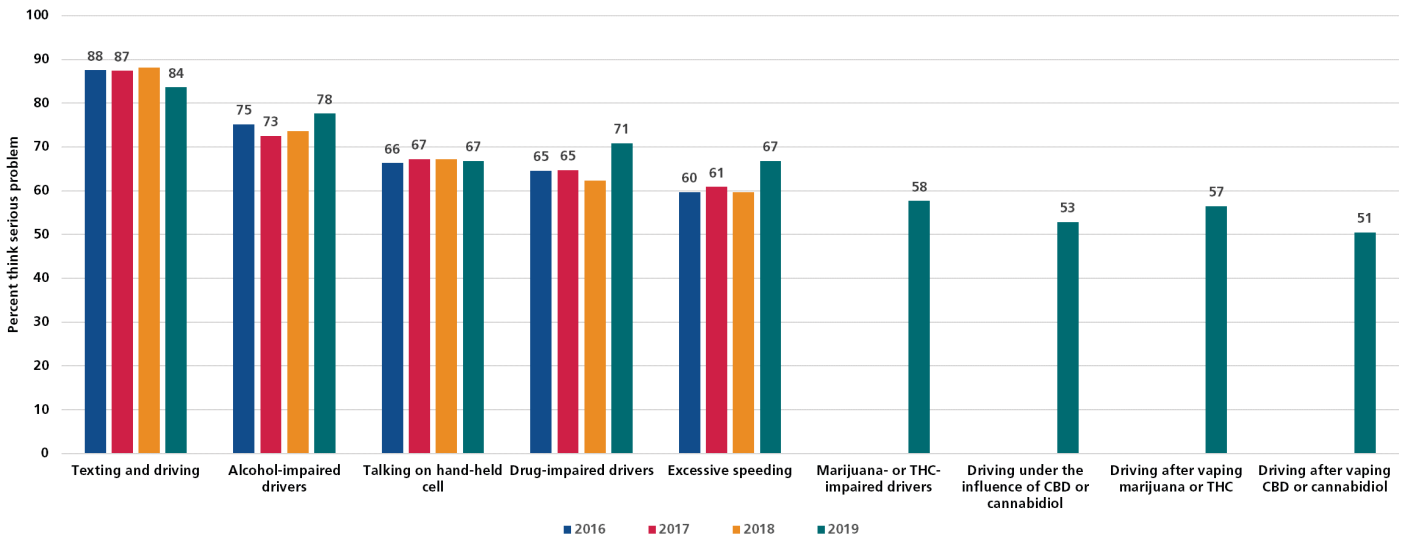
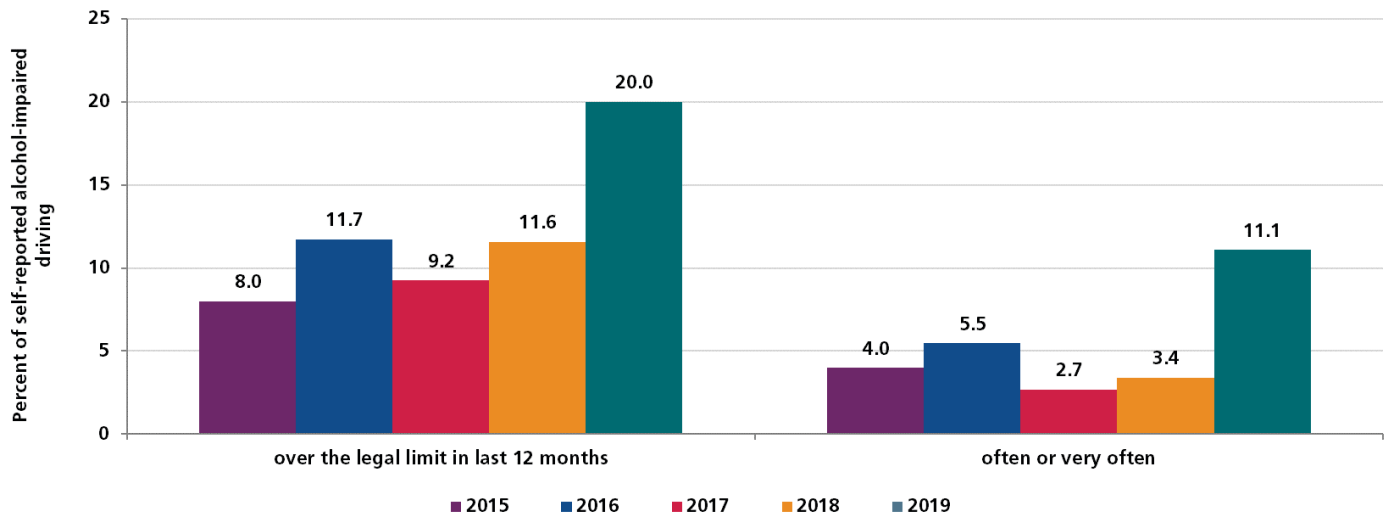


Figure 4: Percent of U.S. drivers self-reporting alcohol-impaired driving in 2015-2019



Alcohol-impaired driving behaviors as reported by U.S. drivers

What were self-reported alcohol-impaired driving behaviors of U.S. drivers? Self-reported alcohol-impaired driving behavior by U.S. drivers is shown in Figure 4. Respondents were asked two questions. First, they were asked how many times in the past 12 months they had driven when they thought they were probably over the legal limit. Results on the left-hand side show the percent of drivers each year who answered one or more times. Second, respondents were asked how often they drive impaired on a scale from 1 (never) to 6 (very often). The results on the right-hand side show the percent of those who chose 5 or 6 on this scale.

The results show that the percent of respondents that reported driving when they thought they were over the legal limit in the last 12 months significantly increased from 11.6% in 2018 to 20% in 2019. This is the highest prevalence reported during the past five years of data collection. Additionally, the percent of respondents that reported driving impaired often or very often was also the highest reported during the past five years with a significant increase from 3.4% in 2018 to 11.1% in 2019.

What are the reasons why U.S. drivers drove when they thought they were over the legal limit?

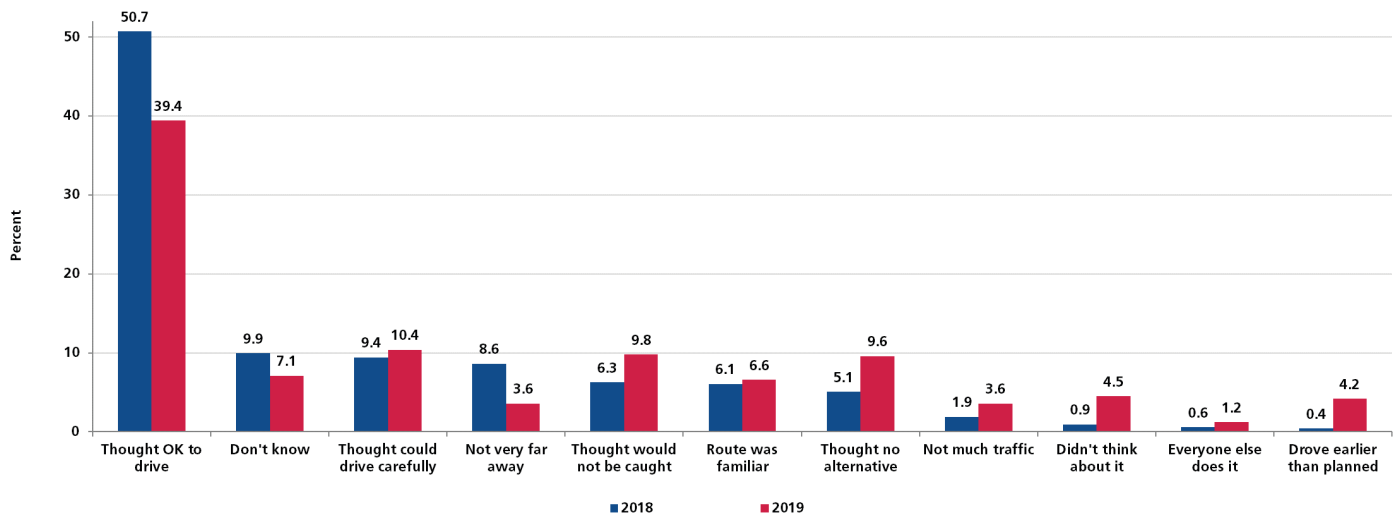
Answers from respondents regarding reasons they drove when they thought they were over the legal limit are presented in Figure 5. The most common response was they thought they were okay to drive (39.4%). However, this is a significant decrease from 50.7% in

2018. Furthermore 10.4% reported they thought they could drive carefully regardless, 9.8% thought they would not be caught and 9.6% thought there was no alternative to driving. A variety of other reasons were somewhat common such as 7.1% who didn't know why they drove while impaired to 6.6% who said the route was familiar. These results are similar to responses in 2018 with few exceptions: the percentage of respondents who "thought they were okay to drive" decreased significantly from 50.7% in 2018 to 39.4% in 2019; those who "thought they would not get caught" showed a non-significant increase from 6.3% in 2018 to 9.8% in 2019 and those that "thought there was no alternative" increased significantly from 5.1% in 2017 to 9.6% in 2019.

39.4% of U.S. drivers thought they were okay to drive even though they thought they were over the legal limit.

A large percentage of U.S. drivers (45.6% four-year average) who drove when they thought they were over the legal limit for alcohol consumption continue to believe they were okay to drive. This suggests they do not understand or appreciate the impairing effects of alcohol on driving or the risk they pose to themselves and other drivers on the road; or, worse case, they simply do not care. These results suggest that educational campaigns designed to help drivers recognize that they are not able to judge their own level of impairment or ability to drive after drinking are needed to help prevent and reduce alcohol-impaired driving.

Figure 5: Why respondents drove when they thought they were over the legal limit in 2019



The increases in those who think they would not get caught and that there were no alternatives are notable and speak to the importance of high-visibility enforcement as well as availability and/or awareness-raising of alternative, safe rides.

What are the characteristics of respondents who reported driving while they thought they were over the legal limit? Data were analyzed to determine if there were any relationships between people who reported driving while they thought they were over the legal limit within the last 12 months and their age, sex, the distance they drive, the number of tickets issued, whether they had previously been injured in a collision, and their marital status. Analysis of the aggregated data from the **past four years** revealed several significant results. Results for 2019 only are also provided in brackets for comparison:

- Older drivers were less likely to report driving when they thought they were over the legal limit. Among respondents aged 21 to 39 years, approximately 21.8% reported this behavior, whereas among those aged 40 to 59 years approximately 8.9% and 8% of those over age 60 reported this (33.1%, 14.8% and 6.3% for these same age categories in 2019).
- Males (16.8%) were more likely than females (8.2%) to report driving while they thought they were over the legal limit (25.8% versus 14.4% in 2019).
- With respect to tickets received in the past 12 months, those who received two or more of them were more likely to report driving when they thought they were over the legal limit (71%)



compared to those who received fewer than two tickets (28.7%) (81.5% versus 14.4% in 2019).

- Persons who had been injured in the past in a motor vehicle crash were more likely to report driving when they thought they were over the legal limit (16.9%) compared to those who had not been injured before (10.8%) (32.9% among those injured versus 15.9% among those not injured in 2019).

What are the characteristics of respondents who reported driving impaired often or very often? The analyses to determine if there were any relationships between people who reported driving impaired often or very often and their demographic characteristics showed similar profiles. Based on the aggregated data from the **past four years**, the following significant results were found:

- Older drivers were less likely to report driving impaired often or very often. Among respondents aged 21 to 39 years, approximately 10.7% reported this behavior, whereas just 3% of those aged 40 to 59 years, and only 3.2% of those over age 60

reported this (21%, 7.4% and 1.5% for these same age categories in 2019).

- > Males (7.9%) were more likely than females (2.8%) to report driving impaired often or very often (Males 16.2%, females 6.2% in 2019).
- > With respect to tickets received in the past 12 months, those who received two or more of them were more likely to report driving impaired often or very often (52.6%) compared to those who received fewer than two tickets (3.2%) (50.8% versus 7.6% in 2019).
- > Persons who had been injured in the past in a motor vehicle crash were more likely to report driving impaired often or very often (9.6%) compared to those who had not been injured before (3.8%) (22.5% among those injured versus 7.5% among those not injured in 2019).

Comparison with other types of unsafe driving behaviors

What types of other unsafe driving behaviors are reported by drivers? Since 2015 the TIRF USA RSM has compared alcohol-impaired driving to other unsafe driving behaviors including speeding through a traffic light, driving well over the speed limit, driving tired or fatigued, and driving distracted.

Red-light running and speeding are found to be among the leading causes of road crashes in the United States and Canada.

Red-light running and speeding are found to be among the leading causes of road crashes in the United States and Canada (Evans, 2006; Elvik, 2005; Goldenbeld and Van Schagen, 2005; Hess, 2004; Kloeden et al., 2001; McGee and Eccles, 2003; Tay, 2000; Vanlaar et al. 2014). The crashes that result from red-light running also vary in severity. Red-light running most often results in right-angle crashes which have a higher injury and fatality rate than most other types of crashes, including rear-end crashes (Helai et al., 2008).

Driving when drowsy/sleepy or fatigued can compromise the ability to drive safely. Both actions lead to impaired performance at the wheel and can ultimately result in falling asleep at the wheel (Brown, 1994; Vanlaar et al. 2008). The 2002 “Sleep in America” survey found that 51% of drivers admitted to driving while drowsy, 17% admitted to dozing off while

driving, and 1% reported having been involved in a crash due to dozing off or fatigue (National Sleep Foundation, 2002). From 2011 through 2015 drowsy driving was reportedly involved in 2.3% to 2.5% of all fatal crashes nationwide and an estimated 33,000 (1.9%) of all injury crashes in 2015 (NHTSA 2017).



Distracted driving has become one of the most significant road safety concerns worldwide, with distraction from mobile devices and other in-vehicle technology being at the forefront of this discussion (Bowman and Robertson, 2016). The 100-Car Naturalistic Driving study of data from crashes and near-crashes conducted by the Virginia Tech Transportation Institute (Klauer et al. 2006) estimated that engaging in a complex secondary task (e.g., texting, reaching for a moving object, applying makeup or dialing) while driving exposed drivers to approximately three times the risk of involvement in a crash or near-crash. In North America, distraction is estimated to be a factor in about 20% to 30% of motor vehicle collisions (Robertson et al. 2017).

Finally, due to the increasing number of states that have legalized marijuana, the survey this year includes driving within two hours after consuming marijuana/THC as a dangerous driving behavior. Numerous studies have been conducted in countries around the world investigating the impairing effects of marijuana on driving skills (Broyd et al. 2016; Hartman et al. 2016; Holland et al. 2011; Huestis 2007; Li et al. 2011; Ramaekers et al. 2004, 2006; Romano et al. 2017). For the most part, these results have demonstrated marijuana produces impairment and measurable decrements in driver skills.

Figure 6 shows significant increases in all unsafe behaviors that were monitored since 2015. It further shows that other behaviors continue to be more prevalent than alcohol-impaired driving (11.1% for driving impaired compared to 13.3% for driving distracted to 18.8% for speeding through a traffic light).

Figure 6: Percent of U.S. drivers who often or very often engage in unsafe driving behaviors in 2015-2019

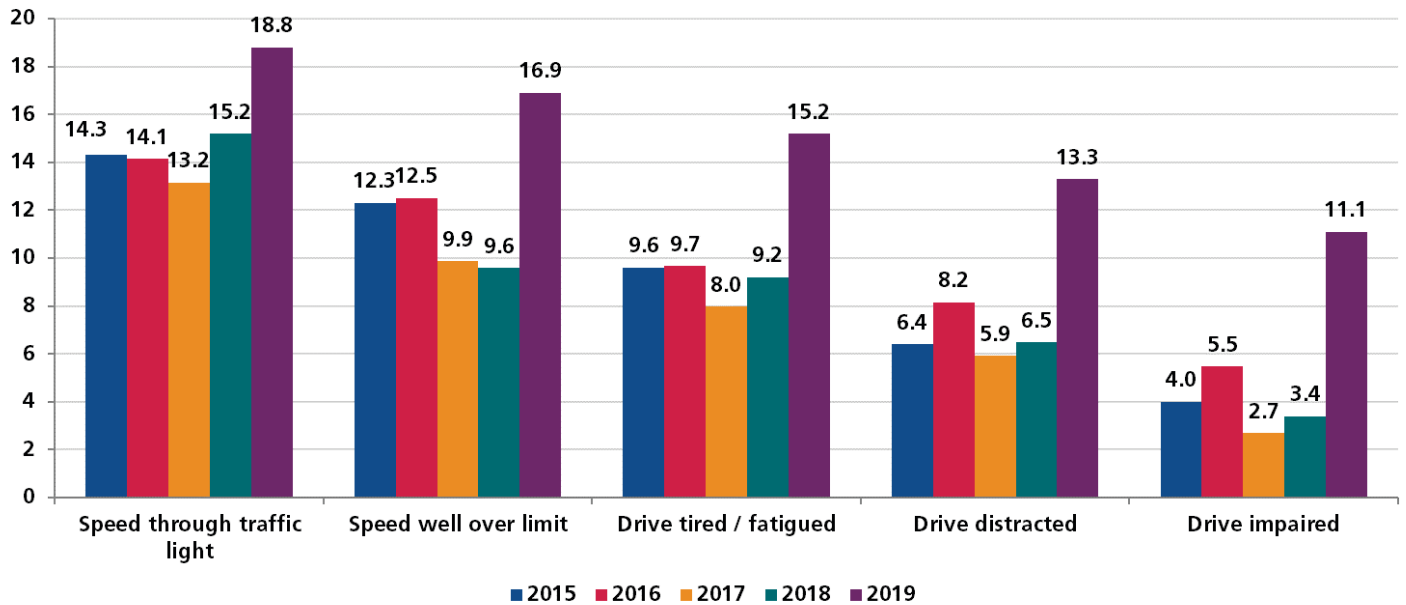
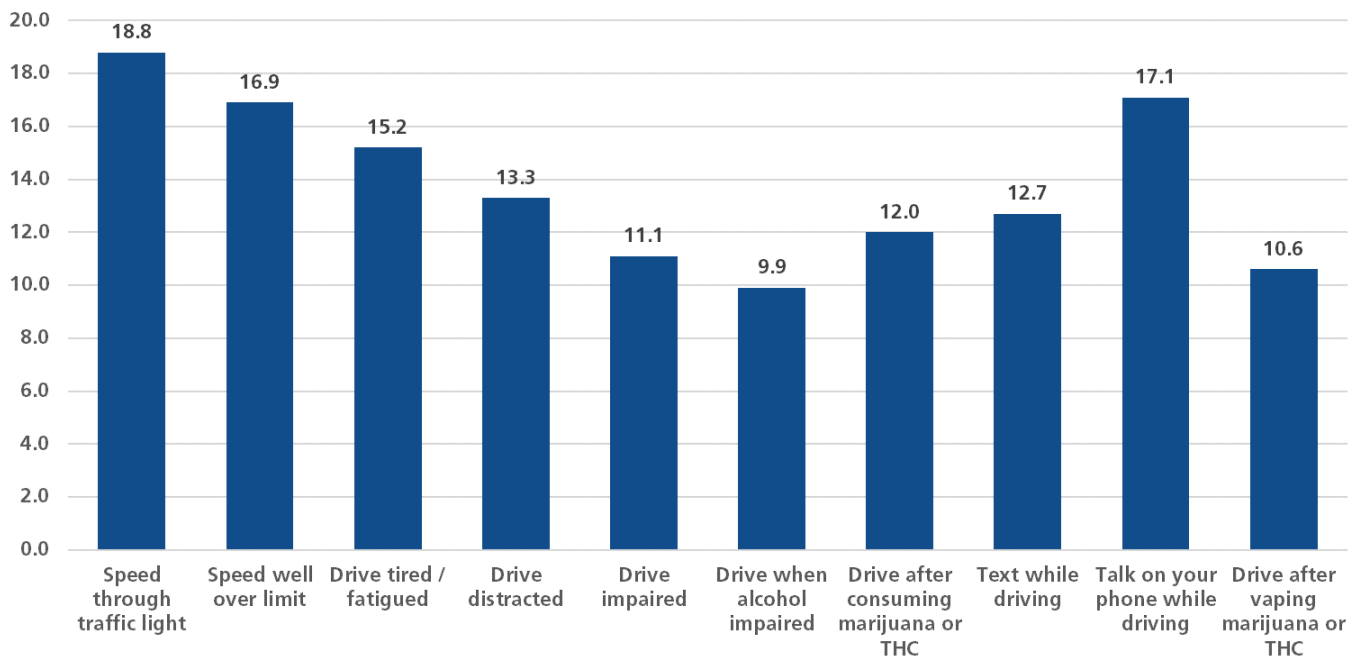


Figure 7 shows the results for unsafe driving behaviors reported in 2019 that includes several behaviors not asked about in previous years. These additional behaviors include texting while driving, talking on their phone while driving and several questions related to alcohol and drug use. The highest reported behaviors were related to speeding, distraction and driving while tired/fatigued. Driving after consuming THC was reported slightly more often than driving when

impaired by alcohol (12% versus 9.9%), which was a statistically significant difference. While the impact of

Speeding, distraction and driving while tired/fatigued were the highest reported unsafe driving behaviors reported in 2019.

Figure 7: Percent of U.S. drivers who often or very often engage in unsafe driving behaviors in 2019



consuming/vaping CBD on driving may not be entirely understood today, we asked people how often they drove after consuming/vaping CBD. The results show that driving after consuming and driving after vaping CBD/cannabidiol was reported by 11.6% and 10.4% of drivers respectively.

How do driver attitudes about dangerous driving affect their behaviors? The relationship between driver attitudes and behaviors with respect to several unsafe driving behaviors was analyzed using logistic regression modeling. Driver attitudes were measured by asking respondents on a six point scale the extent to which they believed it was okay to engage in several unsafe driving behaviors, with a 1 indicating it is completely okay to do so and a 6 indicating it is completely not okay. For scoring purposes, a 5 or 6 was used to indicate they agree that it is not okay to engage in that behavior.

For two unsafe driving behaviors (driving often after consuming or vaping THC; and, speeding) the results consistently showed that males, younger drivers, those who have been injured in a previous car crash and those who have received two or more tickets in the past twelve months were more likely to report engaging in the unsafe behavior. This is similar to the profile of alcohol-impaired drivers described above.

With respect to driving after consuming or vaping THC, respondents who reported that driving after doing so was not okay were 46% less likely to report doing so often. With respect to speeding, those who reported it was not okay to drive well over the speed limit were 47% less likely to report speeding often.

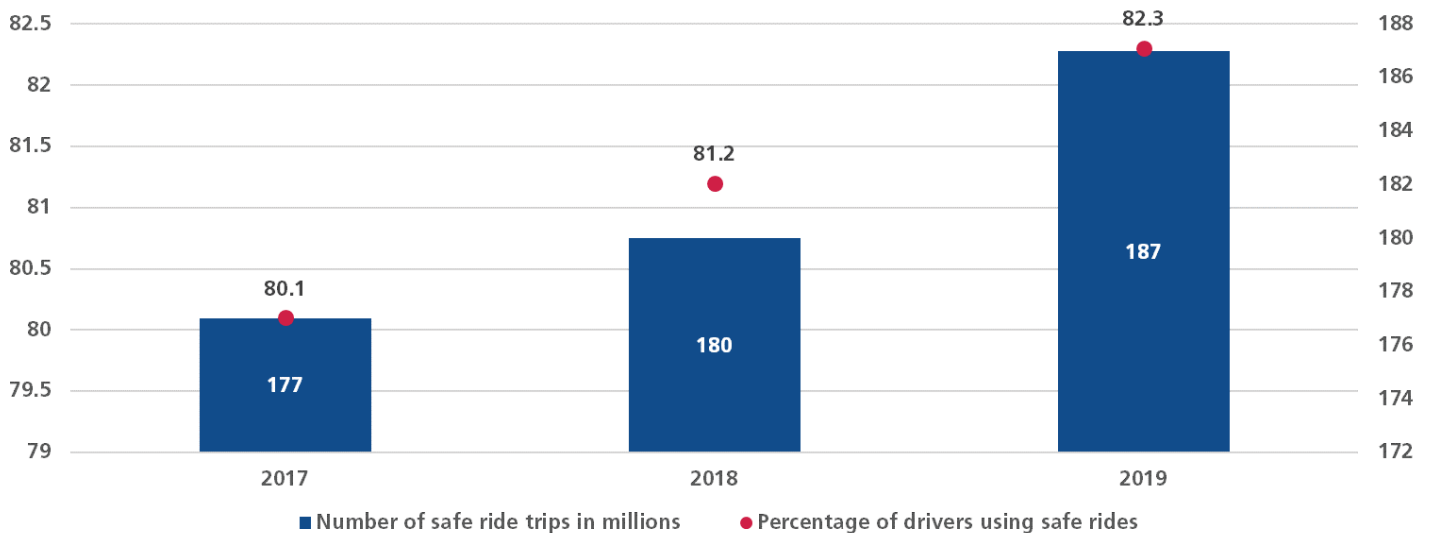
Safe rides

What proportion of drivers report using safe rides? The proportion of respondents indicating they had been a designated driver, used a designated driver, used a taxi or public transportation or ridesharing in 2019 was 82.3%. This represents over 187 million licensed drivers in the U.S. that have used one of the safe ride options in 2019. This indicates a yearly ongoing improvement from 81.2% of respondents in 2018 (180 million) and 80.1% in 2017 (177 million).



Who is using safe rides? A logistic regression model was fit to the 2019 data to examine if gender and age have an impact on who is more or less likely to use a safe ride option. There were no significant differences between males and females. With respect to age, no differences were seen between drivers under the age of 50. Drivers aged 50 or older were found to be 61% less likely than younger drivers to use a safe rides option.

Figure 8: Trends in the use of safe rides 2017-2019



This does not, however, mean that these older drivers are more likely to drive while impaired. They may simply be less likely to be drinking alcohol in the first place when a ride home would be required, or they may rely less on a safe ride as a strategy to avoid driving after drinking.

Conclusions

To date, survey results from the TIRF USA RSM are consistent with trends in alcohol-impaired driving fatalities (with the exception of one year, 2018, when an increase in self-reported alcohol-impaired driving was observed but a decrease in alcohol-impaired driving fatalities⁴). Data from 2019 revealed significant increases in measures of self-reported alcohol-impaired driving. While more data are needed to monitor trends, the significant increase in self-reported alcohol-impaired driving is a concern. It is an indication the number of alcohol-impaired driving fatalities in 2019 may increase.

These results are in sharp contrast to the reported level of concern about alcohol-impaired driving which has remained higher than concern about other social issues as well as other road safety issues (except for texting while driving). The substantial increase in self-reported driving when impaired by alcohol appears disconnected from the reported level of concern reported about this issue and warrants further study.

The most common reasons drivers reported driving when they thought they were over the legal limit can provide guidance to address this. In 2018, half of respondents indicated they believed they were okay to drive, which was similar to the percentage of drivers who reported doing so in previous years. However, in 2019 this percentage dropped to 39.4%, perhaps indicating greater awareness of the impairing effects of alcohol, or of the inaccuracy of their own perceptions of intoxication. Nevertheless, the result still suggests numerous drivers may not recognize the impairing effects of alcohol after they have been drinking or understand how their driving abilities may be affected. Also, the levels observed in 2019 among individuals who believed they would not get caught and that there were no alternatives, speaks to the importance of high-visibility enforcement as well as availability and/or awareness-raising of alternative, safe rides.

Targeted educational strategies to underscore drivers' perception of their own impairment are often inaccurate. Therefore, drivers should not rely solely on how they gauge their own level of impairment when making decisions about driving after drinking.

Messages encouraging drivers to listen to members of their social group who tell them they are too impaired to drive may help to reinforce safer choices. RSM results consistently show young males with a history of crashing and offending are more at risk for engaging in alcohol-impaired driving. Similar profiles were found for those engaging in speeding and driving after consuming or vaping THC. This is consistent with the literature that shows certain subgroups of drivers are more prone to risk-taking in general. While males are indeed more likely to engage in the behavior, 8.2% of females also self-reported driving while they thought they were over the legal limit. It means different subgroups would benefit from such tailored approaches.

On a positive note, the reliance on alternative transportation options to driving impaired has steadily increased in the past few years. In particular, the number rose from 177 million drivers in 2017 indicating they had been a designated driver, used a designated driver, used a taxi or public transportation or ridesharing, to 187 million in 2019. In light of this increase, it seems the belief there are no alternatives may be used as an excuse, at least by a subgroup of impaired drivers. Understanding who is at risk for alcohol-impaired driving, and the conditions leading to this behavior, is important to ensure people have access to safe rides. Communities should be expected to be unique in what safe ride strategies will work, hence tailored implementation is essential. Effective safe ride options and maintaining a minimum level of high-visibility enforcement is equally important to achieve progress.

The significant increases in the prevalence of other self-reported risky driving behaviors, such as speeding through traffic lights, driving well over the speed limit, driving tired or fatigued, and driving distracted are disconcerting. Increases in these behaviors may be indicative of a larger trend related to low awareness of risks and consequences among drivers, and perhaps misperceptions about the responsibility of drivers in operating a vehicle with advanced driver assistance systems (ADAS) such as lane changing alerts, or automatic braking systems. Recent research has shown some drivers are more willing to engage in a range of risky driving behaviors due to misperceptions that safety features of semi-autonomous vehicles will protect

⁴ Note that an adjustment to the 2018 number of fatalities may be made in 2020, similar to previous years (cf. footnote 3), so the consistency for 2018 between indicators of self-reported alcohol-impaired driving and alcohol-impaired fatalities remains to be determined.

them or that vehicles are capable of driving without their intervention (Robertson et al. 2017). This general increase in the prevalence of other unsafe behaviors may also be related to a – perceived or real – decrease in enforcement.

Regarding marijuana, public awareness is often characterized by misperceptions due to the complexity of the science about impairing effects and challenges conveying it. To illustrate, it has been a common misperception among users that they can drive better and/or more safely after consuming marijuana. Of concern, the results from the Traffic Safety Culture Index by the AAA Foundation for Traffic Safety reported just over half of respondents believed using marijuana within one hour of driving increased crash risk (AAA Foundation for Traffic Safety, 2018). Similar results were found in our survey. It was found that 58% of respondents perceive marijuana/THC impaired drivers to be a serious problem and 57% perceive the same for driving after vaping marijuana/THC. While the impact of consuming/vaping CBD on driving is not well understood today, 53% perceive driving under its influence to be a serious problem and 51% agreed the same for driving after vaping. More work is needed to further explore if, and how, CBD affects crash risk. This misperception and lack of awareness about the impairing effects of marijuana on driving can have a direct impact on the rates of marijuana-impaired driving and marijuana-related crashes.

In conclusion, the number of alcohol-impaired driving fatalities continues to decrease. This is indicative of progress achieved. Other positive trends include the increase in the number of drivers stating they relied on safe rides as an alternative strategy to avoid alcohol-impaired driving. In 2019, an estimated 187 million U.S. drivers said they had been a designated driver, used a designated driver, used a taxi or public transportation or ridesharing. Early warning surveillance, however, reveals more drivers reported driving while impaired in 2019, so continued monitoring is needed to determine the impact on crashes. In the interim, further efforts are essential to reduce the burden of the issue on the nation.

References

AAA Foundation for Traffic Safety (2018). 2017 Traffic Safety Culture Index. AAA Foundation for Traffic Safety.

Bowman, K., Robertson, R.D. (October 2016). Preventable Injuries/Fatalities Due to Distracted Driving: A Call for a Coordinated Action. *Journal of Orthopaedic & Sports Physical Therapy*, Vol.46, Issue 10, pp. 818-821.

Brown, I. D. (1994). Driver fatigue. *Human Factors*, 36(2), 298–314.

Broyd, S. J., van Hell, H.H., Beale, C., Yücel, M., Solowij, N. (2016). Acute and Chronic Effects of Cannabinoids on Human Cognition—A Systematic Review. *Biological Psychiatry*, Vol. 79, No. 7, pp. 557–567.

Elvik, R. (2005). Speed and road safety: synthesis evidence from evaluation studies. *Transportation Research Record*, 1908, 59–69.

Evans, L. (2006). *Traffic Safety*, 2nd ed. Science Serving Society, Bloomfield Hills, MI.

Goldenbeld, C., Van Schagen, I., (2005). The effects of speed enforcement with mobile radar on speed and crashes: an evaluation study on rural roads in the Dutch province Friesland. *Accident Analysis and Prevention*, 37, 1135–1144.

Hartman, R. L., Richman, J.E., Hayes, C.E., Huestis, M.A. (2016). Drug Recognition Expert (DRE) Examination Characteristics of Cannabis Impairment. *Accident Analysis and Prevention*, Vol. 92, pp. 219–229.

Helai, H., Chor, C.H., Haque, M.M. (2008). Severity of driver injury and vehicle damage in traffic crashes at intersections: a Bayesian hierarchical analysis. *Accident Analysis and Prevention*, 40, 45–54.

Hess, S. (2004). Analysis of the effects of speed limit enforcement cameras: differentiation by road type and catchment area. *Transportation Research Record*, 1865, 28–34.

Holland, M. G., Schwoppe, D.M., Stoppacher, R., Gillen, S.B., Huestis, M.A. (2011). Postmortem Redistribution of Δ^9 -tetrahydrocannabinol (THC), 11-hydroxy-THC (11-OH-THC), and 11-nor-9-carboxy-THC (THCCOOH). *Forensic Science International*, Vol. 212, No. 1-3, pp. 247–251.

Huestis, M. A. (2007) Human Cannabinoid Pharmacokinetics. *Chemistry & Biodiversity*, Vol. 4, No. 8, pp. 1770–1804.

Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J.D., and Ramsey, D. J. (2006). The Impact on Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data. DOT HS 810 594). National Highway Traffic Safety Administration. Washington, DC.

Kloeden, C.N., Ponte, G., McLean, A.J. (2001). Travelling Speed and the Rate of Crash Involvement on Rural Roads. Australian Transport Safety Bureau, Civic Square, ACT (CR 204).

Li, M. C., Brady, J.E., DiMaggio, C.J., Lusardi, A.R., Tzong, K.Y., Li. G. (2011). Marijuana Use and Motor Vehicle Crashes. *Epidemiologic Reviews*, Vol. 34, No. 1, pp. 65–72.

McGee, H.W., Eccles, K.A., 2003. Impact of red light camera enforcement on crash experience. A synthesis of highway practice. In: NCHRP Synthesis 310.

National Highway Traffic Safety Administration (NHTSA) (October 2017). Traffic Safety Facts. A Brief Statistical Summary. Drowsy Driving 2015. DOT HS 812 446.

National Highway Traffic Safety Administration (NHTSA) (October 2019). Traffic Safety Facts. Research Note. 2018 Fatal Motor Vehicle Crashes: Overview. DOT HS 812 826.

National Sleep Foundation (2002). 2002 Sleep in America Poll. Washington DC.

Ramaekers, J. G., Berghaus, G., van Laar, M., Drummer, O.H. (2004). Dose Related Risk of Motor Vehicle Crashes After Cannabis Use. *Drug and Alcohol Dependence*, Vol. 73, No. 2, pp. 109–119.

Ramaekers, J. G., Moeller, M.R., van Ruitenbeek, P., Theunissen, E.L., Schneider, E., Kauert, G. (2006). Cognition and Motor Control As a Function of $\Delta 9$ -THC Concentration in Serum and Oral Fluid: Limits of Impairment. *Drug and Alcohol Dependence*, Vol. 85, No. 2, pp. 114–122.

Robertson, R.D., Bowman, K., Brown, S. (2017). Distracted Driving. A national action plan. Traffic Injury Research Foundation. Ottawa, Canada.

Robertson, R.D., Meister, S.R., Vanlaar, W.G.M., Mainegra Hing, M. Automated vehicles and behavioural adaptation in Canada (2017) *Transportation Research Part A: Policy and Practice*, 104, pp. 50-57.

Romano, E., Torres-Saavedra, P., Voas, R.B., Lacey, J.H. (2017). Marijuana and the Risk of Fatal Car Crashes: What Can We Learn from FARS and NRS Data? *Journal of Primary Prevention*, Vol. 38, No. 3, pp. 315–328.

Tay, R., 2000. Do speed cameras improve road safety? In: *Proceedings of the Second International Conference on Traffic and Transportation Studies*. American Society of Civil Engineers, Reston.

Vanlaar, W., Robertson, R., Marcoux, K. An evaluation of Winnipeg's photo enforcement safety program: Results of time series analyses and an intersection camera experiment (2014). *Accident Analysis and Prevention*, 62, pp. 238-247.

Vanlaar, W., Simpson, H., Mayhew, D., Robertson, R. Fatigued and drowsy driving: A survey of attitudes, opinions and behaviors (2008). *Journal of Safety Research*, 39 (3), pp. 303-309.

Wicklund, C., Mainegra Hing, M., Robertson, D., Vanlaar, W.G.M. (2018). Alcohol-impaired driving in the United States. Results from the 2018 TIRF USA Road Safety Monitor. Traffic Injury Research Foundation. Ottawa, Canada.

TRAFFIC INJURY RESEARCH FOUNDATION (TIRF)

171 Nepean Street, Suite 200
Ottawa, Ontario, Canada K2P 0B4
www.tirf.ca

Toll Free: 1-877-238-5235
Fax: 613-238-5292

Registered Charity No. 10813 5641 RR0001

TIRF USA Inc.

Corporate Office
20 F Street, 7th Floor,
Washington, DC 20001

www.tirf.us
Email: tirf@tirf.us

December 2019
Traffic Injury Research Foundation USA, Inc.

Copyright © 2019

Financial support provided by Anheuser-Busch Foundation



**ANHEUSER-BUSCH
FOUNDATION**