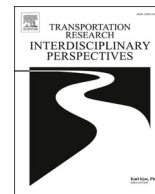


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## Motor vehicle traffic fatalities by race and ethnicity (2010 – 2021)

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### ARTICLE INFO

#### Keywords:

Traffic fatalities  
Motor vehicles  
Race  
Ethnicity

### ABSTRACT

Motor vehicle traffic fatalities (MVTFs) are a public health issue that substantially affects the growing Black or African American, Indigenous, and People of Color (BIPOC) population. To further understand the racial discrepancies that exist in MVTFs, data from the Fatality Analysis Reporting System (FARS) and U.S. Census were utilized to explore factors such as rurality, urbanicity, restraint use, and alcohol-impairment. Calculations considered yearly driver and occupant fatality rates per 100,000 population for each race and ethnicity from 2010 through 2021. A Poisson regression model was used to quantify the relationship between the MVTF rates and the factors of interest. Results demonstrated that the American Indian or Alaska Native population was statistically the most overrepresented group in fatality rates across all factors explored. Additionally, the American Indian or Alaska Native population and Black or African American populations were the only groups to have statistically significant increases in fatality rates in recent years when accounting for factors such as unrestrained vehicle driver/occupants and alcohol-impaired fatality rate. In contrast, the Native Hawaiian or Pacific Islander population has consistently experienced one of the largest statistically significant reductions in driver and occupant fatality rates over time. Further analysis is necessary to develop and implement countermeasures that may reduce the increasing fatality rates of the most vulnerable populations while continuing to decrease rates for others as well. Despite limitations of FARS and population data, these results provide a pathway to reducing MVTFs and associated racial inequities that exist in the nation, particularly as the BIPOC population continues to grow.

### 1. Introduction

The U.S. population is changing and becoming more diverse. Recent U.S. Census data, encompassing 2016 through 2020, show that much of the nation's population growth is attributed to people of color—those identifying as Latino or Hispanic, Black or African American, Asian, Native Hawaiian or Pacific Islander (NHPI), American Indian or Alaska Native (AIAN), or two or more races (Frey, 2021). As the U.S. population changes and the Black or African American, Indigenous, and People of Color (BIPOC) population grows, it is imperative to recognize racial inequities. Given past and current BIPOC experiences of structural, institutional, and individual discrimination (Thakur et al., 2020), recognizing these inequities becomes particularly important for members of these groups.

Discrimination against the BIPOC population is visible through the redlining of neighborhoods, stagnating opportunities to generate wealth, targeted mass incarceration, and discrepancies in access to employment (Thakur et al., 2020). A particularly important area of

racial inequity is motor vehicle traffic fatalities (MVTFs) (Governors Highway Safety Association [GHSA], 2021). The traffic fatality rate in 2021 was 12.94 (National Center for Statistics and Analysis, 2023) per 100,000 population, a 21 % increase from the 10.67 per 100,000 population in 2010 (National Center for Statistics and Analysis, 2022). Additionally, motor vehicle crashes have been a leading cause of death for Americans under 30 for many years and rank in the top 10 causes of death for NHPI, AIAN, and Hispanic or Latino people (Glassbrenner et al., 2022; National Center for Injury Prevention and Control (U.S.) Division of Unintentional Injury Prevention, 2011). While these high-level statistics might suggest a societal problem more than a racial one, previous research has shown that the BIPOC population is disproportionately overrepresented in MVTFs (Glassbrenner et al., 2022; GHSA, 2021; Hilton, 2006; National Center for Statistics and Analysis, 2009). For instance, in 2004, AIAN and Hispanic populations had the highest percentage of MVTFs compared to all fatalities across all age groups (Hilton, 2006). Furthermore, recent data demonstrate that the AIAN population continues to have the highest fatality rate per 100,000

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<https://doi.org/10.1016/j.trip.2024.101163>

Received 4 August 2023; Received in revised form 28 June 2024; Accepted 1 July 2024

Available online 8 July 2024

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population regardless of the method of travel (Glassbrenner et al., 2022). Since the early 2000s, the AIAN population has also had the largest percentage of alcohol-impaired-driving crashes, while the Asian population has had the lowest (Hilton, 2006; National Center for Statistics and Analysis, 2009). Existing data can also identify potential causal factors for these racially dependent elevated fatality rates.

Therefore, increases in MVTFS are a public health issue that has affected the BIPOC population substantially in previous decades. Despite this, more recent fatality data have only received limited scrutiny to determine if these effects are still observable and whether existing countermeasures targeting specific racial groups have been effective. Furthermore, there is limited research on how different vehicle occupants from each race-ethnicity<sup>1</sup> group are affected. Thus, it is imperative to analyze recent MVTFS data by race and ethnicity to understand current trends and to better comprehend how to develop countermeasures and address gaps that members of specific race or ethnicity groups may experience. Consequently, the goal of this study was to use nationwide MVTFS data, grouped by race and ethnicity, to determine time-dependent trends in the driver and occupant traffic fatality rates for each group and to identify any factors that disproportionately affect specific racial and ethnic groups.

## 2. Methods

### 2.1. Data sources

#### 2.1.1. FARS data

Nationwide, MVTFS are recorded in the National Highway Traffic Safety Administration's (NHTSA, 2021) Fatality Analysis Reporting System (FARS). To be included in FARS, a crash must involve a motor vehicle traveling on a trafficway customarily open to the public within the 50 states, the District of Columbia, and Puerto Rico, and must result in the death of a vehicle occupant or nonoccupant within 30 days of the crash (National Center and for Injury Prevention and Control (U.S.), 2020; NHTSA, 2021). FARS has been in service since 1975 and is the only nationwide motor vehicle crash database that includes race and ethnicity as reported on an individual's death certificate (National Center and for Injury Prevention and Control (U.S.), 2020; NHTSA, 2021).

For this analysis, FARS data from 2010 to 2021 were obtained and processed to yield the aggregate data of interest. The data were split into two groups—driver and occupant MVTFS—by using the person type (PER\_TYP) element available in the data. The driver group contained fatalities identified as drivers (PER\_TYP = 1); the occupant group contained fatalities identified as passengers of a motor vehicle either in transport or not in transport (PER\_TYP = {2, 3}). In addition, individuals with unknown occupant type in a motor vehicle in transport (PER\_TYP = 9) were included as occupants because they were individuals inside the vehicle, though their exact seating position was unknown. Data were separated into these two groups due to expected differences in the number of other vehicle occupants across groups and the difference in age group population estimates, as discussed in the next section.

Resulting FARS data were further classified by race and ethnicity. In 2019, FARS added a multi-racial category that allows documentation of multiple races for individuals (National Center for Injury Prevention and Control (U.S.), 2020). However, for consistency in this analysis, only the single race category was used because pre-2019 yearly MVTFS data did not include the multi-racial category. Therefore, 13 of the 17 single race categories presented in FARS were selected and categorized using the Office of Management and Budget (OMB, 1997) guidelines on Race and

Ethnicity Standards for Federal Statistics and Administrative Reporting. The following race and ethnicity groups were created for this analysis:

- **American Indian or Alaska Native (AIAN); Non-Hispanic or Latino:** North American Indian or Alaska Native and Other Indian
- **Black or African American; Non-Hispanic or Latino**
- **Asian; Non-Hispanic or Latino:** Chinese, Japanese, Filipino, Asian Indian, Korean, Vietnamese; Non-Hispanic or Latino
- **Native Hawaiian or Pacific Islander (NHPI); Non-Hispanic or Latino:** Native Hawaiian, Samoan, Guamanian, or Chamorro; Non-Hispanic or Latino
- **White; Non-Hispanic or Latino**
- **Hispanic or Latino:** Mexican, Puerto Rican, Cuban, Central or South American, European Spanish, Hispanic, Origin not Specified or Other Origin

The FARS single race categories of Other Asian or Pacific Islander, Asian or Pacific Islander, No Specific (individual) Race, Other Race, and Unknown were excluded. These race categories did not accurately align with the definitions of the race groups set by OMB.

In addition, only passenger vehicles with a gross weight vehicle rating of 10,000 lbs. or less were included in the analysis. These vehicles included passenger cars, SUVs, and light trucks and encompass over 70 % of vehicles involved in MVTFS from 2010 to 2021 (National Center for Statistics and Analysis, 2021b,c; Stewart, 2023).

#### 2.1.2. Population data

To establish yearly fatality rates, population estimates for each racial and ethnic group were obtained from the U.S. Census Bureau database and the Housing Assistance Council. Specifically, two population estimates using U.S. Census Bureau data from 2010 to 2021 were created for each race and ethnicity: one population estimate for the driver MVTFS analysis, which only included people in the U.S. population who were 15 and older to better represent the driver-eligible population, and one population estimate for the occupant MVTFS that encompassed the yearly total population for each race and ethnicity. The Housing Assistance Council 2010 data were used to further stratify these populations by rural and urban areas, race, and ethnicity (Housing Assistance Council, 2012). This manipulation allowed consideration of the distinct racial and ethnic makeup of rural and urban areas in the relevant analyses.

### 2.2. FARS factors

Four factors were specifically selected and evaluated from the FARS data for analysis, as differences in the prevalence of these factors were hypothesized to be present among different racial and ethnic groups. In addition, these factors are commonly reported in NHTSA's Traffic Safety Facts publications as factors that can affect a motor vehicle crash outcome:

- **Rurality:** whether an MVTFS occurred in a rural area.
- **Urbanicity:** whether an MVTFS occurred in an urban area.
- **Restraint system use:** whether an MVTFS was unrestrained.
- **Alcohol-impairment:** whether a driver of at least one vehicle involved in an MVTFS was alcohol-impaired.

Rurality and urbanicity were selected mainly to account for the longer emergency medical services response times in rural areas compared to urban locations (Byrne et al., 2019). In addition, the racial and ethnic demographics of rural and urban areas are not identical. There tends to be less diversity in rural America; over three quarters of the rural population in America is white compared to 44 % in urban areas (Parker et al., 2018; U.S. Department of Agriculture, 2018).

Analyses explored restraint system use, as it reduces the risk of MVTFS by 45 % among drivers and front-seat passengers (National

<sup>1</sup> **Note to readers:** This report evaluates motor vehicle traffic fatalities by race and ethnicity. The language used in this report follows the Associated Press (AP) guidelines when discussing race and ethnicity, where "white" is not capitalized when referring to race (Explaining AP Style, 2020).

Center for Injury Prevention and Control (U.S.) Division of Unintentional Injury Prevention, 2011). In addition, people who do not wear a seat belt are 30 times more likely to be ejected from a vehicle during a crash; ejection results in a fatality more than 3 out of 4 times when it occurs (National Center for Injury Prevention and Control (U.S.) Division of Unintentional Injury Prevention, 2011). Furthermore, evidence from the 2019 National Occupant Protection Use Survey showed that front seat belt use is lower among Black or African American occupants (86.4 %) than white occupants (90.7 %) (Office of Behavioral Safety Research, 2021), suggesting the potential presence of racial and ethnic effects.

Finally, alcohol-impairment was selected for analysis because alcohol can reduce the function of the brain and impair thinking, reasoning, and muscle coordination, which are essential abilities to operate a vehicle safely (National Center for Statistics and Analysis, 2021a). In addition, research suggests AIAN drivers are most exposed to risk from alcohol-impaired driving, while Asian drivers are the least exposed (National Center for Statistics and Analysis, 2009; Office of Behavioral Safety Research, 2010). The AIAN population also has 3 times the rate of alcohol-related deaths compared to the general U.S. population (American Addiction Centers, 2022).

It is important to note that the term “alcohol-impaired” according to FARS refers to the blood alcohol content (BAC) of an MVTF-involved driver; it does not imply that a crash or a fatality was caused by alcohol-impairment (National Center for Statistics and Analysis, 2021a). Also, any fatal crash where any driver had a BAC of .08 g/dL or higher is designated as an alcohol-impaired crash (National Center for Statistics and Analysis, 2021a).

### 2.3. Analysis

Two different analyses were completed for the study. The first analysis used a descriptive approach that involved calculating the frequency of occurrence annually between 2010 and 2021 for rurality, urbanicity, alcohol-impairment, and unrestrained MVTFs across race and ethnicity, split between driver and occupant MVTFs. These frequencies were divided by the appropriate driver or occupant yearly population estimate for each race or ethnicity to obtain the factor’s fatality rate per 100,000 population, accounting for dissimilarities in demographics, population size, and location (rural/urban) across the groups. To minimize data loss effects, any MVTFs that had unknown information about any specific factor of interest were excluded only for the analysis of that factor.

The second complementary analysis involved a Poisson regression model to quantify the relationship between the MVTF rates and the factors of interest. The outcome variable was the rate of MVTFs, calculated using the frequency data divided by the respective driver and occupant population of each race and ethnicity in rural or urban locations. Limitations in available data precluded identifying changes in the population splits as a function of year, which were therefore assumed to remain constant during the periods of interest for the analysis. The predictor variables were:

- **Race/Ethnicity:** Categorical variable; levels: AIAN, Asian, Black or African American, Hispanic, NHPI, and white (reference category). To avoid duplication, Hispanic ethnicities were always categorized as “Hispanic” regardless of race(s) listed.
- **Alcohol:** Binary variable; levels: presence (Yes) or absence (No; reference category) of alcohol involvement.
- **Location:** Binary variable; levels: rural (reference category) or urban area.
- **Restraint:** Binary variable; levels: whether restraint was used (Yes; reference category) or not used (No).
- **Person Type:** Categorical variable; levels: person involved was a driver (reference category) or an occupant.

- **Year:** Categorical variable; levels: year of the incident, from 2010 (reference category) to 2021.

Several interactions of interest were also included in the model, specifically: Race/Ethnicity x Alcohol, Race/Ethnicity x Location, and Race/Ethnicity x Restraint. These interactions were intended to quantify the relationship between race and ethnicity and the predictor factors of interest.

The Poisson regression model was fitted using R with the “glm” function in the “stats” package, specifying the Poisson family for the response distribution. Any MVTF that had unknown information about any of the factors explored was not included in the Poisson regression analysis to eliminate the need for imputation or estimation. This resulted in the loss of only ~ 10 % of the available observations. Furthermore, the data were checked for equidispersion and residual deviance. The residual deviance relative to degrees of freedom was assessed to ensure it was close to 1, indicating a reasonable fit. Statistical significance was assessed using a Type I error of 0.05.

## 3. Results

### 3.1. Descriptive analysis

The total, driver, and occupant fatality rates per 100,000 population were calculated to understand how driver and occupant MVTFs are accounted in the total fatality rate for each group. From this distribution, driver MVTFs represented approximately 65 % of the total fatality rate for the white population, 50 % for the AIAN, Black or African American, and Hispanic population, and less than 40 % for the NHPI and Asian population. Meanwhile, occupant MVTFs accounted for approximately one third of total fatalities and 20 % of the total fatality rate for all groups except the white population, where occupant MVTFs accounted for 13.6 %. Overall, AIAN people had the highest total, driver, and occupant fatality rates per 100,000 population (Table 1); the Asian population had the lowest. Note that, in this analysis, the total traffic fatality rates per 100,000 population were obtained from a GHSA, (2021) analysis. However, there were methodological differences between the GHSA’s traffic fatality rates and this study. In the GHSA study, the population estimates for each group were derived from the Kaiser Family Foundation estimates, not the U.S. Census Bureau. Also, the GHSA analysis was limited to the years 2015 through 2019. Nevertheless, the GHSA results provide an approximate comparison estimate to the figures calculated as part of this investigation.

When the yearly rural, urban, unrestrained, and alcohol-impaired fatality rates (Table A1 in Appendix A) were calculated for each race and ethnicity and entered into the model, most of the predictor variables and interaction effects were statistically significant (Table A2 in

**Table 1**  
MVTF rates for total, driver, and occupant across different racial and ethnic groups.

	Race or Ethnicity					
	AIAN	Asian	Black or African American	NHPI	White	Hispanic
<b>Total fatality rate per 100,000 population</b>	29.12	3.06	13.70	10.22	11.04	9.38
<b>Driver fatality rate per 100,000 population</b>	17.17	1.12	7.66	4.56	7.14	4.89
<b>Occupant fatality rate per 100,000 population</b>	7.1	0.70	2.20	1.80	1.50	2.00

Appendix A). Exceptions included years 2012, 2013, 2014, and 2019, suggesting some stable result patterns across time. In general and across the factors of interest, the AIAN population had the highest fatality rates, while the Asian population had the lowest fatality rates.

### 3.2. Rural fatality rates

Between 2010 and 2021, the AIAN population had the highest driver and occupant rural fatality rates per 100,000 population, while the Asian population had the lowest (Fig. 1). All driver groups, except AIAN, Black or African American, and Hispanic drivers, experienced a decrease in driver rural fatality rates between 2010 and 2021. The Asian and Hispanic populations experienced the greatest percent change, a 37 % reduction and 37 % increase, respectively, for driver rural fatality rates, while the white population experienced the lowest (10 % decrease) over the 2010–2021 period.

In contrast, the occupant rural fatality rates showed different patterns. The Hispanic population had the second highest mean rural occupant fatality rate. Interestingly, all groups experienced a decrease in occupant rural fatality rate between 2010 and 2021, with the Asian population exhibiting the largest decrease (54 %).

### 3.3. Urban fatality rates

Although, in raw frequency, more rural than urban fatalities occurred in the timeframe of interest, the urban fatality rate was 2.17 times higher than the rural fatality rate when accounting for population size of the groups explored. Differences between these urban and rural rates as a function of race and ethnicity, however, were similar across the different groups.

Like driver rural fatality rates, the AIAN population had the highest mean driver urban fatality rate between 2010 and 2021, followed by the white population (Fig. 2). In addition, all populations also experienced higher mean rates in driver fatalities in urban areas compared to rural areas. The Asian driver fatality rates remained the lowest, regardless of rurality or urbanicity. The NHPI population was the only group that did not demonstrate an increase in driver urban fatality rates between 2010 and 2021. The Black or African American population showed the greatest increase (156 %), followed by the AIAN population (109 %).

In comparison, the AIAN and Black or African American populations had the highest occupant urban fatality rates, and the Asian population had the lowest. As observed for driver fatality rates, the occupant urban fatality rate for the period evaluated was larger than the occupant rural fatality rate across all groups. In addition, the Asian and NHPI populations were the only groups to not experience an increase in occupant

urban fatality rates between 2010 and 2021. In fact, the AIAN and Black or African American population had the largest increases in occupant urban fatality rates between 2010 and 2021: 88 % and 85 %, respectively.

### 3.4. Unrestrained fatality rates

The distribution of restraint use varied significantly across the racial and ethnic groups. All groups, except for the Asian population, had at least 1.02 times the unrestrained fatality rate of the white population. In fact, the AIAN population had 2.06 times the unrestrained fatality rate of the white population, a statistically significant difference. In contrast, the white population had 2.4 times the unrestrained fatality rate of the Asian population, which was also a statistically significant difference.

When analyzing the unrestrained fatality rates by person type, the AIAN population had the highest mean driver unrestrained fatality rates, followed by the Black or African American population (Fig. 3). The Asian population had the lowest driver unrestrained fatality rate across all years. The NHPI population experienced the largest decrease in unrestrained driver fatality rates (70 % reduction) between 2010 and 2021, indicating increased seat belt use among this population. In contrast, the Black or African American and AIAN populations showed over 50 % increases in unrestrained driver fatality rates between 2010 and 2021. In fact, the driver unrestrained fatality rate for the Black or African American population has steadily been increasing since 2014.

The AIAN population also had the highest occupant unrestrained fatality rate, while the Asian population had the lowest. The percent decrease in unrestrained occupant fatality rates was largest for the Asian population. In contrast, the Black or African American and AIAN populations were the only groups that experienced an increase in unrestrained fatality rates between 2010 and 2021.

### 3.5. Alcohol-impaired fatality rates

The rates of fatalities associated with alcohol impairment varied substantially and significantly across race and ethnicity. For example, the AIAN population and Asian population alcohol-impaired fatality rates were 2.56 and 0.50 times the alcohol-impaired fatality rate of the white population, respectively.

The AIAN population had the highest driver alcohol-impaired mean fatality rates, while Asians had the lowest (Fig. 4). Interestingly, Black or African American, white, and NHPI populations started with similar driver alcohol-impaired fatality rates in 2010 (~2 fatalities per 100,000 population), but the trajectories for these rates diverged over time. Asian, NHPI, and white populations were the only groups that

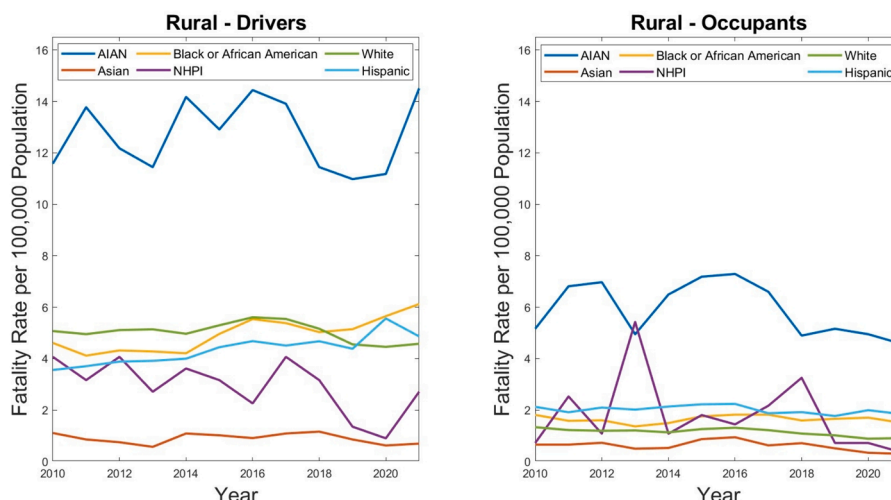


Fig. 1. Yearly driver and occupant rural fatality rate per 100,000 population across race and ethnicity from 2010 to 2021.

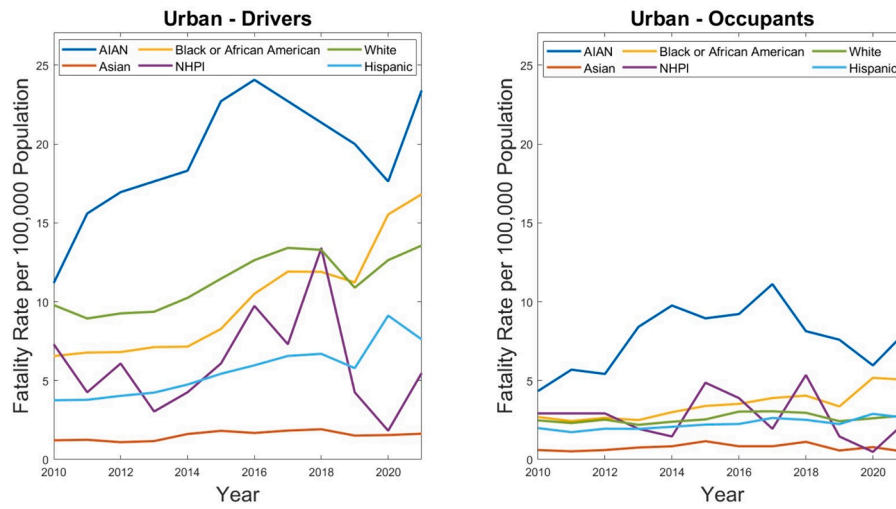


Fig. 2. Yearly driver and occupant urban fatality rate per 100,000 population for each race and ethnicity from 2010 to 2021.

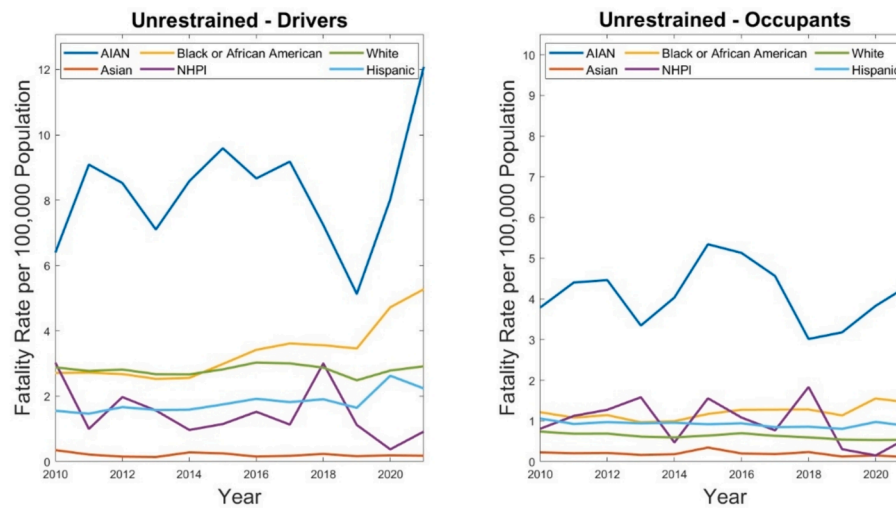


Fig. 3. Yearly mean driver and occupant unrestrained fatality rate per 100,000 population for each race and ethnicity from 2010 to 2021.

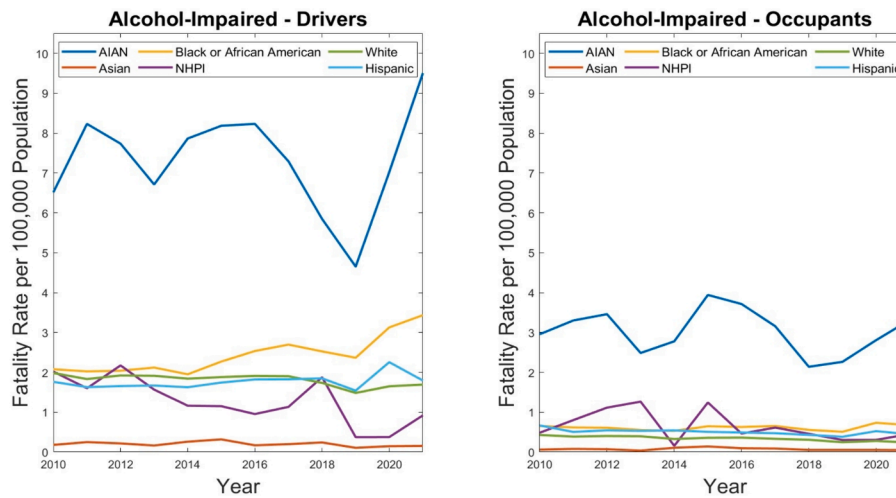


Fig. 4. Yearly mean driver and occupant alcohol-impaired fatality rate per 100,000 population for each race and ethnicity from 2010 to 2021.

experienced a decrease in driver alcohol-impaired fatality rate between 2010 and 2021. In fact, the Black or African American population demonstrated a substantial rate increase between 2014 and 2021. In contrast, the NHPI population had the largest reduction in fatality rate (54 %) between 2010 and 2021.

For **occupants**, the AIAN population had the highest occupant alcohol-impaired fatality rates. The NHPI population had the second highest occupant alcohol-impaired fatality rate, while the white population had the second lowest. The Hispanic and white populations experienced the highest decreases in the occupant fatality rates between 2010 and 2021, whereas the AIAN population experienced the largest increase.

#### 4. Discussion

Results of this investigation highlight that the AIAN population had the highest driver and occupant fatality rates per capita across all the factors examined, with a fatality rate 1.39 times higher than the white population. In contrast, the Asian population had the lowest fatality rates per capita, 0.40 times the fatality rate of the white population. These findings align with previous research; however, previous studies did not always separate data by drivers and occupants (GHS, 2021; National Center for Statistics and Analysis, 2009). Results from this study demonstrate that the occupant fatality rate is approximately one third of the driver fatality rate. Thus, the separation of driver and occupant fatalities allowed observation of any variations in the ratio between driver and occupant fatality rates among the different racial and ethnic groups. The results obtained highlight the importance of separate evaluations of these two vehicle occupant classifications.

Some findings from the rural and urban fatality rate analysis did not follow the same patterns as the distribution of racial populations in rural and urban areas. In particular, the majority of AIAN and white populations reside in rural areas in the U.S., but the urban fatality rate per capita for those two population groups is higher than the rural fatality rate. Higher urban fatality rates were also observed for the Asian population, but for this racial group, the urban population is larger than the rural population (Housing Assistance Council, 2012; U.S. Department of Agriculture, 2018). The gap between rural and urban fatality rates for Asians, however, was not as large as for other groups. Additional investigation of this observation may be warranted.

Analyzing the MVTs by urban and rural areas uncovered additional noteworthy differences. Although there were more MVTs in rural areas, the fatality rate was 2.17 times higher in urban areas compared to rural areas when accounting for population size for each racial and ethnic group. This observation is likely associated with the lower urban population size for the different racial and ethnic groups, except for the Asian population. Nevertheless, the urban or rural location of the MVTs similarly affects different races and ethnicities, suggesting that the location of the crash has a higher influence than race or ethnicity.

Rural area occupant fatality rates increased between 2012 and 2016 for all groups except NHPI. Still, these rates have slowly declined since then, resulting in the decrease seen for all groups when comparing 2010 to 2021 rural occupant fatality rates. The urban occupant fatality rates, in contrast, did not follow this pattern for the period observed. In fact, the urban occupant fatality rates have increased for all groups except the Asian population. The AIAN and Black or African American urban occupant fatality rates, specifically, have increased at a higher rate in recent years compared to other groups. This pattern is also reflected in the urban driver fatality rates, where the AIAN, Black or African American, and Hispanic populations demonstrate an increase over 100 % between 2010 and 2021.

Unrestrained fatality rates for drivers were the highest among AIAN people, 2.06 times higher than the white population, while the Asian population had the lowest, 0.42 times the fatality rate of the white population. These findings align with previous research (Glassbrenner et al., 2022; GHS, 2021; Hilton, 2006). Specifically, the Black or

African American population was expected to have a high unrestrained fatality rate due to observed lower levels of seat belt use, which was confirmed by the analysis results. In fact, the AIAN, Black or African American, and Hispanic populations are the only groups that experienced an increase in driver unrestrained fatality rates from 2010 to 2021. Similar results were also seen in occupant unrestrained fatality rates for the AIAN and Black or African American populations. These results suggest that more effective countermeasures in these areas are needed to target the AIAN, Black or African American, and Hispanic communities. Factors related to the associated decrease in unrestrained fatality rates seen for the NHPI and Asian populations should be studied to generate ideas for these countermeasures.

The findings for driver and occupant alcohol-impaired MVTs in this study were very similar to the results obtained for unrestrained fatality rates. Once again, the AIAN population has the highest alcohol-impaired fatality rate, which was 2.57 times higher than the alcohol-impaired fatality rate for the white population. The Asian population has distinctively lower equivalent rates, half the rate of the white population, which corresponds with previous findings (Glassbrenner et al., 2022; GHS, 2021; Hilton, 2006). In addition, the Black or African American population has the second highest driver alcohol-impaired fatality rate from 2010 to 2021. In fact, the AIAN and Black or African American populations experienced an increase in percent change in driver and occupant alcohol-impaired fatality rates over the observed period. However, the increase was much larger for drivers than occupants. Historically, in the early 2000s, the Hispanic population had high numbers of alcohol-impaired MVTs (National Center for Statistics and Analysis, 2009). However, the results of this study suggest that the Hispanic population has observed a substantial decrease in occupant alcohol-impaired fatality rate, and the driver alcohol-impaired fatality rates only increased 2 % from 2010 to 2021. Similarly, the NHPI population experienced the highest decrease in driver alcohol-impaired fatalities between 2010 and 2021. This may suggest cultural differences in perceptions toward drinking and driving and/or differential exposure and/or effectiveness of enforcement and drunk driving prevention campaigns.

Overall, the AIAN population results are substantially different from other groups in every FARS factor analyzed in this study. A distinguishable aspect about the AIAN community that needs to be acknowledged is that 22 % of their population live on tribal land or reservations where tribes have the authority to create and enforce their own motor vehicle safety laws (Office for State, Tribal, Local and Territorial Support, 2015; U.S. Department of Health Human Services Office of Minority Health, 2022). Based on the results of this study, AIAN fatalities have substantially larger unrestrained and alcohol-impaired rates for drivers and occupants compared to other races and ethnic groups. These factors can be influenced by traffic laws and enforcement, which are different in tribal lands compared to states (Congressional Research Service, 2016; Office for State, Tribal, Local and Territorial Support, 2015). Also, tribal lands are usually rural, 60 % of their roads are unpaved (U.S. Department of Transportation, 2022), and crash locations will be remote from services such as medical centers (Congressional Research Service, 2016). Highway funding can also be limited compared to states, as many tribes compete for federal and state grants (Congressional Research Service, 2016). These environmental and systemic factors can profoundly influence a motor vehicle crash outcome and are likely adversely affecting the motor vehicle fatality rate for tribal land communities. Furthermore, this analysis may not reflect the real magnitude of the problem. Although AIAN fatality rates are already comparatively higher than rates for other groups, it is widely believed that MVTs in tribal lands are substantially unreported in FARS (U.S. Department of Health Human Services Office of Minority Health, 2022). A tribe's reporting is voluntary, and their crash reporting system may not be the same or might not be compatible with state systems that feed into FARS (Congressional Research Service, 2016). Future research should examine the effectiveness of current efforts to reduce MVTs in

tribal communities through the Bipartisan Infrastructure Law programs that provide funding to tribal governments to support Vision Zero plans (U.S. Department of Transportation, 2022).

The examination of rates, which were the focus of this investigation, can sometimes mask the true extent of the crash problem in the United States. There were 39,007 MVTFs in 2020 and 42,939 in 2021, which were the largest numbers seen since the early 2000s (Stewart, 2023). A NHTSA summary report of traffic crashes in this timeframe demonstrated that there was also an increase in risky driving behaviors, such as alcohol-impaired and unrestrained driving, and an increase in both urban and rural traffic fatalities (Stewart, 2023). These findings correspond particularly with the driver MVTf results in the analysis for most of the groups analyzed. For example, AIAN, Black or African American, NHPI, and white populations experienced an increase in driver fatality rates in 2020 and 2021 for all factors. Interestingly, the Hispanic population was the only group that did not experience an increase in fatality rates during this timeframe for drivers or occupants.

In part, these recent increases in fatalities have been linked to the COVID-19 pandemic and its many effects on our transportation system. U.S. data show an increase in MVTFs in 2020, although there were fewer vehicle miles traveled (Stewart, 2023). Additionally, urban MVTFs increased more than rural MVTFs (Stewart, 2023). There was also an increase in ejection rates in 2020, which implies an increased frequency of unrestrained drivers or occupants (Office of Behavioral Safety Research, 2022). Lastly, a small study by NHTSA concluded that there were higher levels of alcohol and drugs in participants during the pandemic compared to a prior period (Thomas et al., 2020). The fatality rates observed in this investigation for these factors generally match the predictions that would be suggested by these pandemic effects, but further study is needed to reach stronger conclusions.

#### 4.1. Limitations

The data sources used in this study have several limitations. First, FARS data are obtained from multiple sources. Each state provides documents such as police accident reports, vehicle registration files, driver licensing files, death certificates, emergency medical services reports, and other state records (NHTSA, 2021). Although these documents provide valuable information, there can be inconsistencies in data recording and the level of detail collected (Güss et al., 2020).

Second, this study focused on fatal crashes only, which represent a small number (less than 1 %) of total police-reported crashes (Stewart, 2022). By focusing on fatal crashes, the results of this investigation do not fully demonstrate how each race and ethnicity is affected by motor vehicle crashes, particularly those crashes where fatalities do not occur.

Third, the U.S. Census Bureau collects race and ethnicity data following OMB guidelines through questionnaires (U.S. Census Bureau, 2022). Over the last decade, the U.S. Census Bureau has tried to improve respondent understanding of the questions related to race and ethnicity, along with specification for membership in each group, to enhance the accuracy of the resulting responses. Nonetheless, the population estimates in this study are based on self-identification and the effectiveness of the inclusivity strategies used by the U.S. Census Bureau (2022).

Fourth, the data obtained from the Housing Assistance Council to calculate rural and urban population estimates of each group were modified for the study, and only 2010 population data were available for the analysis. Therefore, the population estimates for each race and ethnicity do not reflect any annual variations.

Fifth, due to the vehicle type restrictions and the availability of racial and ethnic groups used at the onset of the investigation, the analysis is not completely representative of fatalities across all vehicles on all public roads. While this resulted in the exclusion of 21 % of MVTFs, the case counts available were still substantial.

Finally, this study did not account for factors like different state laws,

enforcement of seat belt laws, and administrative license revocation for alcohol-impaired driving (Bhutta et al., 2024). For instance, all states have either primary or secondary seat belt laws. Currently, there are only 17 states that have primary seat belt laws for all occupants (Bhutta et al., 2024). In this analysis, the effect that these laws may have on seat belt use is confounded by the differences in racial and ethnic populations that may exist among different states with different laws and enforcement strategies. These differences also extend to some other factors considered in this investigation.

## 5. Conclusion

The analyses highlight notable differences in fatality rates for each racial and ethnic group explored. Race and ethnicity, alcohol-impairment, location (rural or urban), restraint use, and person type (driver and occupant) all combined to significantly predict MVFT rates. It is evident from this analysis that, between 2010 and 2021, the AIAN population continued to be overrepresented in MVTFs. This overrepresentation may be associated with their overrepresentation in several factors that are known to influence motor vehicle crash outcomes. In the same period, the Black or African American population also had an increase in driver fatality rates for all factors explored.

Nevertheless, not all changes have been negative. In contrast to other groups, the NHPI population has consistently experienced one of the largest reductions in driver and occupant fatality rates for alcohol-impaired, rural, urban, and unrestrained fatality rates, and the Asian population has consistently shown the lowest rates in the same period.

Further analysis is necessary to develop and implement countermeasures that may reduce the increasing fatality rates among the AIAN and Black or African American populations while also continuing to decrease the rates for other populations. Separating and analyzing the data by driver and occupant MVTFs, as was done in this analysis, provides a unique perspective and realization that, while these two groups can follow similar patterns, these patterns are not identical. Despite the limitations of FARS and population data, these results can provide a pathway to reducing MVTFs and associated racial inequities that exist in the nation, particularly as the BIPOC population continues to grow.

### CRediT authorship contribution statement

**Jacqueline Chavez Orellana:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Christina Witcher:** Data curation, Methodology, Resources, Writing – review & editing. **Miguel A. Perez:** Conceptualization, Data curation, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

Data will be made available on request.

### Acknowledgements and/or Funding Sources

The authors acknowledge the expert guidance that Kaye Sullivan offered in understanding the intricacies of FARS data and her assistance with data extraction. This research was not externally funded. The lead author received support from a Doctoral Fellowship from the Virginia Tech Institute for Critical Technology and Applied Science.

Appendix A

Table A1

Driver and occupant fatality rates for all FARS factors explored in the analysis from 2010 through 2021.

	Year	Driver Race and Ethnicity						Occupant Race and Ethnicity					
		AIAN	Asian	Black or African American	NHPI	White	Hispanic	AIAN	Asian	Black or African American	NHPI	White	Hispanic
Rural	2010	11.58	1.11	4.61	4.07	5.07	3.56	5.16	0.66	1.82	0.72	1.34	2.13
	2011	13.78	0.86	4.12	3.17	4.95	3.71	6.81	0.66	1.59	2.53	1.23	1.92
	2012	12.18	0.75	4.32	4.07	5.11	3.89	6.97	0.73	1.61	1.09	1.20	2.10
	2013	11.45	0.57	4.28	2.71	5.14	3.92	4.95	0.50	1.37	5.43	1.21	2.02
	2014	14.17	1.09	4.21	3.62	4.97	4.00	6.49	0.53	1.50	1.09	1.14	2.14
	2015	12.91	1.02	4.96	3.17	5.30	4.45	7.19	0.88	1.76	1.81	1.27	2.23
	2016	14.44	0.91	5.54	2.26	5.61	4.68	7.29	0.95	1.82	1.45	1.32	2.24
	2017	13.91	1.09	5.38	4.07	5.54	4.51	6.60	0.63	1.82	2.17	1.22	1.88
	2018	11.45	1.17	5.03	3.17	5.17	4.68	4.90	0.72	1.60	3.26	1.09	1.92
	2019	10.98	0.86	5.15	1.36	4.56	4.39	5.16	0.52	1.66	0.72	1.02	1.77
	2020	11.18	0.63	5.65	0.90	4.46	5.56	4.95	0.34	1.71	0.72	0.89	2.00
	2021	14.51	0.70	6.12	2.71	4.58	4.87	4.58	0.30	1.51	0.36	0.92	1.85
Urban	2010	11.19	1.22	6.56	7.31	9.79	3.76	4.34	0.60	2.69	2.92	2.48	1.99
	2011	15.60	1.25	6.78	4.26	8.94	3.78	5.70	0.52	2.44	2.92	2.31	1.73
	2012	16.95	1.10	6.81	6.09	9.26	4.04	5.42	0.60	2.64	2.92	2.53	1.95
	2013	17.63	1.17	7.13	3.04	9.37	4.24	8.41	0.76	2.50	1.95	2.20	1.94
	2014	18.31	1.62	7.16	4.26	10.25	4.75	9.76	0.84	3.00	1.46	2.39	2.08
	2015	22.72	1.82	8.28	6.09	11.46	5.44	8.95	1.16	3.40	4.87	2.54	2.21
	2016	24.07	1.68	10.51	9.74	12.64	5.97	9.22	0.84	3.53	3.90	3.04	2.25
	2017	22.72	1.83	11.91	7.31	13.42	6.57	11.12	0.84	3.90	1.95	3.06	2.63
	2018	21.36	1.92	11.90	13.39	13.29	6.70	8.14	1.12	4.05	5.36	2.96	2.52
	2019	20.00	1.52	11.23	4.26	10.89	5.79	7.59	0.57	3.37	1.46	2.43	2.25
	2020	17.63	1.55	15.54	1.83	12.64	9.13	5.97	0.79	5.18	0.49	2.61	2.90
	2021	23.39	1.63	16.82	5.48	13.57	7.61	8.14	0.48	5.05	2.44	2.80	2.64
Unrestrained	2010	6.40	0.35	2.71	3.03	2.88	1.56	3.79	0.23	1.21	0.81	0.74	1.06
	2011	9.09	0.22	2.72	1.00	2.77	1.47	4.40	0.21	1.08	1.12	0.69	0.93
	2012	8.53	0.15	2.68	1.98	2.82	1.67	4.46	0.21	1.14	1.27	0.69	0.97
	2013	7.10	0.14	2.53	1.57	2.68	1.58	3.34	0.16	0.97	1.58	0.61	0.94
	2014	8.58	0.28	2.56	0.97	2.67	1.59	4.03	0.18	0.99	0.47	0.60	0.96
	2015	9.59	0.25	2.99	1.15	2.82	1.75	5.34	0.35	1.17	1.56	0.64	0.92
	2016	8.67	0.16	3.42	1.53	3.03	1.92	5.13	0.20	1.28	1.08	0.70	0.94
	2017	9.18	0.18	3.61	1.13	3.00	1.82	4.56	0.18	1.28	0.77	0.63	0.85
	2018	7.24	0.23	3.56	3.00	2.88	1.91	3.01	0.23	1.28	1.83	0.60	0.86
	2019	5.13	0.17	3.46	1.12	2.49	1.65	3.18	0.13	1.14	0.30	0.54	0.81
	2020	8.03	0.19	4.72	0.38	2.79	2.63	3.83	0.15	1.55	0.15	0.53	0.97
	2021	12.08	0.18	5.28	0.92	2.92	2.24	4.34	0.11	1.45	0.60	0.54	0.88
Alcohol-impaired	2010	6.51	0.18	2.08	2.02	1.98	1.76	2.96	0.06	0.65	0.48	0.43	0.67
	2011	8.23	0.25	2.02	1.60	1.83	1.63	3.30	0.08	0.62	0.80	0.39	0.51
	2012	7.74	0.22	2.04	2.17	1.92	1.66	3.46	0.07	0.61	1.11	0.40	0.55
	2013	6.71	0.16	2.12	1.57	1.91	1.67	2.49	0.04	0.55	1.27	0.40	0.53
	2014	7.86	0.26	1.95	1.16	1.84	1.63	2.78	0.11	0.53	0.16	0.33	0.54
	2015	8.18	0.32	2.27	1.15	1.88	1.74	3.94	0.14	0.65	1.24	0.36	0.51
	2016	8.23	0.17	2.53	0.95	1.91	1.82	3.71	0.10	0.63	0.46	0.36	0.49
	2017	7.29	0.20	2.70	1.13	1.90	1.83	3.16	0.09	0.65	0.61	0.33	0.47
	2018	5.85	0.24	2.52	1.88	1.73	1.85	2.14	0.05	0.56	0.46	0.31	0.43
	2019	4.65	0.11	2.37	0.37	1.48	1.54	2.26	0.05	0.51	0.30	0.25	0.38
	2020	7.02	0.15	3.13	0.38	1.65	2.26	2.81	0.05	0.74	0.31	0.28	0.52
	2021	9.50	0.16	3.43	0.92	1.69	1.79	3.31	0.05	0.67	0.45	0.24	0.45

Table A2

Poisson regression model results.

Term	Coef.	Std.Error	z	p-value
(Intercept)	0.47	0.01	53.71	0.00
RaceEthnicityAmerican Indian	0.33	0.03	10.35	0.00
RaceEthnicityAsian	-0.92	0.04	-26.19	0.00
RaceEthnicityBlack	-0.21	0.01	-17.21	0.00
RaceEthnicityHispanic	-0.07	0.01	-6.46	0.00
RaceEthnicityNHPI	-0.62	0.12	-5.08	0.00
AlcoholYes	-0.97	0.01	-163.75	0.00
RuralUrbanUrban	0.78	0.01	140.60	0.00
RestraintNo	-0.08	0.01	-16.00	0.00
PersonOccupant	-1.29	0.00	-261.65	0.00
Year2011	-0.05	0.01	-4.40	0.00
Year2012	-0.01	0.01	-1.12	0.26
Year2013	-0.03	0.01	-2.41	0.02

(continued on next page)

Table A2 (continued)

Term	Coef.	Std.Error	z	p-value
Year2014	0.00	0.01	0.34	0.73
Year2015	0.09	0.01	8.76	0.00
Year2016	0.17	0.01	16.36	0.00
Year2017	0.18	0.01	17.18	0.00
Year2018	0.14	0.01	13.59	0.00
Year2019	0.02	0.01	1.60	0.11
Year2020	0.12	0.01	10.92	0.00
Year2021	0.13	0.01	12.07	0.00
RaceEthnicityAmerican Indian:AlcoholYes	0.94	0.03	30.00	0.00
RaceEthnicityAsian:AlcoholYes	-0.68	0.05	-12.69	0.00
RaceEthnicityBlack:AlcoholYes	0.28	0.01	20.94	0.00
RaceEthnicityHispanic:AlcoholYes	0.36	0.01	28.14	0.00
RaceEthnicityNHPI:AlcoholYes	0.54	0.12	4.47	0.00
RaceEthnicityAmerican Indian:RestraintNo	0.72	0.03	21.99	0.00
RaceEthnicityAsian:RestraintNo	-0.86	0.04	-19.48	0.00
RaceEthnicityBlack:RestraintNo	0.39	0.01	30.95	0.00
RaceEthnicityHispanic:RestraintNo	0.02	0.01	1.97	0.05
RaceEthnicityNHPI:RestraintNo	0.41	0.12	3.42	0.00
RaceEthnicityAmerican Indian:RuralUrbanUrban	-0.43	0.04	-11.32	0.00
RaceEthnicityAsian:RuralUrbanUrban	-0.41	0.04	-10.12	0.00
RaceEthnicityBlack:RuralUrbanUrban	-0.16	0.01	-13.04	0.00
RaceEthnicityHispanic:RuralUrbanUrban	-0.62	0.01	-50.85	0.00
RaceEthnicityNHPI:RuralUrbanUrban	-0.30	0.12	-2.47	0.01

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