RESEARCH BRIEF

# Traffic Safety Impact of the COVID-19 Pandemic: Fatal Crashes Relative to Pre-Pandemic Trends, United States, May–December 2020

December 2022

Despite a brief reduction during the initial months of the COVID-19 pandemic, the number of people killed in motor vehicle crashes in the United States surged in 2020 to its highest level in over a decade. The purpose of the research reported here is to advance the understanding of how safety on U.S. roads changed during the pandemic, beyond its initial months, by comparing the involvement of specific crash-, vehicle-, and driver-related factors in fatal crashes during May–December 2020 to what would have been expected had the pandemic not occurred and pre-pandemic trends continued. Data from all fatal crashes in the U.S. from 2011–2019 were used to develop statistical models of the monthly number of fatal crashes through December 2019. These models were then used to forecast how many fatal crashes would been expected in each month of 2020 without the pandemic. Overall, the number of traffic fatalities in 2020 was 2,570 (7.1%) more than expected based on pre-pandemic trends. However, a sharp decrease in traffic fatalities in March and April 2020 partially offset an even larger increase later in the year. During the eight-month period of May–December 2020, the number of traffic fatalities was 3,083 (12.1%) more than expected. Importantly, however, this increase was not uniform across all factors examined. This Research Brief identifies specific crash-, vehicle-, and driver-related factors that contributed most to the overall increase in traffic fatalities during this period, as well as others that continued to follow pre-pandemic trends or that even decreased.

## METHOD

The purpose of this study was to examine the involvement of particular crash-, vehicle-, driver-, and behavioral-related factors in fatal motor vehicle crashes during the COVID-19 pandemic relative to what would have been expected based on recent pre-pandemic trends. Because traffic safety during the initial months of the pandemic has been studied extensively (e.g., Shaik & Ahmed, 2022), and because the year-over-year increase in the absolute number of traffic fatalities began in or around May 2020 (Stewart, 2021), the current study focuses on comparing the observed traffic fatalities versus forecasts in May–December 2020.

Data were obtained from the Fatality Analysis Reporting System (FARS) database compiled by the National Highway Traffic Safety Administration (NHTSA). FARS contains data on every crash that occurs each year on public roads in the U.S. and results in a death within 30 days. Records from all fatal crashes that occurred between January 1, 2011 and December 31, 2020 were included.

The main outcome measures were the total number of fatal crashes, number of vehicles/drivers involved in fatal crashes, and number of fatalities overall in May–December 2020 relative to the corresponding numbers forecast from models of pre pandemic data. These outcomes were expressed both as differences (actual − forecast) and as percent increases or decreases relative to the forecast (100% × [actual/forecast − 1]). These outcome measures were computed overall and for subgroups of crash, vehicle, driver, and victim characteristics. The actual number was considered significantly different from the corresponding forecast if the actual number fell outside of the 95% confidence interval of the forecast. The 95% confidence interval of the sum of forecasts for multiple months was estimated by simulating the forecast 10,000 times, computing the corresponding sum in each simulation, and taking the 2.5th and 97.5th percentile values of the sum as the endpoints of the confidence interval.

Forecasts were estimated using Seasonal Autoregressive Integrated Moving Average (SARIMA) models of monthly counts of the relevant variable (Box & Jenkins, 1976). The numbers of seasonal and non-seasonal lags, differences, and moving average terms in each model were determined using the Hyndman-Khandakar algorithm (Hyndman & Khandakar, 2008; Hyndman & Athanasopoulos, 2018) with selection based on the Akaike Information Criterion (Akaike, 1974). Models were fitted to monthly counts of each relevant variable from January 2011 through December 2019, and were then used to forecast the numbers of crashes or fatalities that would have been expected in each month of 2020 if pre-pandemic trends had continued. Note that because separate models were used to model trends and produce forecasts for each subgroup (e.g., each category of driver age), forecasts summed across subgroups may differ from the corresponding overall forecast (e.g., the sum of the forecasts over all categories of driver age may not equal the forecasted total number of drivers in fatal crashes).

Because the main outcome of the study was the difference between the actual numbers of fatal crashes that occurred versus model-based forecasts of what would have occurred without the pandemic, it is important to ensure that the forecasts were reasonable. To validate the forecasting approach, the above-described method was used to fit models based on data from 2010-2018, forecast monthly fatal crashes in 2019 (when there was no pandemic), and compare the forecasts to the corresponding actual numbers. All analyses were performed using statistical software R.

## RESULTS

A total of 38,824 people died in motor vehicle crashes in the U.S. in 2020, 2,570 (7.1%) more than forecast from models developed using data from years 2011–2019 (Figure 1). The actual number of fatalities in January 2020 was similar to the forecast. There were slightly more fatalities than forecast in February, and slightly fewer than forecast in March. In April 2020—the first full month of the pandemic—the number of fatalities was much lower than forecast. By May 2020, however, the actual number of fatalities returned to levels similar to the forecast, and the number of fatalities greatly exceeded the respective monthly forecasts for the remainder of 2020. In May through December collectively, there were a total of 28,611 traffic fatalities nationwide, which represented 3,083 (12.1%) more than forecast for the same period.

### Characteristics of Crash Victims

Table 1 shows the number of people who died in crashes in May–December 2020 relative to corresponding forecasts, in relation to selected demographic characteristics. The increase in traffic fatalities relative to the corresponding forecast was greatest on both a numeric and percentage basis for young adults aged 25–39 (Figure 2a). The number of fatalities among this group exceeded the forecast by 22.8%, and this accounted for nearly half of the entire increase in fatalities among road users of all ages. Fatalities among teens aged 16–19, young adults

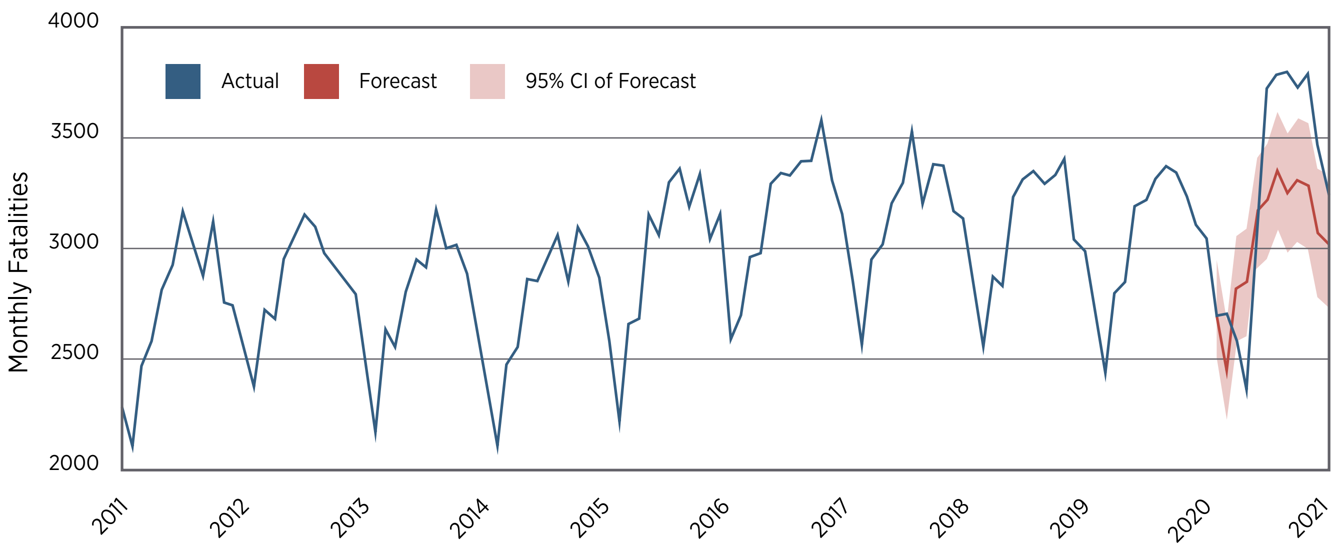


**Figure 1. Monthly number of traffic fatalities, United States, 2011–2020, and number forecast for 2020 based on time series model of monthly fatalities in 2011–2019.**

20–24, and middle-aged adults aged 40–54 were also significantly greater than forecast. Fatalities among adults aged 55–69 and among children aged <16 did not differ significantly from their corresponding forecasts. Fatalities among adults aged 70 years and older were significantly fewer than forecast (Figure 2b).

The number of men killed in crashes in May–December 2020 was 13.4% greater than forecast and accounted for the vast majority of the entire increase in traffic fatalities. Although the difference was not statistically significant, the number of women killed in crashes was 4.6% greater than forecast.

The numbers of fatalities of passenger vehicle drivers and passengers, motorcyclists, and bicyclists were all significantly greater than forecast. Fatalities of occupants of large trucks and buses were slightly fewer than forecast, though the difference was not statistically significant. Among vehicle occupants, the number of fatalities of occupants wearing seatbelts was slightly (though not significantly) lower than the corresponding forecast, whereas the number of fatalities of occupants not wearing seatbelts was much greater than forecast. Among motorcyclists, fatalities increased significantly

**Table 1. Number of people killed in crashes during May–December 2020 relative to forecasts based on time series models of monthly traffic fatalities in 2011–2019, in relation to selected characteristics.**

| | Actual | Forecast | (95% CI) | Difference | |
|---|---|---|---|---|---|
| | | | | N | % |
| Total People Killed | 28,611 | 25,528 | (23,821–27,211) | **3,083** | **12.1** |
| **Victim Age (years)** | | | | | |
| <16 | 987 | 924 | (823–1,026) | 63 | 6.9 |
| 16–19 | 1,688 | 1,469 | (1,272–1,662) | **219** | **14.9** |
| 20–24 | 3,064 | 2,575 | (2,262–2,892) | **489** | **19.0** |
| 25–39 | 8,084 | 6,582 | (6,012–7,147) | **1,502** | **22.8** |
| 40–54 | 5,883 | 5,199 | (4,753–5,647) | **684** | **13.2** |
| 55–69 | 5,527 | 5,399 | (5,069–5,734) | 128 | 2.4 |
| 70+ | 3,245 | 3,683 | (3,412–3,959) | **−438** | **−11.9** |
| **Victim Gender** | | | | | |
| Male | 20,780 | 18,324 | (17,283–19,358) | **2,456** | **13.4** |
| Female | 7,753 | 7,413 | (6,794–8,024) | 340 | 4.6 |
| **Road User Type** | | | | | |
| Driver of car or light truck | 13,052 | 11,678 | (10,832–12,520) | **1,374** | **11.8** |
| Passenger of car or light truck | 4,217 | 3,944 | (3,673–4,207) | **273** | **6.9** |
| Occupant of large truck or bus | 621 | 634 | (500–769) | −13 | −2.0 |
| Motorcyclist | 4,536 | 3,915 | (3,538–4,299) | **621** | **15.9** |
| Pedestrian | 4,552 | 4,522 | (4,200–4,859) | 30 | 0.7 |
| Bicyclist or other cyclist | 724 | 663 | (615–710) | **61** | **9.3** |
| **Seatbelt Use (vehicle occupants)[a]** | | | | | |
| Yes | 7,768 | 7,930 | (7,387–8,463) | −162 | −2.0 |
| No | 8,223 | 6,955 | (6,340–7,561) | **1,268** | **18.2** |
| **Helmet Use (motorcyclists)[a]** | | | | | |
| Yes | 2,613 | 2,408 | (2,250–2,560) | **205** | **8.5** |
| No | 1,765 | 1,488 | (1,278–1,700) | **277** | **18.6** |

Note: Sums of forecasts across categories of characteristics may not equal the forecast of the total because different models were used for each category and because cases with other or unknown values of characteristics were included in the total.
Differences shown in **bold** are statistically significant at 95% confidence level.
a. Occupants with unknown seatbelt use and motorcyclists with unknown helmet use were excluded.

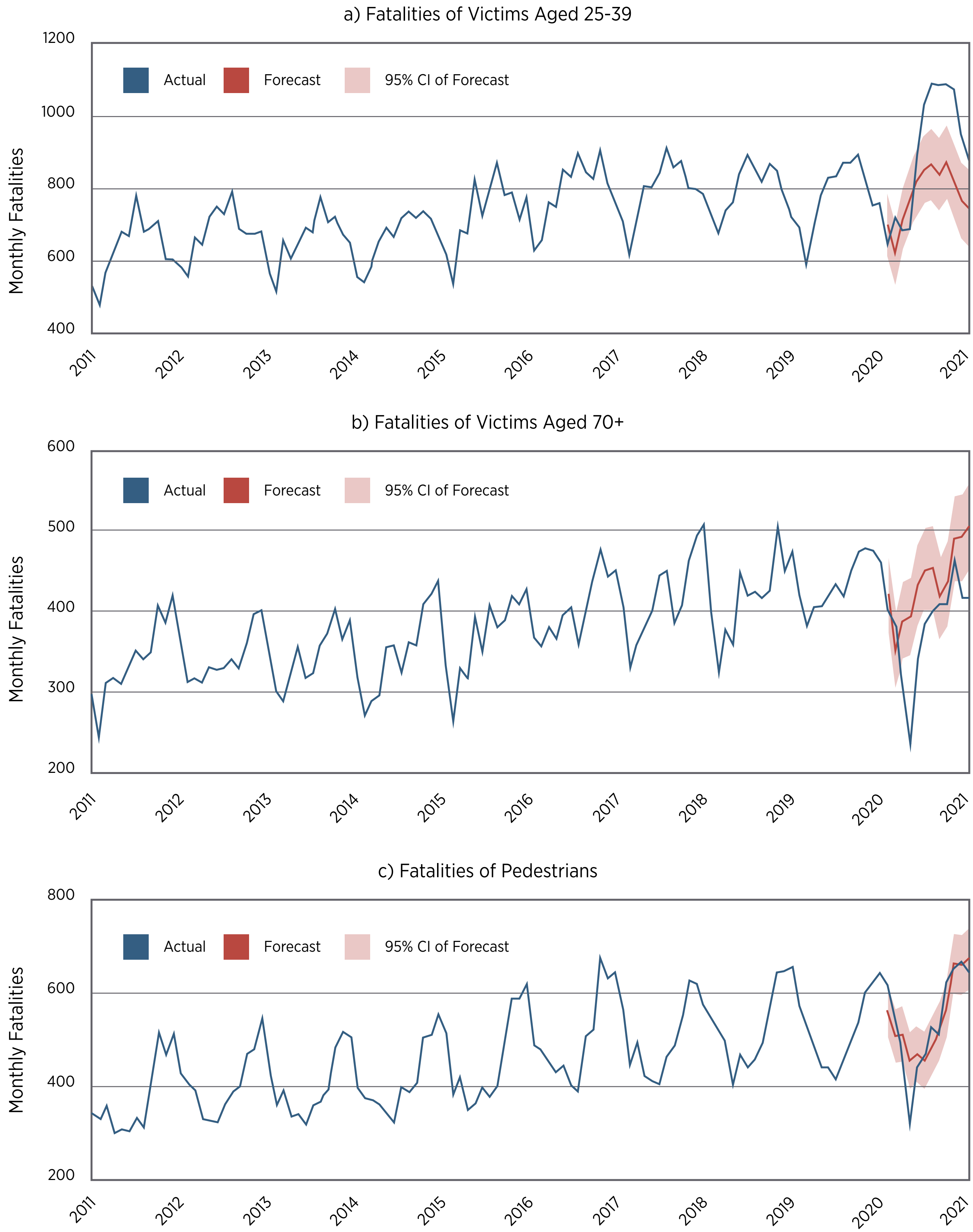


**Figure 2. Monthly number of traffic fatalities in the United States and number forecast for 2020 based on time series model of monthly fatalities in 2011–2019; select subgroups exhibiting different patterns relative to forecasts.**

both among motorcyclists wearing helmets and among those not wearing helmets, though the increase among those not wearing helmets was larger. The number of pedestrians killed was not significantly different from the forecast, though importantly, the forecast itself reflected a rapidly increasing trend in pedestrian fatalities, which began several years before the pandemic (Figure 2c).

## Crash Characteristics

Table 2 shows the number of fatal crashes that occurred in May–December 2020 relative to the corresponding forecasts in relation to selected crash characteristics. The number of fatal single-vehicle crashes was 15% greater than forecast, and the number involving two or more vehicles was 7.9% greater than forecast. The number of fatal crashes in which a single vehicle struck a non-motorist (e.g., a pedestrian or a bicyclist) did not differ significantly from the corresponding forecast. Importantly, however, the number of fatal crashes involving non-motorists increased significantly relative to the previous year; however, as noted previously and illustrated in Figure 2, this increase largely followed the substantial increasing trend in fatal crashes involving non-motorists that was already evident several years prior to the pandemic.

When examined in relation to type of road, the number of fatal crashes on urban Interstate highways and other urban freeways was 21.8% greater than forecast. The number of fatal crashes on other urban roads and streets was 10.6% greater than forecast, and importantly, the forecast itself reflected a significant increasing trend in fatal crashes on urban roads and streets in evidence for several years prior to the pandemic. On rural Interstate highways and freeways, the actual number of fatal crashes was slightly (though not significantly) lower than forecast. The number of fatal crashes on other rural roads was 7.4% greater than forecast.

When examined in relation to time of day, the increase in fatal crashes relative to corresponding forecasts was largest both in absolute terms and on a percentage basis in the late night-to-very early morning hours (10 pm–2 am), though a similarly large increase was observed in

**Table 2. Number of fatal crashes during May–December 2020 relative to forecasts based on time series models of monthly traffic fatalities in 2011–2019, in relation to selected crash characteristics.**

| | Actual | Forecast | (95% CI) | Difference | |
|---|---|---|---|---|---|
| | | | | N | % |
| Total Fatal Crashes | 26,335 | 23,448 | (21,672–25,218) | **2,887** | **12.3** |
| Type of Crash | | | | | |
| Single vehicle only | 10,356 | 9,006 | (8,280–9,732) | **1,350** | **15.0** |
| Single vehicle vs. non-motorist | 4,855 | 4,895 | (4,566–5,232) | −40 | −0.8 |
| Multi-vehicle crash | 11,124 | 10,308 | (9,610–10,988) | **816** | **7.9** |
| Type of Road | | | | | |
| Urban Interstate/freeway | 2,908 | 2,388 | (2,163–2,617) | **520** | **21.8** |
| Urban arterial/collector/local | 11,860 | 10,726 | (9,781–11,673) | **1,134** | **10.6** |
| Rural Interstate/freeway | 1,388 | 1,451 | (1,065–1,836) | −63 | −4.3 |
| Rural arterial/collector/local | 9,833 | 9,155 | (8,611–9,692) | **678** | **7.4** |
| Time of Day | | | | | |
| 6 am–9:59 am | 2,853 | 3,043 | (2,854–3,233) | **−190** | **−6.3** |
| 10 am–1:59 pm | 3,762 | 3,716 | (3,366–3,854) | 46 | 1.2 |
| 2 pm–5:59 pm | 5,312 | 4,948 | (4,516–5,385) | 364 | 7.4 |
| 6 pm–9:59 pm | 6,324 | 5,498 | (5,235–5,762) | **826** | **15.0** |
| 10 pm–1:59 am | 4,840 | 3,969 | (3,647–4,284) | **871** | **21.9** |
| 2 am–5:59 am | 3,004 | 2,719 | (2,442–2,989) | **285** | **10.5** |

Note: Sums of forecasts across categories of characteristics may not equal the forecast of the total because different models were used for each category.
Differences shown in **bold** are statistically significant at 95% confidence level.

the earlier evening hours (6–10 pm). A significant 10.5% increase was observed during the early morning hours (2–6 am) as well. In contrast, the number of fatal crashes during typical morning commute hours was 6.3% lower than forecast, and the number during late morning-to-early afternoon (10 am–2 pm) and mid-to-late afternoon (2–6 pm) did not differ significantly from the forecast.

## Driver Characteristics and Behaviors

Table 3 shows the numbers of drivers involved in fatal crashes in May–December 2020 compared with forecasts in relation to selected characteristics of the drivers. The numbers of teenage and young adult drivers ages 16–19, 20–24, and 25–39 involved in fatal crashes all exceeded their respective forecasts by 14%–17%. Collectively these groups accounted for the vast majority of the overall increase in driver fatal crash involvements. The number of drivers younger than 16 years of age involved in fatal crashes was much greater than forecast on a percentage basis (76.9%), though this group contributed little to the overall increase in terms of their absolute number. The number of drivers aged 70+ involved in fatal crashes was significantly fewer than forecast. The men involved in fatal crashes was 12.3% greater than forecast; whereas the number of women involved in fatal crashes was similar to the forecast.

Drivers without valid licenses accounted for the majority of the increase in fatal crashes in May–December 2020 relative to the forecast. The number of fatal-crash-involved drivers with valid licenses in May–December 2020 was a statistically non-significant 0.5% greater than forecast. In contrast, the number of drivers with suspended or revoked licenses exceeded the forecast by 37.5%, the number with no known license exceeded the forecast by 44.8%, and the number with expired licenses exceeded the forecast by 84.3%.

The numbers of fatal-crash-involved drivers with previous crashes, license suspensions, and DWI convictions in the past 5 years were 7.7%, 12.6%, and 27.2% greater than forecast, respectively. The number of drivers whose driving records included previous speeding violations or other moving violations both increased slightly, though neither was statistically significant. The number of drivers with at least one of the above (i.e., at least one crash, license suspension, DWI conviction, speeding violation, or other moving violation in the past 5 years) was 11.8% greater than forecast. Collectively, these drivers accounted for slightly more than half of the entire increase in driver fatal crash involvements in May–December 2020, relative to the forecast.

The number of fatal-crash-involved drivers who police reported were speeding was 1,364 (21.8%) greater than forecast. The number reported not speeding exceeded the corresponding forecast by a similar number (1,350) but a much smaller percentage (4.7%) and did not differ significantly from the corresponding forecast. The number of fatal-crash-involved drivers with blood alcohol concentrations of 0.08 g/dL or greater exceeded the corresponding forecast by 20.1%. The number of drivers with no detectable alcohol and the number with non-zero blood alcohol concentration lower than 0.08 exceeded their respective forecasts by 7% and 11.7%, respectively, though neither difference was statistically significant due to the substantial uncertainty in both the imputed blood alcohol concentration values and in the forecasts. The number of drivers who fled the scene of fatal crashes was 31.2% greater than forecast.

## Vehicle Characteristics

Table 4 shows the number of vehicles involved in fatal crashes during May–December 2020 in relation to the characteristics of the vehicles relative to the corresponding forecasts. The number of cars, pickup trucks, vans, minivans, and SUVs involved in fatal crashes exceeded the corresponding forecast by 7.4%. The number of motorcycles involved in fatal crashes exceeded the forecast by 16%. The number of other types of vehicles involved in fatal crashes was much greater than forecast; however, this finding is not readily interpretable due to the diverse array of vehicle types represented. The number of large trucks and buses involved in fatal crashes was slightly lower than forecast, though not significantly.

The number of drivers of new vehicles (<5 years old) involved in fatal crashes was slightly lower than forecast, though the difference was not statistically significant. In contrast, the numbers of fatal-crash-involved vehicles 15–19 and 20+ years old exceeded corresponding forecasts by 18.2% and 21.3%, respectively, both of which were statistically significant and which collectively accounted for nearly two-thirds of the entire increase in the number of vehicles involved in fatal crashes. The number of fatal-crash-involved vehicles 10–14 years old was similar to the number forecast.

The number of fatal-crash-involved vehicles that were

**Table 3. Number of drivers involved in fatal crashes during May–December 2020 relative to forecasts based on time series models of monthly traffic fatalities in 2011–2019, in relation to driver characteristics and behaviors.**

| | Actual | Forecast | (95% CI) | Difference | |
|---|---|---|---|---|---|
| | | | | N | % |
| All Drivers Involved in Fatal Crashes | 39,979 | 36,689 | (34,158–39,189) | **3,290** | **9.0** |
| **Driver Age (years)** | | | | | |
| <16 | 164 | 93 | (54–132) | **71** | **76.9** |
| 16–19 | 2,409 | 2,064 | (1,851–2,267) | **345** | **16.6** |
| 20–24 | 4,538 | 3,967 | (3,553–4,391) | **571** | **14.4** |
| 25–39 | 12,424 | 10,685 | (9,887–11,477) | **1,739** | **16.2** |
| 40–54 | 8,772 | 8,091 | (7,572–8,613) | **681** | **8.4** |
| 55–69 | 7,069 | 7,125 | (6,674–7,570) | −56 | −0.8 |
| 70+ | 3,298 | 3,765 | (3,508–4,011) | **−467** | **−12.4** |
| **Driver Gender** | | | | | |
| Male | 29,304 | 26,087 | (24,489–27,717) | **3,217** | **12.3** |
| Female | 9,467 | 9,296 | (8,511–10,089) | 171 | 1.8 |
| **Driver License Status[a]** | | | | | |
| Valid | 30,519 | 30,377 | (28,534–32,156) | 142 | 0.5 |
| Suspended/Revoked | 3,072 | 2,234 | (1,936–2,532) | **838** | **37.5** |
| Expired | 736 | 399 | (321–479) | **337** | **84.3** |
| Never Licensed | 2,537 | 1,753 | (1,610–1,895) | **784** | **44.8** |
| Other | 111 | 64 | (43–85) | **47** | **73.5** |
| **Police-Reported Speeding** | | | | | |
| Speeding | 7,615 | 6,251 | (5,783–6,745) | **1,364** | **21.8** |
| Not speeding | 30,082 | 28,732 | (26,222–31,358) | 1,350 | 4.7 |
| **Blood Alcohol Concentration (g/dL)[b]** | | | | | |
| 0.00 | 30,043 | 28,085 | (26,006–30,164) | 1,958 | 7.0 |
| 0.01–0.07 | 1,597 | 1,430 | (1,281–1,578) | 167 | 11.7 |
| 0.08+ | 8,256 | 6,875 | (6,231–7,518) | **1,381** | **20.1** |
| **Hit and Run** | | | | | |
| Left scene | 1,897 | 1,446 | (1,066–1,830) | **451** | **31.2** |
| **Driving record (past 5 years)[c]** | | | | | |
| Involved in crash | 6,670 | 6,191 | (5,816–6,587) | **479** | **7.7** |
| License suspended | 5,270 | 4,681 | (4,323–5,049) | **589** | **12.6** |
| DWI conviction | 1,318 | 1,036 | (856–1,222) | **282** | **27.2** |
| Speeding violation | 6,881 | 6,524 | (5,517–7,544) | 357 | 5.5 |
| Other moving violation | 6,943 | 6,506 | (5,715–7,272) | 437 | 6.7 |
| Any of the above | 16,292 | 14,579 | (13,151–16,087) | **1,713** | **11.8** |

Note: Sums of forecasts across categories of characteristics may not equal the forecast of the total because different models were used for each category and because cases with other or unknown values of characteristics were included in the total.
Differences shown in **bold** are statistically significant at 95% confidence level.
a. Excludes crashes that occurred in the state of Illinois due to excessive number of missing values.
b. Based multiply-imputed blood alcohol concentration (Rubin et al., 1998) when actual concentration was unknown.
c. Forecasts based on models of years 2015–2019.

**Table 4. Number of vehicles involved in fatal crashes during May–December 2020 relative to forecasts based on time series models of monthly traffic fatalities in 2011–2019, in relation to vehicle characteristics.**

| | Actual | Forecast | (95% CI) | Difference N | Difference % |
|---|---|---|---|---|---|
| All Vehicles Involved in Fatal Crashes | 39,979 | 36,689 | (34,158–39,189) | **3,290** | **9.0** |
| **Vehicle Type** | | | | | |
| Car or light truck | 30,057 | 27,974 | (26,076–29,870) | **2,083** | **7.4** |
| Motorcycle | 4,644 | 4,002 | (3,595–4,398) | **642** | **16.0** |
| Large truck or bus | 3,608 | 3,803 | (3,507–4,088) | −195 | −5.1 |
| Other vehicle type | 1,636 | 1,121 | (1,050–1,192) | **515** | **46.0** |
| **Vehicle age (years)** | | | | | |
| <5 | 9,566 | 9,823 | (8,607–11,044) | −257 | −2.6 |
| 5–9 | 8,292 | 7,282 | (6,251–8,311) | 1,010 | 13.9 |
| 10–14 | 8,114 | 8,070 | (6,940–9,173) | 44 | 0.5 |
| 15–19 | 7,763 | 6,569 | (5,938–7,189) | **1,194** | **18.2** |
| 20+ | 4,856 | 4,005 | (3,801–4,215) | **851** | **21.3** |
| **Relation to Vehicle Owner** | | | | | |
| Driver is owner | 21,198 | 20,068 | (18,481–21,628) | 1,130 | 5.6 |
| Other private owner | 11,492 | 9,950 | (9,044–10,852) | **1,542** | **15.5** |
| Business/gov't vehicle | 3,979 | 4,085 | (3,950–4,222) | −106 | −2.6 |
| Rental vehicle | 369 | 345 | (268–378) | 24 | 6.9 |
| Vehicle reported stolen | 106 | 73 | (39–107) | 33 | 45.6 |

Note: Sums of forecasts across categories of characteristics may not equal the forecast of the total because different models were used for each category and because cases with other or unknown values of characteristics were included in the total.
Differences shown in **bold** are statistically significant at 95% confidence level.

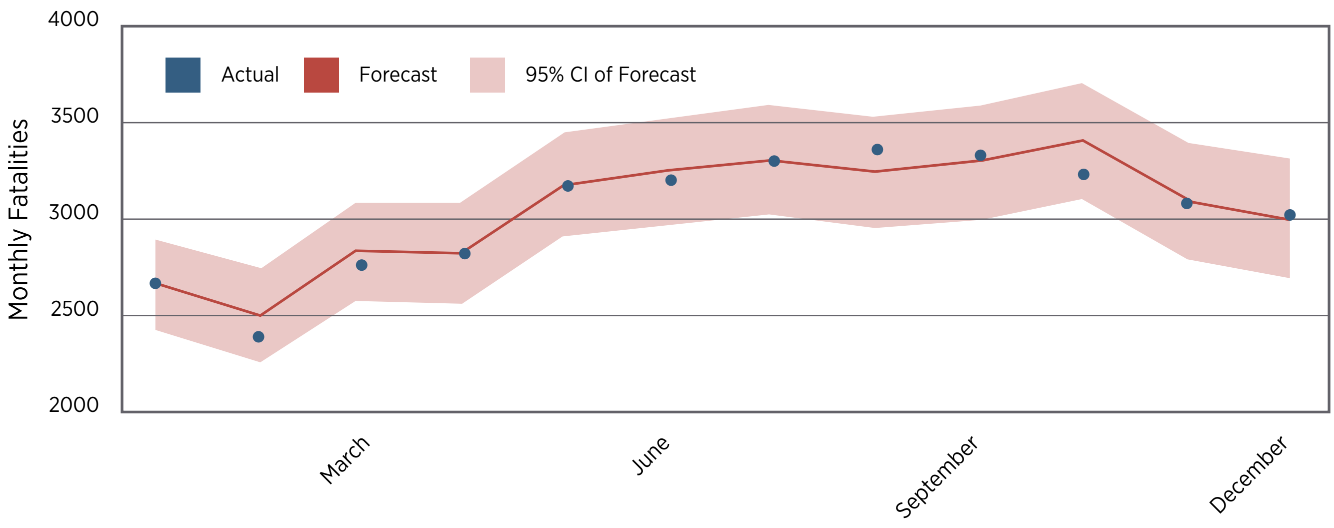


**Figure 3. Model validation: Actual monthly number of traffic fatalities in 2019 and forecast based on time-series model of monthly traffic fatalities in 2010–2018.**

privately owned and being driven at the time of the crash by persons other than their registered owner exceeded the corresponding forecast by 15.5%, which was statistically significant and which accounted for nearly half of the entire increase in the number of vehicles involved in fatal crashes. The number of fatal-crash-involved vehicles driven by their owners was 5.6% greater than forecast, though the difference was not statistically significant.

### Model Validation

To verify that the method used in this study produced realistic forecasts of the numbers of fatalities, fatal crashes, and driver involvements in fatal crashes that would have been expected without the pandemic, all analyses reported previously were replicated using data from years 2010–2018 to produce forecasts for each month of 2019, when there was no pandemic. In this validation exercise, models performed well overall and for most subgroups. The total number of fatalities forecast for 2019 was 36,607, which differed from the actual number by a statistically non-significant 252 (0.7%) (Figure 3). Differences between actual numbers of fatal crashes in 2019 versus forecasts were statistically non-significant for all quantities reported previously in Tables 1–4 except drivers with BAC ≥0.08, drivers who left the scene, vehicles 5–9 and 10–14 years old, and crashes on urban freeways. There was only one instance (out of 75) in which the forecast was significantly higher than the corresponding actual value.

## DISCUSSION

The COVID-19 pandemic has had a substantial impact on motor vehicle travel in the United States and worldwide. A report by the International Transport Forum (ITF) found that vehicle miles of travel decreased by an average of 12.2% in 2020 relative to the average levels in 2017–2019 in 11 countries for which such data were available (ITF, 2021). Data from Federal Highway Administration (FHWA) show a similar pattern, with 13.2% fewer miles driven on U.S. roads in 2020 than in 2019. This decrease in driving led to a reduction in traffic fatalities in most other highly motorized countries (ITF, 2021). The U.S. was an outlier, reporting 7% more fatalities overall and 21% more fatalities per mile driven in 2020 than in 2019 (Stewart, 2022).

Several studies in the U.S. and abroad examined changes in counts or rates of crashes during the initial months of the pandemic. Most of these studies were focused specifically on evaluating the impact of government-issued “stay-at-home” orders or “lockdowns” in March through April or early May of 2020, and reported large reductions in crash frequencies. There were, however, some early signs that severe and fatal crashes were not decreasing similarly. A study of crashes in Missouri found a statistically significant decrease in the frequency of crashes resulting in minor or no injuries during lockdowns, but found no change in the frequency of crashes that resulted in serious or fatal injuries (Qureshi et al., 2020). A Connecticut-based study found that while overall crash frequency decreased significantly during stay-at-home orders, rates of single-vehicle crashes per mile driven increased (Doucette et al., 2021). Studies from Ohio and California found that traffic volumes decreased and speeds increased during the period of stay-at-home orders, and that these changes were correlated with increased probability of crashes resulting in severe outcomes (Stiles et al., 2021; Hughes et al., 2022).

Importantly, however, the large increase in traffic fatalities in the U.S. began in approximately May or June of 2020 (depending how the beginning of the increase is defined). The current study thus sought to investigate how the characteristics of traffic fatalities on U.S. roads changed beyond the initial months of the pandemic, after stay-at-home orders had been lifted in most places. Results indicate that there were approximately 3,083 (12.1%) more traffic fatalities in the U.S. in the May–December 2020 period than there would have been had the pandemic not occurred and previous trends continued.

While expert opinion and previous studies have pointed to increased travel speeds facilitated by decreased congestion as the cause of the increase in fatalities (Governors Highway Safety Association, 2020; Stiles et al., 2021; Hughes et al., 2022), the current study provides evidence that many additional factors were likely at play as well. First, the current study finds that much of the increase in fatal crashes relative to expectations based on pre-pandemic trends took place during the evening, night, and early morning hours—times during which congestion typically did not preclude speeding even before the pandemic. Second, results reveal that the increase in fatalities was not uniform across factors examined. In addition to speeding, scenarios present in greater than expected numbers in fatal crashes in 2020 included drivers with illegal alcohol levels, drivers without valid licenses, drivers of older vehicles, drivers of vehicles registered to others, crash involvements and deaths of teens and young adults aged 16–39, and deaths of vehicle occupants not wearing seatbelts. In contrast, several crash types followed pre-pandemic trends (e.g., crash involvements of drivers with valid licenses; pedestrian fatalities), and a few decreased (e.g., crashes of elderly drivers; crashes during typical morning commute hours).

Results suggest that different segments of the population responded differently to the pandemic. The increase in fatal crash involvements relative to recent pre-pandemic trends was by far the largest among young adults; drivers aged 25–39 alone accounted for approximately half of the entire increase, and drivers aged 16–39 accounted for more than three-quarters of it. This is consistent with results of a previous AAA Foundation for Traffic Safety survey of driving behavior during the fall of 2020, which reported that while the pandemic led most drivers to reduce their driving, a small percentage of drivers reported having increased their driving, and those drivers were predominantly younger (Tefft et al., 2022). Moreover, in that study, the small subgroup of drivers who reported having increased their driving during the pandemic were also more likely to report engagement in a wide range of risk-increasing behaviors (e.g., speeding, aggressive driving, impaired driving, etc.), which remained significant even after adjustment for demographics. While some of the increase in speeding and the associated fatal crashes has been shown to be associated with reductions in congestion (Stiles et al., 2021; Hughes et al., 2022), an increase in travel among drivers with greater than average propensity toward speeding and other aberrant behaviors would also help to explain some of the other findings of the current study, such as the increase in fatal crashes involving alcohol-impaired driving and deaths of vehicle occupants not wearing seatbelts.

There were also changes in the mix of vehicles involved in fatal crashes relative to that which would have been expected based on pre-pandemic trends. Nearly two-thirds of the entire increase in driver crash involvements relative to the forecasts was among drivers of vehicles 15+ years old. While some of the increase in vehicle age could be due to reduced vehicle sales during the pandemic delaying the replacement of the oldest vehicles, previous research has also found vehicle age to be correlated with socioeconomic status (Metzger et al., 2020). Additionally, fatal crash involvements of drivers operating vehicles they did not own increased by a much larger amount than did crash involvements of drivers of their own vehicles. The use of vehicles owned by others is likely also correlated with socioeconomic status, as on average, lower-income households own fewer vehicles than higher-income households and are more likely to own no vehicles (Federal Highway Administration, 2019). Collectively, findings regarding driver age, vehicle age, and vehicle ownership may be suggestive of a disproportionate increase in fatal crash involvements among drivers of lower socioeconomic status during the pandemic. This would be consistent with previous results showing shifts in crash hotspots to low-income areas (Lin et al., 2021). While unequal ability to work remotely (Wolfe et al., 2021) would explain a shift in the distribution of socioeconomic status among drivers involved in fatal crashes during the pandemic, reasons for the large increases in the absolute number of fatal crash involvements of drivers of older and non-owned vehicles are unclear and warrant additional research.

Drivers without valid licenses accounted for almost the entirety of the increase in driver fatal crash involvements in May–December 2020 relative to the corresponding forecast. The reasons for this are unclear. Many states closed their licensing agency offices during the initial months of the pandemic and granted extensions to licenses expiring during the pandemic (Feiss et al., 2021). This could have contributed to the large increase in the number of fatal-crash-involved drivers whose licenses were reported as expired. Licensing agency closures likely posed a barrier to new drivers seeking their first licenses as well. However, the contribution of licensing agency closures to the increase in fatal crashes of unlicensed drivers was likely not large, 80% of the unlicensed drivers involved in fatal crashes in May–December 2020 were aged 20 years or older. While speculative, it seems unlikely that most of these unlicensed drivers would have been licensed if not for the pandemic-related closures of state licensing agencies. Moreover, licensing agency closures would not explain the large increase fatal crash involvements of drivers whose licenses had been suspended or revoked. The number of fatal-crash-involved drivers with previous crashes, license suspensions, impaired driving convictions, and/or other moving violations on their driving record increased significantly as well and accounted for half of the overall increase in fatal crash involvements relative to corresponding forecasts. Collectively, these results clearly indicate that much of the increase in fatal crashes during the pandemic involved vehicle operators who were not authorized to drive and/or had a history of aberrant driving. Given this unexpected shift, reversing the increasing trend in fatal crashes is likely to require efforts to prevent driving by disqualified drivers, as well as educating, training, and licensing persons who drive despite having never obtained a license.

A large increase in hit-and-run fatal crashes was also noted. This is likely attributable in large part to the previously noted increase in fatal crash involvements of drivers without valid licenses and drivers impaired by alcohol. While their having left the scene precludes ascertainment of the licensing status and alcohol use of many of these drivers, past research has shown that drivers alcohol impairment and lack of a valid license are both strongly predictive of leaving the scene of a fatal crash (Benson et al., 2021).

While the current study revealed several potentially important patterns underlying the increase in fatal crashes during the post stay-at-home order period of the first year of the COVID-19 pandemic, the reasons for these patterns remain elusive. It is notable that the increase in fatal crashes was concentrated among relatively young drivers and featured greater than expected involvement of factors likely correlated with lower socioeconomic status (e.g., older vehicles and vehicles owned by others). This characterizes a population that likely experienced significant stress, anxiety, and mental health challenges during the pandemic. Studies have documented increased prevalence of many non-driving-related negative health behaviors during the pandemic including disordered eating (Simone et al., 2021), increased alcohol consumption (Pollard et al., 2020), and suicide attempts (Yard et al., 2021). A systematic review of the mental health consequences of the pandemic reported increases in psychiatric symptoms among healthcare workers, post-traumatic stress symptoms among people who had been infected with COVID-19, as well as a decrease in "psychological well-being" among the general population (Vindegaard & Benros, 2020). Studies predating the pandemic have found that anxiety (Dula et al., 2010; Wickens et al., 2013) and depression (Hill et al., 2017) are significantly associated with crash involvement. Thus, it is possible that some of the increase in fatal crashes observed during the pandemic could be attributable to indirect effects of the pandemic on mental health.

This study has several limitations that should be noted. The study compared observed data from May–December 2020 to forecasts derived from models. In validation, the model-based forecasts closely matched prior-year data overall and for most subgroups pertinent to key findings, but deviated significantly from the data on a few occasions. Results with respect to the variables noted previously (alcohol-intoxicated drivers, drivers who left the scene, crashes on urban freeways, and the middle categories of vehicle age) should be treated with caution. Another limitation is that exposure data (e.g., miles driven) were not considered. Data on national and regional aggregate total monthly miles of driving exist (e.g., Federal Highway Administration, 2021); however, they are not suitable for granular analyses of monthly changes in the relative exposure of drivers in relation to the driver, vehicle, and contextual factors that were the focus of the current study. Thus, for a given factor of interest (e.g., speeding), the current study cannot determine whether the factor became more prevalent, more dangerous, or both. Finally, data were compiled from police crash reports and in some cases were incomplete. In particular, roughly 4% of drivers involved in fatal crashes over the study period left the scene; variables of interest (e.g., age, license status, driving record, etc.) were unavailable for approximately half of them. Given the significant increase in drivers leaving the scene during the period of interest, in conjunction with other research on the association of other risk factors with leaving the scene (Benson et al., 2021), results might underestimate the magnitudes of increases in risk factors associated with leaving the scene (e.g., alcohol impairment, unlicensed driving, history of aberrant driving).

## Conclusions & Future Work

The COVID-19 pandemic has had a substantial impact on motor vehicle travel in the United States and worldwide. While most highly motorized countries in the world experienced fewer fatalities on their roads during the first year of the COVID-19 pandemic than in the recent past, the U.S. experienced significantly more, despite a substantial reduction in total driving. The research reported here sought to determine whether this reflected a general increase in the risk of travel on U.S. roads, or whether there were identifiable crash scenarios or road-user groups that contributed more than others to the overall increase in traffic fatalities. Examining the period during which the increase in fatal crashes was most pronounced (May–December 2020), findings show that the increase in traffic fatalities was not uniform; several factors stood out.

Fatal crash involvements of speeding drivers increased by more than 20% relative to pre-pandemic trends. Past research attributed this to reductions in total travel reducing congestion and facilitating speeding, other factors clearly contributed to worsening safety on U.S. roads as well. The largest increase in fatal crashes was during the late night and early morning hours—times when traffic congestion would not have typically precluded speeding even before the pandemic. In addition, there were significant shifts in the characteristics of fatal crash involved drivers and crash victims. Fatal crash involvements and deaths of teenagers and young adults aged 16–39 increased far more than did those of children or older adults and accounted for roughly three quarters of the overall increase in fatalities relative to pre-pandemic trends. Fatal crash involvements of drivers operating vehicles owned by others and drivers of vehicles 15+ years old increased markedly as well, suggestive of socioeconomic disparities in exposure to risk during this period. A large increase in fatal crash involvement of drivers without valid licenses and/or with a history of aberrant driving was also observed. Among vehicle occupants who died in crashes, occupants not wearing seatbelts accounted for nearly the entire increase.

The AAA Foundation for Traffic Safety is conducting additional research to understand how the COVID-19 pandemic and the many associated societal changes have influenced traffic safety. Findings reported here appear to be suggestive of socioeconomic disparities in the increase in traffic fatalities during the first year of the pandemic; future research will investigate this finding further using additional sources of data. In addition, preliminary data from the National Highway Traffic Safety Administration suggest that traffic fatalities continued to increase throughout 2021 and at least the first half of 2022 (National Center for Statistics and Analysis, 2022). Future research by the AAA Foundation for Traffic Safety will examine whether the increasing trend in traffic fatalities has continued to follow patterns identified here or whether new patterns have emerged.

## REFERENCES

Akaike, H. (1974). *A New Look at the Statistical Model Identification. In: Parzen, E., Tanabe, K., Kitagawa, G. (eds) Selected Papers of Hirotugu Akaike. Springer Series in Statistics.* Springer, New York, NY. DOI: 10.1007/978-1-4612-1694-0_16.

Benson, A. J., Tefft, B. C., Arnold, L. S., & Horrey, W. J. (2021). Fatal hit-and-run crashes: Factors associated with leaving the scene. Journal of Safety Research, 79: 76–82. DOI: 10.1016/j.jsr.2021.08.007.

Box, G. E., & Jenkins, G. M. (1976). *Time series analysis: Forecasting and control.* Wiley.

Doucette, M. L., Tucker, A., Auguste, M. E., et al. (2021). Initial impact of COVID-19's stay-at-home order on motor vehicle traffic and crash patterns in Connecticut: an interrupted time series analysis. *Injury Prevention,* 27: 3–9. DOI: 10.1136/injuryprev-2020-043945.

Dula, C. S., Adams, C. L., Miesner, M. T., & Leonard, R. L. (2010). Examining relationships between anxiety and dangerous driving. *Accident Analysis and Prevention, 42*(6), 2050–2056. DOI: 10.1016/j.aap.2010.06.016.

Federal Highway Administration. (2021). *Traffic Volume Trends: January 2021.* United States Department of Transportation: Washington, DC. Retrieved from: https://www.fhwa.dot.gov/policyinformation/travel_monitoring/21jantvt/

Federal Highway Administration. (2019). *Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance. 23rd Edition.* Part 1; Chapter 3. Federal Highway Administration, Washington, DC.

Governors Highway Safety Association. Absent Traffic Jams, Many Drivers Getting More Reckless [Internet]. 2020. Available from: https://www.ghsa.org/resources/news-releases/coronavirus-reckless-driving20.

Hill, L. L., Lauzon, V. L., Winbrock, E. L., et al. (2017). Depression, antidepressants and driving safety. *Injury Epidemiology,* 4:10. DOI: 10.1186/s40621-017-0107-x.

Hughes J. E., Kaffine D., & Kaffine L. (2022). Decline in congestion increased crash severity in the wake of COVID-19. *Transportation Research Record.* DOI: 10.1177/03611981221103239.

Hyndman R. J., & Athanasopoulos G. (2018). *Forecasting: Principles and Practice. (2nd ed.)* OTexts. https://otexts.org/fpp2/

Hyndman R. J., & Khandakar Y. (2008). Automatic Time Series Forecasting: The forecast Package for R. *Journal of Statistical Software,* 27(3), 1–22. DOI: 10.18637/jss.v027.i03

International Transport Forum. (2021). *Road Safety Annual Report 2021: The Impact of Covid-19.* OECD Publishing, Paris.

Lin, L., Shi, F., & Li, W. (2021). Assessing inequality, irregularity, and severity regarding road traffic safety during COVID-19. *Nature Scientific Reports.* 11:13147. DOI: 10.1038/s41598-021-91392-z.

Metzger, K. B., Sartin, E., Foss, R. D., Joyce, N., & Curry, A. E. (2020). Vehicle safety characteristics in vulnerable driver populations. *Traffic Injury Prevention,* 21(Supplement 1): S54–S59. DOI: 10.1080/15389588.2020.1805445

National Center for Statistics and Analysis. (2022). *Early estimate of motor vehicle traffic fatalities for the first half (January-June) of 2022.* (Crash•Stats Brief Statistical Summary. Report No. DOT HS 813 376). National Highway Traffic Safety Administration, Washington, DC.

Pollard M. S., Tucker J. S., & Green H. D. (2020). Changes in adult alcohol use and consequences during the COVID-19 pandemic in the US. *JAMA Network Open.* 3(9):e2022942. DOI: 10.1001/jamanetworkopen.2020.22942

Qureshi, A. I., Huang, W., Khan, S., et al. (2020). Mandated societal lockdown and road traffic accidents. *Accident Analysis and Prevention*, 146. 105747. DOI: 10.1016/j.aap.2020.105747.

Rubin D. B., Schafer J. L., & Subramanian R. (1998). *Multiple Imputation of Missing Blood Alcohol Concentration (BAC) values in FARS.* Report No. DOT HS 808 816. Washington, DC: National Highway Traffic Safety Administration.

Simone, M., Emery, R. L., Hazzard, V. M., et al. (2021). Disordered eating in a population-based sample of young adults during the COVID-19 outbreak. *International Journal of Eating Disorders*, 54(7):1189–201. DOI: 10.1002/eat.23505

Stewart, T. (2022). *Overview of Motor Vehicle Crashes in 2020.* Report No. DOT HS 813 266. National Highway Traffic Safety Administration, Washington, DC.

Stiles J., Kar A., Lee J, & Miller H. J. (2021). Lower volumes, higher speeds: Changes to crash type, timing, and severity on urban roads from COVID-19 stay-at-home policies. *Transportation Research Record.* DOI: 10.1177/03611981211044454.

Tefft, B. C., Villavicencio, L., Benson, A., Arnold, L. S., Kim, W., Añorve, V., & Horrey, W. J. (2022). *Self-Reported Risky Driving in Relation to Changes in Amount of Driving During the COVID-19 Pandemic* (Research Brief). AAA Foundation for Traffic Safety, Washington, DC.

Vindegaard, N. & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity,* 89: 531–542. DOI: 10.1016/j.bbi.2020.05.048.

Wickens, C. M., Mann, R. E., Stoduto, G., et al. (2013). The impact of probable anxiety and mood disorder on self-reported collisions:  A population study. *Journal of Affective Disorders,* 145(2): 253-255. DOI: 10.1016/j.jad.2012.04.046.

Wolfe R., Harknett K., & Schneider D. 2021. Inequalities at work and the toll of COVID-19. *Health Affairs Health Policy Brief.* DOI: 10.1377/hpb20210428.863621.

Yard, E., Radhakrishnan, L., Ballesteros, M. F., et al.  (2021). Emergency Department Visits for Suspected Suicide Attempts Among Persons Aged 12–25 Years Before and During the COVID-19 Pandemic—U nited States, January 2019–May 2021. *Morbidity and Mortality Weekly Report.* 70(24):888–894. DOI: 10.15585/mmwr.mm7024e1

## ABOUT THE AAA FOUNDATION FOR TRAFFIC SAFETY

The AAA Foundation for Traffic Safety is a 501(c)(3) nonprofit, publicly supported charitable research and education organization. It was founded in 1947 by the American Automobile Association to conduct research to address growing highway safety issues. The organization's mission is to identify traffic safety problems, foster research that seeks solutions and disseminate information and educational materials. AAA Foundation funding comes from voluntary, tax-deductible contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies and other individuals or groups.

## SUGGESTED CITATION

Tefft, B.C., & Wang, M. (2022). *Traffic Safety Impact of the COVID-19 Pandemic: Fatal Crashes Relative to Pre-Pandemic Trends, United States, May–December 2020* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety.