

Analysis of Emergency Response to Crashes Based on Demographic Parameters

Dinakara Abburi, Mehrnaz Doustmohammadi, Michael Anderson*

Department of Civil Engineering, University of Alabama in Huntsville, Huntsville, USA

Abstract Timely emergency response to crashes has the potential to save lives. As such, emergency vehicles have priority in traffic with the goal of minimizing response time. However, even with traffic priority, it sometime takes a long time for emergency vehicles to arrive at the scene of a crash. This paper examines the difference in response times between different locations in Alabama – essentially the difference in response time between rural and urban crash locations. The data used in this paper for analysis include over 560,000 crashes that occurred in Alabama during a 5 year period, of which roughly 125,000 had emergency vehicles deployed to the crash location. From the analysis, there was a clear difference in response time between urban and rural counties, which has a significant impact on the safety of the residence in rural locations where the population tends to be older and roadways tend to have a higher speed. Both of these situations are potentially hazardous leading to an increase in severity of crashes, which will increase the need for emergency medical service.

Keywords Traffic Crashes, Response Time, County Differences

1. Introduction and Background

Travel demand continues to grow every year, and with the growth comes a corresponding increase in traffic crashes. Traffic crashes have a large impact on society in terms of cost, delay and injuries/fatalities. Emergency response plays a very crucial role in reducing the impact of crashes by providing medical response to injured travellers and supplemental transport to medical facilities for care [1-5]. As such, emergency vehicles are given priority on roadways to assist in reducing response time to allow for critical care to be provided. Previous research has indicated that improving emergency services at crash locations is essentially related to reducing the response time associated with arriving at the crash location [6-16].

While studies are being conducted related to improving response time and impact of improved response time, this paper examines difference in response time based on location of the crash in Alabama. The objective of this paper is highlight the differences in response time associated with the location of the crash and present issues associated with differences in response time as they relate to the population being served and roadways travelled. The paper contains a comparison of emergency response times

for 10 different counties in Alabama that have different demographic, socioeconomic and geographical background. The paper shows that rural crashes often have a higher emergency response time, which when examining the population characteristics, rural counties tend to have older citizens, and roadway characteristics, rural counties tend to have more mileage of higher speed facilities based as a percentage of total roadway miles, lead to a situation of greater impact for increased response time.

2. Data Collection and Methodology

The crash data used in this research paper were obtained from the Critical Analysis Reporting Environment (CARE) maintained by the Center for Advanced Public Safety (CAPS) at the University of Alabama. The demographic and socioeconomic data were downloaded from the census website [17].

The crash data records include a detailed report on the crash prepared by the first officer on scene. The crash database had over 560,000 crashes which occurred between 2010 and 2014. Of the total crashes, only those in which emergency personal were called to the crash location were included. This reduced the number of crashes used in the study to just over 140,000.

The crash data obtained contains a variety of details including time, location, weather, urban/rural, age of the driver/drivers, gender of the driver/drivers, to name a few items. In addition, the data also contains the time for emergency vehicle response if requested/required. The

* Corresponding author:

andersmd@uah.edu (Michael Anderson)

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emergency response time is divided into 11 time frames. The number of crashes as well as corresponding percentage of crashes in each time option is shown in Table 1.

Table 1. Crash Time by Time

EMS Delay	Number of Crashes	Percent of Crashes
0 to 5 Minutes	30,528	23.7
6 to 10 Minutes	37,670	29.3
11 to 15 Minutes	22,804	17.7
16 to 20 Minutes	13,526	10.6
21 to 30 Minutes	12,493	9.7
31 to 45 Minutes	5,470	4.3
46 to 60 Minutes	1,651	1.3
61 to 90 Minutes	1,130	0.9
91 to 120 Minutes	242	0.2
121 to 180 Minutes	243	0.2
Over 180 Minutes	2,747	2.1

For the analysis in this work, the crashes where the response time exceeded 120 minutes were not included in the analysis. Therefore, the total number of crashes used in the analysis was 125,514.

Using the crashes in the 9 time frames, the initial analysis focused understanding the crashes that required emergency response. For emergency response crashes, the main harmful event was collision with another vehicle (61 percent of the crashes) with overturn/rollover crashes being a distance second (10 percent of the crashes). The manner of crash that were most likely to require emergency response were rear-end crashes (front to rear), followed by 90 degree side impact crashes. Single vehicle crashes also had a very high likelihood to result in the need to have emergency response. As expected, the majority of crashes occurred during daytime hours when the weather was clear or cloudy, which is when the most vehicle miles of travel occur. Surprisingly, the data show that only 4 percent of the crashes had an indication of

distraction to the driver, only 7 percent indicated that the driver impaired by drugs or alcohol and just over 3 percent of crashes involved a commercial vehicle. Not surprisingly just over 70 percent of the crashes where emergency response was requested involved possibly injury, injury, incapacitating injury or fatality and most crashes occurred on higher speed facilities.

3. Ten County Analysis

The aggregate analysis of crashes and emergency response resulted in mainly typical crash numbers. To further the analysis, ten specific counties in Alabama were selected to add demographic data to enhance the analysis. The counties selected had unique population levels, median income, age distribution, and land area. The 10 counties selected were Bullock, Cherokee, Greene, Jefferson, Madison, Mobile, Perry, Shelby, Sumter and Wilcox. Table 2 shows some of the demographic data used to identify differences between the counties. The urbanized counties include Jefferson, Madison, Mobile and Shelby, each part of an urbanized area as defined by the census, while the most rural counties are Bullock, Greene, Perry and Sumter. The high income counties include Jefferson, Madison and Shelby while the low income counties include Greene, Perry and Wilcox. The largest counties by area are Mobile, Jefferson and Sumter and the smallest counties by areas are Bullock, Cherokee and Greene. Table 3 shows the percent of time required for emergency response in each county.

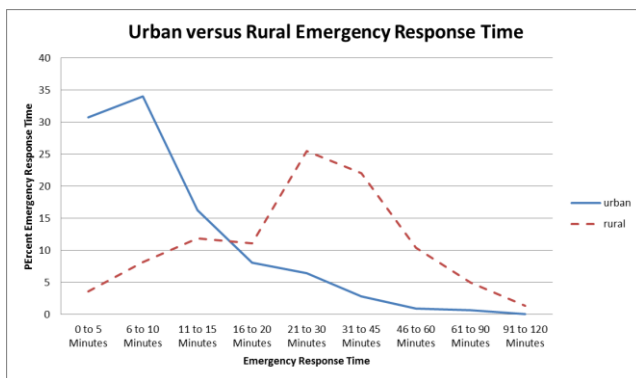
Analyzing the urbanized counties versus the rural counties, Figure 1 shows the differences in percent emergency response time for the two criteria after averaging the values for the counties in each category. From the figure, it is obvious that the response time in the urban counties greatly exceeds the response time the rural counties, with the urban counties having a maximum at 6 to 10 Minutes and the rural counties having a maximum at 21 to 30 Minutes.

Table 2. County Demographics

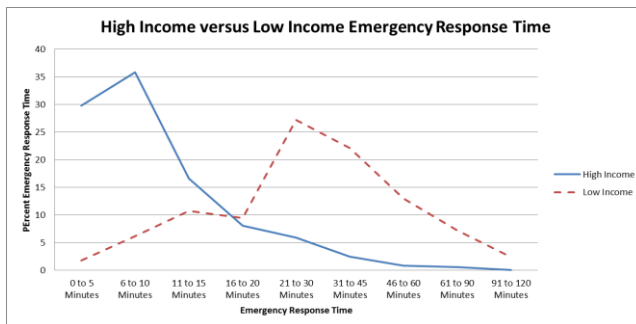
County	Population	Average Income	Percent Pop. Under 18	Percent Pop. 18-24	Percent Pop. 25-44	Percent Pop. 45-64	Percent Pop. Over 65	Median Age	Land Area (Sq. Miles)
Bullock	10,474	20,289	26.1	10.3	29.3	21.2	13.2	35	622.81
Cherokee	26,021	21,322	22.2	7.6	27.6	26.7	15.9	40	533.70
Greene	9,045	14,738	29.2	8.9	25.1	22.1	14.7	35.9	647.11
Jefferson	658,466	26,529	24.8	9.6	29.7	22.3	13.6	36	1,111.28
Madison	334,811	29,918	25.6	9.4	34.5	22.7	10.8	35.7	801.59
Mobile	412,992	21,548	27.5	10	28.7	21.9	12	34.4	1,229.44
Perry	10,591	13,433	29.8	11.1	23.6	20.7	14.9	33.3	719.66
Shelby	195,085	33,978	26.3	8.2	33.7	23.4	8.5	34.9	784.93
Sumter	13,763	14,460	29.1	12.2	25.3	19.5	13.9	32.1	903.89
Wilcox	11,670	12,573	30.7	9.1	25.5	21	13.7	33.8	888.50

Table 3. Percent Response Time for Crashes

County	Total Crashes	0 to 5 Minutes	6 to 10 Minutes	11 to 15 Minutes	16 to 20 Minutes	21 to 30 Minutes	31 to 45 Minutes	46 to 60 Minutes	61 to 90 Minutes	91 to 120 Minutes
Bullock	192	2.6	10.9	12.0	12.5	26.0	22.4	6.3	3.1	0.0
Cherokee	858	22.3	23.9	20.9	14.9	12.0	4.0	1.4	0.5	0.2
Greene	290	1.0	4.8	9.7	13.1	29.0	23.1	9.7	6.9	2.8
Jefferson	18,967	26.2	34.4	18.5	9.0	7.3	3.1	0.9	0.7	0.1
Madison	11,162	30.6	35.0	15.6	8.0	6.3	2.9	1.0	0.5	0.1
Mobile	10,552	33.8	28.7	15.3	8.3	8.0	3.7	1.3	0.8	0.1
Perry	155	1.3	5.2	10.3	5.2	29.0	21.3	18.7	7.1	1.9
Shelby	3,937	32.5	38.1	15.6	7.1	4.2	1.4	0.6	0.6	0.0
Sumter	386	9.3	11.9	15.3	13.7	17.9	21.2	7.0	2.8	0.8
Wilcox	237	3.0	8.4	12.2	10.1	23.6	21.9	10.5	7.6	2.5

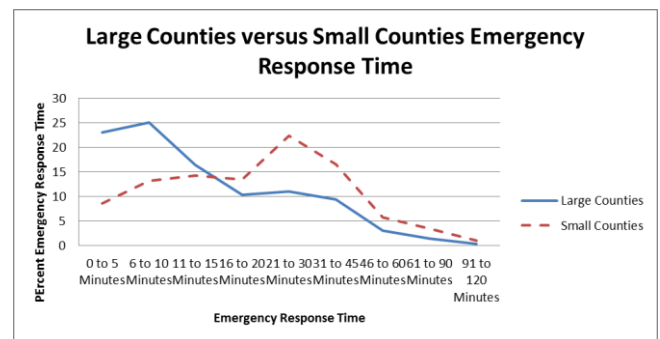
**Figure 1.** Urban versus Rural Emergency Response Time

Almost the same graph is generated when considering the income levels for the different counties, see Figure 2.

**Figure 2.** High Income versus Low Income Emergency Response Time

There is a more even graph developed for county size, see Figure 3.

Determining the average response time for emergency vehicles to arrive at crashes in the ten counties used the average time in each time frame times the total crashes in that time frame divided by the total crashes in the county – essentially a weighted average of the response time, see Table 4. The results in Table 4 clearly show that the increase in urbanization and income result in a lower average response time when responding to crashes with the urban high income counties averaging 10.3 minutes and the rural low income counties averaging 33.5 minutes.

**Figure 3.** Large County versus Small County Income Emergency Response Time**Table 4.** Mean Response Time

County	Mean Response Time (Minutes)	Rural vs. Urban	Income
Bullock	25.2	Rural	
Cherokee	13.4		
Greene	33.1	Rural	Low
Jefferson	11.3	Urban	High
Madison	10.4	Urban	High
Mobile	11.2	Urban	
Perry	35.2	Rural	Low
Shelby	9.2	Urban	High
Sumter	24.6		
Wilcox	32.2	Rural	Low

4. Conclusions

Results clearly illustrate that the lower income, rural counties have a higher average response time than the higher income, urban counties. Considering roadways in rural counties tend to be higher speed as a percent of total miles and the demographic in rural counties tend to have a slightly higher percent of the population aged 65 or older, the delay in emergency response is very important as traffic crashes in rural area have a greater likelihood of involving elderly drivers traveling at high speeds, which will lead to increased

severity and a greater need for emergency services. Additionally, as the demographic in rural areas will continue to be an increase in elderly drivers, this problem is only going to worsen in the future.

Overall, while this analysis is limited, the results are important for agencies to understand the difficulty in providing shorter emergency response time in rural areas. A possible result of this paper could possibly be new measures leading to a better understanding of the placement of emergency response vehicles in rural counties to reduce the travel time to crashes. Additionally, the access to rural hospitals, especially those with trauma centers, while not addressed in this work can be another important consideration in developing infrastructure to better support rural counties. The improvement of response time in the future has the potential to reduce health care costs in rural areas and improve quality of life for those unfortunate enough to be involved in a serious traffic crash.

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