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# New England Low Fatality Rates versus Low Safety Belt Use


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16. Abstract

This study examines the apparent anomaly of low safety belt usage in New England and relatively low fatality rates in New England. There are many variables that effect fatalities. Restraint use is one of the independent variables that contribute to fatalities and the subsequent fatality rates. The values of other variables in New England offset the expected high fatality rates if only safety belt use is considered.

Restraint use continues to be the most effective individual countermeasure to reduce traffic crash related injuries and fatalities.

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# Executive Summary


**Background Issue**
How can both the fatality rates and safety belt use rates be lower for New England than for the rest of the country? This appears to be contradictory. Is there a logical explanation to resolve this apparent anomaly?

**Methodology**
Two distinct but complimentary approaches were used to answer this question. First, dichotomous logistic models were developed to identify crash variables that are associated with fatal crashes.

For the second approach, continuous models for four commonly used fatality rates were constructed. Three “good/better/best” levels were modeled for each fatality rate. The first level, the good level, modeled the characteristics of each State; the second level, the better level, added alcohol information. The third level, the best level, added safety belt usage to the second-level models.

**Conclusions**
Safety belt use is not the only variable affecting the fatality rates. There are many other contributing crash factors. During the first approach, which uses multivariate logistic models, significant crash variables were associated with the crash being classified as a fatal crash, that is, someone died as a result of it. These significant crash variables included speed limits of at least 55 mph, only a single vehicle involved in the crash, crashes at night, rollover crashes, head-on crashes, curved roadways, and restraint use. These significant crash variables were shown to be different for New England compared to the rest of the United States. The odds of a fatal crash in New England were shown to be not significantly different than the rest of the United States when adjustments were made for differences in crash characteristics of the New England States.

The second approach acknowledges that there are a host of non-crash-related variables that can affect fatality rates. In particular, in addition to restraint use, other factors including such variables as the average vehicle miles driven, income, employment, minority density, land use, and the percent of fatal crashes with a maximum imputed blood alcohol concentration of .08 grams pre deciliter or higher affect the fatality rates of the States. The best-level continuous models explained approximately 90 percent of the variation for the four commonly used fatality rates among the States, i.e., $R^2 \approx 0.90$. One sees that the values of these other factors reduce/offset the effect of low restraint use and result in lower-than-expected fatality rates if only restraint use is considered.

The difference in restraint use in fatal crashes between New England (53 %) and the rest of the United States (58 %) is not very great and is narrowing.

Restraint use is the only factor under control of each vehicle occupant. Restraint use remains the most effective counter-measure to reduce injuries and deaths available to vehicle occupants.

Increased restraint use in New England will further reduce fatalities and injuries in New England although such increased use would not significantly alter the apparent anomaly, which appears to be the result of other factors.

## New England Low Fatality Rates versus Low Safety Belt Use

### 1. Background

Reported New England safety belt use, as measured by State surveys, is lower than much of the United States. However, New England fatality rates are not correspondingly high. (The New England States are: Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont.)

Data extracted from the National Center for Statistics and Analysis published data[1] from 2000 to 2002 shows that the restraint use rate of fatally injured occupants of passenger cars and light trucks for New England is 32 percent and for the rest of the nation the corresponding restraint use is 41 percent. When the unknowns are distributed, the rates are 38 percent and 44 percent respectively.

Table 1 shows the reported restraint use in fatal crashes for New England and the rest of the United States by year. Restraint use of non-fatally-injured people are included in the calculations. Although the reported restraint use in New England is somewhat lower than in the rest of the United States, the restraint use has been increasing both in New England and the rest of the United Sates. In addition, the difference between New England and the rest of the United States is diminishing.

Four commonly published fatality rates are:
(1) fatalities per 100 million vehicle miles traveled,
(2) fatalities per 100,000 drivers,
(3) fatalities per 100,000 registered vehicles, and (4) fatalities per 100,000 population. These four published fatality rates are 1.01, 12.30, 10.69, 9.13, respectively, for New England and 1.53, 22.55, 19.57, 15.25, respectively, for the rest of the United States.

The question arises, how can both the fatality rates and belt use rates be lower for New England than the rest of the country. This appears to be contradictory. To answer the question we actually need to answer a more general question, that is: What are the significant factors, i.e., the independent variables, that explain State fatality rates? The simple explanation of the apparent anomaly is that restraint use is one of many factors associated with fatality rates. The values of these other factors reduce/offset the effect of low restraint use and result in lower-than-expected fatality rates if only restraint use is considered.

**Table 1: Reported Restraint Use in Fatal Crashes by Year**

| Year | New England | Rest of US |
|---|---|---|
| | | |
| 2000 | 47 % | 54 % |
| 2001 | 49 % | 55 % |
| 2002 | 53 % | 56 % |
| 2003 | 53 % | 58 % |
| | | |
| Improvement | 6 percentage points | 4 percentage points |
| | | |
| Source: NHTSA/NCSA/FARS/SAS | | |

### 2. Approach

Several different questions have been proposed to examine the apparent discrepancy in fatality rates compared to belt use rates:

- Does State-reported safety belt use predict belt use in fatal crashes?
- Are significant crash variables different for New England compared to the rest of the United States?
- Which additional crash characteristics indicate a fatality will occur in a crash?
- Are the odds of a fatal crash in New England significantly different/higher than the rest of the United States? When adjustments are made for differences in crash characteristics in the New England States, is the New England location still a significant variable?

Finally, continuous models for each of the four fatality rates were constructed. Three "good/better/best" model levels for each rate were constructed. The first level, the good level, modeled the characteristics of each State; the second level, the better level, added alcohol information. The third

[1] Traffic Safety Facts 2000, DOT HS 809 337, pp. 148-149 , Table 108 and pp. 156-157, Table 112, April 2002
Traffic Safety Facts 2001, DOT HS 809 484, pp. 148-149, Table 108 and pp. 156-157, Table 112, December 2002
Traffic Safety Facts 2002, DOT HS 809 620, pp. 148-149, Table 108 and pp. 156-157, Table 112, January 2004

level, the best level, added safety belt usage to the second level models. The best-level models explained approximately 90 percent of the variation among the States, i.e., $R^2 \approx 0.90$.

## 3. Databases

NHTSA's belt use data: Data on belt use is collected by most of the States and the District of Columbia. Belt use rates from the States and territories are based on surveys conducted according to criteria issued in Section 157 of Title 23 of the Federal Register (23 CFR Part 1340). These criteria were established as part of an occupant protection incentive grant program for the 50 States, the District of Columbia, and Puerto Rico.

NHTSA's National Automotive Sampling System-General Estimates System (NASS-GES) data are obtained from a nationally representative sample selected from all police-reported crashes. To be eligible for the GES sample, a police accident report must be completed for the crash, and the crash must involve at least one motor vehicle traveling on a trafficway and result in property damage, injury, or death.

NHTSA's *Fatality Analysis Reporting System, (FARS)* became operational in 1975. FARS data are based on a census of fatal traffic crashes within the United States including the District of Columbia and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle traveling on a trafficway customarily open to the public, and must result in the death of an occupant of a vehicle or a nonmotorist within 30 days of the crash.

The Federal Highway Administration's *Highway Statistics* provides data on highway mileage and performance. The statistics have been analyzed and reported using procedures that provide comparability of values among the States. As a result, some values may differ from values reported by the States or other agencies for similar items.

## 4. State-Reported Belt Use as a Predictor of Belt Use in Fatal Crashes

Belt use survey data collected using the criteria as stated in the Databases section of this note from 1998 to 2002, also found in Glassbrenner,[2] were combined with reported belt use in fatal crashes in a linear regression model. Both belt use rates, for fatally injured outboard front-seat passengers and for all outboard front-seat passengers involved in fatal crashes were modeled. The results are as follows:

$$\hat{Y} = 0.689 * SRBU - 0.091$$
$$\hat{Z} = 0.818 * SBRU - 0.002$$

Where:
$\hat{Y}$ is the estimated safety belt use rate for fatally injured outboard front-seat passengers,
$\hat{Z}$ is the estimated safety belt use rate for all outboard front-seat passengers involved in fatal crashes; and *SRBU* is the State reported belt use as reported in Glassbrenner.[2]

In both cases, the p-values for the coefficients of SRBU are ($p < 0.0001$). The R-square values are 73.8 percent and 77.4 percent for fatally injured outboard front- seat passengers and all outboard front-seat passengers respectively. This demonstrates a relationship between State-reported belt use and belt use in fatal crashes as reported in FARS. If this relationship did not exist, then there would not be any reason to be concerned about the unexpected relationship between observed belt use in New England and the New England fatality rates.

The results of this analysis are: The belt use rate of fatally injured outboard front-seat passengers is approximately 58 percent of the State-reported belt use rate. Correspondingly, the belt use rate for all outboard front-seat passengers is approximately 82 percent of the State-reported belt use rate. The difference between belt use rate for fatalities, 58 percent and 82 percent of all passengers, is largely due to the effectiveness of seat belts.

## 5. Four Variables Associated with Fatalities

Speed limits of 55 mph or higher, rollovers, good weather, and crashes that occur in rural areas are positively associated with increasing fatalities; see table 2.

[2] Glassbrenner, Donna, Safety Belt Use in 2003 – Use Rates in the States and Territories DOT HS 809 713, National Highway Traffic Safety Administration, March 2004.

**Table 2: Variables Associated with Increasing Fatalities**

| Variable | New England | Rest of US |
|---|---|---|
| Speed limit ≥ 55 mph | 24 % | 56 % |
| Rollovers | 6 % | 9 % |
| Good weather | 84 % | 88 % |
| Rural crashes | 42 % | 61 % |
| Source: NHTSA/NCSA/FARS/SAS | | |

Each of these variables tends to reduce the fatalities in New England compared to the rest of the United States.

Good weather often increases the odds of a fatality. A reasonable explanation is that many vehicles are driven at slower speeds in bad weather than in good weather. As a result, many crashes that occur in bad weather may have less kinetic energy to dissipate and as a result there are fewer fatalities.

The figure of Appendix B shows these four variables for each State. The States and the District of Columbia have been partitioned into three levels, Better than Average/white, Average/gray, and Below Average/black with 17 jurisdictions in each level. When examining the figure one sees that the New England States are mostly classified as Better than Average/white, for these variables.

## 6. Variables Indicative of Fatalities in Crashes

To identify additional variables that are associated with fatal crashes, the General Estimates System was chosen.

Since the GES data are from a complex sample survey rather than a census, professional software for survey data analysis for multi-stage sample designs (SUDAAN) developed by Research Triangle Institute was used to analyze these this data. In addition to the variables already discussed, five additional crash characteristics were identified as associated with increasing the odds of a fatality of an outboard front-seat passenger given a crash; see table 3.

**Table 3: Characteristics That Raise the Odds of a Front-Seat Fatality Occurring Within a GES Crash**

| Characteristic | Odds Ratio | p-value |
|---|---|---|
| Speed limit ≥ 55 mph | 2.639 | 0.0001 |
| Single-vehicle crash | 2.480 | <0.0001 |
| Night crash | 1.535 | 0.0001 |
| Rollover-involved crash | 3.450 | <0.0001 |
| Head-on crash | 10.327 | <0.0001 |
| Curved roadway | 2.235 | <0.0001 |
| Good weather | 1.624 | 0.0022 |
| Unbelted | 5.549 | <0.0001 |
| Source: NHTSA/NCSA/GES/SUDAN | | |

## 7. Fatal New England Crashes Compared to Fatal Crashes in the Rest of the United States

In fatal crashes, by definition, at least one person must die. In a single-vehicle crash with a single occupant and no nonoccupants the driver/occupant always dies in the crash by definition. This can cause technical problems when logistic regression is employed.[3] To avoid these problems, the fatal crash data were limited to crashes involving at least two individuals.

This reduced set of crashes is analyzed with logistic regression to estimate the change in the odds of a fatality of an occupant in a passenger vehicle due to the crash occurring in New England. The result is New England increases the odds of a fatality by 14.5 percent. The coefficient has a p-value of < 0.0001. We can therefore conclude that within this limited set of crashes, the location of New England raises the odds of a fatality compared to the rest of the country by 14.5 percent.

From the previous analysis of the GES data one sees that several crash characteristics -speed limit of 55 mph or higher, single-vehicle crashes, night crashes, rollover-involved crashes, head-on crashes, curved roadways, good weather, and lack of restraint use -- all raise the odds of a crash leading to a fatality. In

[3] Hosmer, D. W. and Lemeshow, S. Applied Logistic Regression, John Wiley and Sons 1989.

addition, the difference of a rural location compared to an urban location is known to increase the odds of a fatality in a crash. Armed with this information we can now ask the question:

Is the New England location a significant variable, if adjustments are made for other independent characteristics that are known to contribute to fatal crashes? The answer is no; see Table 4.

One can interpret the results of Table 4 in the following way. Although there is a distinct difference in the propensity for a fatality within New England compared to the rest of the country, that difference is offset by differences in crash characteristics.

It is clear that crash characteristics are associated with fatalities and therefore fatality rates. In addition to the location of the crash (New England versus the rest of the country) other factors contribute to fatalities. The models constructed so far address discrete events. Continuous-fatality-rate models are now investigated.

### Table 4: FARS Characteristics Associated with Fatal Crashes

| Characteristic | p-value |
|---|---|
| | |
| Speed limit ≥ 55 mph | <0.0001 |
| Single-vehicle crash | <0.0001 |
| Night crash | <0.0001 |
| Rollover-involved crash | 0.0236 |
| Head-on crash | <0.0001 |
| Curved roadway | <0.0001 |
| Good weather | <0.0001 |
| Unbelted | <0.0001 |
| Rural location | <0.0001 |
| **New England** | **0.1358** |
| | |
| Source: NHTSA/NCSA/FARS/SAS | |

## 8. Fatality Rate Models

Three levels of non-linear continuous models are used to predict four commonly used fatality rates. The modeled fatality rates were: (1) fatalities divided by 100 million vehicle miles traveled, (2) fatalities divided by licensed drivers, (3) fatalities divided by registered vehicles, and (4) fatalities divided by population. The "good" models represent the inherent nature of each State and have terms that reflect differences in congestion and mobility, affluence, culture, the environment, and land use (rural versus urban). The "better" models add the first of two social behavior variables, namely, the presence of alcohol in fatal crashes. Finally, the "best" models add data on safety belt use. SAS® brand software was used to determine the coefficients of the terms of the multivariate models. All terms included in all the models were statistically significant with p-values of less than 0.05.

The "good" models, which represent the inherent nature of the States, explain from 82 percent to 86 percent of the variation, that is, $0.82 \leq R^2 \leq 0.86$. With the addition of the alcohol data to the model, even more of the variation is explained, with $0.83 \leq R^2 \leq 0.91$.
Inclusion of data on safety belt use in the "best" models raises the explained variation to at least 86 percent, that is, $0.86 \leq R^2 \leq 0.91$; see table 5.

### Table 5: $R^2$ Values by Level Modeled and Dependent Variable.

| Level | VMT | Drivers | Registered Vehicles | Pop. |
|---|---|---|---|---|
| | | | | |
| Good | 0.82 | 0.83 | 0.86 | 0.85 |
| Better | 0.83 | 0.84 | 0.91 | 0.89 |
| Best | 0.86 | 0.91 | 0.91 | 0.91 |
| | | | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | | | |

Safety belt usage is critically important in understanding fatality rates. When building multivariate models one technique allows the software to add the variables to the model according to their importance in explaining the variance of the dependent variable. When this is done for the "best" models the first appearance of safety belt usage is either the second or fourth variable added to the model. The improvement in $R^2$ ranges from a low of 0.05 to a high of 0.21.

**Table 6: Order of First Appearance of Safety Belt Usage in Best Models**

| Model | 1st Appearance | $R^2$ Improvement |
|---|---|---|
| | | |
| VMT | 2nd variable | 0.14 |
| Drivers | 2nd variable | 0.21 |
| Reg. Veh. | 4th variable | 0.05 |
| Population | 2nd variable | 0.17 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

The models with their variables and associated coefficients are in Appendix A. The variable definitions appear below by categories.

Variables reflecting differences in congestion and mobility:

VMT/Drivers:
Total vehicle miles traveled in the State divided by the number of licensed drivers in the State.
VMT/Population:
Total vehicle miles traveled in the State divided by the State population. (Included in all three models.)
VMT/Vehicles:
Total vehicle miles traveled in the State divided by the number of registered vehicles in the State.
Area/Population:
Total land area in square miles in the State divided by the State population.
Area/Vehicles:
Total land area in square miles in the State divided by the number of registered vehicles in the State.

Variables reflecting differences in affluence:

Per Cap Income:
Per capita income for the State.

% Unemployed:
Unemployment rate for the State.

% Employed:
Percent of residents 16 or older with full- or part-time employment.

Variable reflecting differences in culture:

% Minority:
The percent of the population within the State that is classified as any racial minority or Hispanic. (Included in all models.)

Variables reflecting differences in land use (rural versus urban):

Area:
Rural and urban areas within a State in square miles.
Rural Area:
Rural area within a State in square miles
% Rural Area:
The percent of the State's land that is classified as rural area.
Lane Miles:
The urban and rural lane miles within the State.
Rural Lane Miles:
Rural lane miles within the State
% Rural Lane Miles:
The percent of all lane miles within the State classified as rural

Variables reflecting differences in social behavior:

% Alcohol ≥ 0.08:
The percent of fatal crashes, within the State, with a maximum imputed blood alcohol concentration (BAC) level of .08 or higher. (Included in all three level-2 and level-3 models.)
% Unrestrained:
The percent of unrestrained outboard front-seat passengers, involved in fatal crashes, within the state. (Included in all level- 3 models.)

## 9. Conclusions

The difference in restraint use in fatal crashes between New England, 53 percent, and the rest of the United States, 58 percent, is not very great and is narrowing.

Restraint use is only one of several variables needed to adequately account for the differences in fatality rates among the States.

Combinations of variables that describe differences in social economic conditions (including safety belt use), congestion, affluence, culture, and land use predict virtually all of the variance of the four fatality rates for the 50 States and the District of Columbia.

The differences in the other variables, beyond the control of vehicle occupants, reduce the expected high fatality rates in New England, if only restraint use is considered.

Restraint use, which appears in all of the "best" models, is the only variable over which motor vehicle occupants have control.

Restraint use is the most effective countermeasure to reduce injuries and fatalities.

# Appendix A

## Variables and coefficients of the models

## Fatalities Divided by 100 Million Vehicle Miles Traveled

**Table A1: Fatalities Divided by 100 Million Vehicle Miles Traveled. Good Model – State Characteristics Only**

| Independent Variables | Coefficients | $R^2 = 0.82$ |
|---|---|---|
| | | |
| VMT/Drivers | -0.000036 | p = .0322 |
| Area/Vehicles | $3.65E10^{-5}$ | p = .0005 |
| % $Minority^2$ | $3.18E10^{-6}$ | P = .0096 |
| Lane $Miles^2$ | $2.78E10^{-14}$ | p = .0315 |
| (Per Cap Income) * | | |
| (% Employed) | $-1.74E10^{-7}$ | p < .0001 |
| (Per Cap Income) * | | |
| (% Rural Area) | $6.32E10^{-7}$ | p < .0001 |
| (% Minority) * | | |
| (% Unemployed) | $4.08E10^{-5}$ | p = .0087 |
| % Employed | -0.00054 | p = .0012 |
| Lane Miles | $-2.20E10^{-8}$ | p = .0065 |
| Area/Population | 0.00015 | p = .0002 |
| 1/(% Minority) | -0.01845 | p = .0177 |
| 1/(% Unemployed) | -0.08450 | p < .0001 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

The "*" indicates the interaction term between the two variables.

**Table A2: Fatalities Divided by 100 Million Vehicle Miles Traveled. Better Model – State Characteristics With Alcohol**

| Independent Variables | Coefficients | $R^2 = 0.83$ |
|---|---|---|
| | | |
| VMT/Area | 0.00131 | p = .0136 |
| Area/Drivers | -0.00260 | p = .0227 |
| % Rural Lane Miles | 0.01193 | p = .0013 |
| % $Employed^2$ | $-5.63E10^{-6}$ | p < .0001 |
| % Alcohol $\geq 0.08^2$ | 0.02507 | P = .0003 |
| (Per Cap Income) * | | |
| (% Unemployed) | $-4.80E10^{-8}$ | p = .0002 |
| Lane $Miles^2$ | -0.00123 | p = .0003 |
| Area/Population | 0.00036 | p = .0200 |
| 1/(% Minority) | -0.02897 | p < .0001 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

## Fatalities Divided by 100 Million Vehicle Miles Traveled Continued

**Table A3: Fatalities Divided by 100 Million Vehicle Miles Traveled. Best Model – State Characteristics With Alcohol and Safety Belt Use**

| Independent Variables | Coefficients | $R^2 = 0.86$ |
|---|---|---|
| | | |
| Rural Lane Miles/Area | -0.00094 | p = .0013 |
| % Rural Area | 0.03706 | p = .0002 |
| % Alcohol ≥ 0.08[2] | 0.10160 | p = .0032 |
| (Per Cap Income) * (% Unemployed) | $-5.69E10^{-8}$ | p = .0011 |
| (% Employed) * (% Restrained) | $-5.60E10^{-6}$ | p = .0006 |
| (% Employed) * (% Alcohol ≥ 0.08) | -0.00997 | p = .0144 |
| (% Employed) * (% Restrained) | $7.64E10^{-5}$ | p < .0001 |
| Drivers/Area | 0.01235 | p = .0390 |
| Area/Population | 0.00042 | p = .0053 |
| Area/Drivers | -0.00031 | p = .0062 |
| 1/(% Minority) | -0.02658 | p < .0001 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

## Fatalities Divided by Licensed Drivers

**Table A4: Fatalities Divided by Licensed Drivers Good Model – State Characteristics Only**

| Independent Variables | Coefficients | $R^2 = 0.83$ |
|---|---|---|
| | | |
| VMT/Drivers | 0.01421 | p < .0001 |
| Area/Population | 0.00202 | p = .0055 |
| Area/Vehicles | -0.00165 | p = .0323 |
| % Minority | 0.00428 | p = .0003 |
| % Minority$^2$ | 1.45E10$^{-5}$ | p = .0037 |
| % Unemployed$^2$ | 9.24E10$^{-4}$ | p = .0001 |
| Rural Area$^2$ | -9.65E10$^{-13}$ | p = .0235 |
| Per Cap Income | 8.62E10$^{-6}$ | p < .0001 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

**Table A5: Fatalities Divided by Licensed Drivers Better Model – State Characteristics With Alcohol**

| Independent Variables | Coefficients | $R^2 = 0.84$ |
|---|---|---|
| | | |
| VMT/Drivers | 0.01179 | p = .0240 |
| VMT/Population | 0.01356 | p = .0491 |
| VMT/Vehicles | -0.00751 | p = .0268 |
| % Rural Lane Miles | 0.20642 | p < .0001 |
| % Minority$^2$ | -2.79E10$^{-5}$ | p = .0204 |
| (Per Cap Income) * | | |
| (% Rural Area) | -3.76E10$^{-6}$ | p = .0056 |
| (% Minority) * | | |
| (% Alcohol ≥ 0.08) | 0.01010 | p < .0001 |
| % Employed | -0.00726 | p < .0001 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

**Table A6: Fatalities Divided by Licensed Drivers**
**Best – State Characteristics With Alcohol and Safety Belt Use**

| Independent Variables | Coefficients | $R^2 = 0.91$ |
|---|---|---|
| | | |
| VMT/Drivers | 0.01322 | p < .0001 |
| Area/Population | 0.00237 | p = .0002 |
| Area/Vehicles | -0.00206 | p = .0016 |
| % Rural Area | 0.33236 | p < .0001 |
| % Minority$^2$ | -5.34E10$^{-5}$ | p = .0001 |
| % Alcohol ≥ 0.08 | -0.27909 | p = .0464 |
| Rural Area$^2$ | -9.18E10$^{-13}$ | p = .0235 |
| (Per Cap Income) * | | |
| (% Rural Area) | -5.85E10$^{-6}$ | p = .0022 |
| (% Minority) * | | |
| (% Alcohol ≥ 0.08) | 0.01414 | p < .0001 |
| (% Unemployed) * | | |
| (% Unrestrained) | 2.82E10$^{-4}$ | p = .0014 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

## Fatalities Divided by Registered Vehicles

**Table A7: Fatalities Divided by Registered Vehicles**
**Good Model – State Characteristics Only**

| Independent Variables | Coefficients | $R^2 = 0.86$ |
|---|---|---|
| | | |
| VMT/Vehicles | 0.01426 | $p < .0001$ |
| Area/Population | 0.00145 | $p = .0050$ |
| Area/Vehicles | -0.00138 | $p = .0060$ |
| % Rural Lane Miles | 0.18152 | $p < .0001$ |
| Minority | 0.00364 | $p = .0004$ |
| $\text{Minority}^2$ | $-1.99E10^{-5}$ | $p = 0.160$ |
| % Employed | -0.00447 | $p = .0026$ |
| (Per Capita Inc) * | | |
| (% Rural Area) | $-4.65E10^{-6}$ | $p = .0003$ |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

**Table A8: Fatalities Divided by Registered Vehicles**
**Better Model –**
**State Characteristics With Alcohol**

| Independent Variables | Coefficients | $R^2 = 0.91$ |
|---|---|---|
| | | |
| VMT/Vehicles | 0.01473 | $p < .0001$ |
| Area/Vehicle | 0.00109 | $p = .0358$ |
| Area/Population | 0.00141 | $p = .0043$ |
| % Rural Lane Miles | 0.12657 | $p = .0007$ |
| % Employed | -0.00519 | $p = .0006$ |
| Per Capita Income | $-1.24E10^{-5}$ | $p = .0082$ |
| % Alcohol $\geq 0.08$ | -0.82876 | $p = .0215$ |
| % $\text{Minority}^2$ | $-3.86E10^{-5}$ | $p = .0007$ |
| % $\text{Area}^2$ | $-8.55E10^{-13}$ | $p = .0089$ |
| (Per Capita Inc) * | | |
| (% Alcohol $\geq 0.08$) | $2.65E10^{-5}$ | $p = .0331$ |
| (% Minority) * | | |
| (% Alcohol $\geq 0.08$) | 0.01192 | $p < .0001$ |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

# Fatalities Divided by Registered Vehicles Continued

**Table A9: Fatalities Divided by Registered Vehicles**
**Best Model – State Characteristics With Alcohol and Safety Belt Use**

| Independent Variables | Coefficients | $R^2 = 0.91$ |
|---|---|---|
| | | |
| VMT/Population | 0.00810 | p = .0088 |
| VMT/Vehicle | 0.01086 | p < .0001 |
| % Rural Area | 0.28177 | p < .0001 |
| % Minority$^2$ | 2.66E10$^{-5}$ | p = .0095 |
| (% Minority) * | | |
| (% Alcohol ≥ 0.08) | 0.01824 | p < .0001 |
| (% Minority) * | | |
| (% Rural Area) | -0.00384 | p = .0001 |
| (% Employed) * | | |
| (% Alcohol ≥ 0.08) | -0.00541 | p = .0001 |
| % Unrestrained | -0.01336 | p = .0035 |
| % Unrestrained$^2$ | 1.02E10$^{-4}$ | p = .0041 |
| % Unemployed$^2$ | -0.00273 | p = .0128 |
| (% Unemployed) * | | |
| (% Unrestrained) | 7.68E10$^{-4}$ | p = .0018 |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

## Fatalities Divided by Population

**Table A10: Fatalities Divided by Population**
**Good Model – State Characteristics Only**

| Independent Variables | Coefficients | $R^2 = 0.86$ |
|---|---|---|
| | | |
| VMT/Population | 0.01495 | $p < .0001$ |
| Area/Population | 0.00151 | $p = .0035$ |
| Area/Vehicles | -0.00116 | $p = .0326$ |
| % Minority | 0.00260 | $p = .0024$ |
| % Minority$^2$ | $-2.30E10^{-5}$ | $P = .0307$ |
| % Employed | -0.00298 | $p = .0378$ |
| Per Cap Income | $-4.75E10^{-6}$ | $p = .0004$ |
| Rural Area$^2$ | $-7.58E10^{-13}$ | $P = .0275$ |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

**Table A11: Fatalities Divided by Population**
**Better Model – State Characteristics With Alcohol**

| Independent Variables | Coefficients | $R^2 = 0.89$ |
|---|---|---|
| | | |
| VMT/Population | 0.01460 | $p < .0001$ |
| Area/Population | 0.00155 | $p = .0005$ |
| Area/Vehicles | -0.00119 | $p = .0107$ |
| % Rural Lane Miles | 0.12932 | $p = .0001$ |
| % Employed | -0.00612 | $p < .0001$ |
| % Minority$^2$ | $2.44E10^{-5}$ | $p = .0020$ |
| Rural Area$^2$ | $-8.69E10^{-13}$ | $p = .0035$ |
| (% Minority) * | | |
| (% Alcohol ≥ 0.08) | 0.00801 | $p < .0001$ |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

**Table A12: Fatalities Divided by Population**
**Best Model – State Characteristics With Alcohol and Safety Belt Use**

| Independent Variables | Coefficients | $R^2 = 0.91$ |
|---|---|---|
| | | |
| VMT/Population | 0.01362 | $p < .0001$ |
| Area/Population | 0.00183 | $p < .0001$ |
| Area/Vehicles | -0.00153 | $p = .0008$ |
| % Rural Lane Miles | 0.09445 | $p = .0008$ |
| % Minority$^2$ | $-3.17E10^{-5}$ | $p = .0008$ |
| Rural Area$^2$ | $-6.93E10^{-13}$ | $p = .0189$ |
| (Per Cap Income) * | | |
| (% Alcohol ≥ 0.08) | $-4.83E10^{-6}$ | $p = .0258$ |
| (% Minority) * | | |
| (% Alcohol ≥ 0.08) | 0.00984 | $p < .0001$ |
| (% Employed) * | | |
| (% Unrestrained) | $-6.90E10^{-5}$ | $p = .0004$ |
| % Unrestrained | 0.00525 | $p < .0001$ |
| | | |
| Source: NHTSA/NCSA, FHWA, US Census/SAS | | |

# Appendix B

## Variables Associated With Increasing Fatalities by State

### Legend

| | |
|---|---|
| Better than average | |
| Average | |
| Below Average | |

## Table B1 Variables Associated With Increasing Fatalities by State

| LOCATION | Speed limit >= 55 MPH | Rollover | Good weather | Rural |
|---|---|---|---|---|
| | | | | |
| New England | | | | |
| Connecticut | | | | |
| Maine | | | | |
| Massachusetts | | | | |
| New Hampshire | | | | |
| Rhode Island | | | | |
| Vermont | | | | |
| Other USA | | | | |
| Alabama | | | | |
| Alaska | | | | |
| Arizona | | | | |
| Arkansas | | | | |
| California | | | | |
| Colorado | | | | |
| Delaware | | | | |
| Dist of Columbia | | | | |
| Florida | | | | |
| Georgia | | | | |
| Hawaii | | | | |
| Idaho | | | | |
| Illinois | | | | |
| Indiana | | | | |
| Iowa | | | | |
| Kansas | | | | |
| Kentucky | | | | |
| Louisiana | | | | |
| Maryland | | | | |
| Michigan | | | | |
| Minnesota | | | | |
| Mississippi | | | | |
| Missouri | | | | |
| Montana | | | | |
| Nebraska | | | | |
| Nevada | | | | |
| New Jersey | | | | |
| New Mexico | | | | |
| New York | | | | |
| North Carolina | | | | |
| North Dakota | | | | |
| Ohio | | | | |
| Oklahoma | | | | |
| Oregon | | | | |
| Pennsylvania | | | | |
| South Carolina | | | | |
| South Dakota | | | | |
| Tennessee | | | | |
| Texas | | | | |
| Utah | | | | |
| Virginia | | | | |
| Washington | | | | |
| West Virginia | | | | |
| Wisconsin | | | | |
| Wyoming | | | | |

Source: NHTSA/NCSA/FARS/SAS

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For additional copies of this technical report, please call 800-934-8517 or fax your request to 202-366-3189. For questions regarding the data reported in this research, call Joseph Tessmer, 202-366-5820. This technical report and other general information on highway traffic safety may be found at: www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/AvailInf.html.

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