Senior Fatal Crashes IMPACT Special Study

Senior Fatal Crashes (SFCs) vs Senior Non-Fatal Crashes (SNFCs)

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0.0 Introduction

In this study, the word *Senior* will mean *Senior Causal Driver*, where the age of a senior driver is defined for this study to be 66 years and above. Over the five years of data (CY2018-2022) used in this study, there were 108,409 senior-caused motor vehicle crashes. These resulted in the following crash severities:

Relative Severity of Senior Caused Crashes

Severity	Senior	Non-Senior	Totals	Percent Senior Crashes
Fatal Injury	507	3,865	4,372	11.60%
Suspected Serious Injury	1,900	18,383	20,283	9.37%
Suspected Minor Injury	5,937	54,363	60,300	9.85%
Possible Injury	6,283	57,889	64,172	9.79%
Property Damage Only	52,723	589,022	581,745	9.06%
Unknown	1,600	17,823	19,423	8.24%
TOTALS	68,950	681,345	750,295	9.19%

The purpose of this report is to provide information by which the total number of Senior Fatal Crashes (SFCs) may be reduced, and to reduce the severity of the *potential* SFCs that will occur so that fewer of them result in fatalities. The primary analytical technique employed to generate most of the displays for this purpose (in Sections 4-8) is a component within the Critical Analysis Reporting Environment (CARE) called Information Mining Performance Analysis Control Technique (IMPACT). For a detailed description of the meaning of each element of the IMPACT outputs, please see: http://www.caps.ua.edu/software/care/

Sections 4 through 8 present the results of a number of IMPACT evaluations of Senior Fatal Crashes (SFCs) compared to Senior Non-Fatal Crashes (SNFCs) over a recent five-year period (CY2018-2022). The purpose of these comparisons is to determine the causes of fatal crashes that might distinguish those that involve Senior Fatal Crashes (SFCs) from Senior Non-Fatal Crashes (SNFCs). This is different from many of the other CARE Special Studies that have been performed, which had the goals of reducing all of a particular type of crash regardless of severity, not concentrating on those that were fatal.

IMPACT works by surfacing "over-representations." An *over-represented* attribute is found in this study when that attribute has a greater share of Senior Fatal Crashes (SFCs) than would be expected if its proportion were the same as that for Senior Non-Fatal Crashes (SNFCs). That is, the SNFC crashes are serving as a *control* to which the SFCs are being compared to determine over-representations, which could typically indicate causes.

As a first example, over the five years of the crash data studied (CY2018-2022), we found that SFCs for the Highway Classification attribute value of "County" roads had 24.65% of the fatal crashes (SFCs), which was a significantly higher proportion of crashes than did the Senior Non-Fatal Crashes (SNFCs) on County roads, which was 12.07% (details in Section 2.3). The Odds Ratio was 2.043*, where the * indicates that the difference in the proportions is statistically significant, and the red background indicates that it was over twice that expected (what we will generally call *highly* significant). The Odds Ratios are calculated from the corresponding proportions, which for this example were 24.66% for SFCs and 12.07% for SNFCs (e.g., 24.66/12.07=2.043). When such differences are statistically significant (as in this case), this is evidence that this attribute should be given additional attention, and in some cases, further analyses are performed to obtain information for *countermeasure* development. For example, additional *selective enforcement* for SFCs (e.g., excessive speed, seatbelts, and Impaired Driving) might concentrate more on County roads than they have in the past.

Unless otherwise stated, the items within the tables given above the charts in the IMPACT displays are ordered by *Max Gain*. *Max Gain* is the improvement by SFC reduction that could be obtained if a countermeasure were applied to reduce the proportion of the Senior Fatal Crashes (SFCs) to the proportion of Senior Non-Fatal Crashes (SNFCs) for the particular attribute under consideration. In the Highway Classification example given above, this would reduce the 24.65% to 12.07%, which would produce the gain of a reduction of 69.894 fatal crashes. (For the complete IMPACT display see Section 2.3). This potential reduction in fatal crashes is called Max Gain because it is generally the maximum gain that could be expected by implementation of the most effective countermeasures. The Max Gain for each attribute value can be seen in the extreme right column of the IMPACT display tables.

This report continues with three sections that provide a high-level summary of the IMPACT results and a more detailed explanation of their specifics. These are called: (1.0) Summary of Findings and Recommendations, (2.0) Filter and IMPACT Set-ups, and (3.0) Senior Fatal Crash Comparison by Year. Section 2.3, as introduced above, is also introductory in that it provides more details for the IMPACT example given above (for the Highway Classifications).

Section 3 is another IMPACT comparison (this one for the year attribute) between fatal and non-fatal Senior crashes (SFCs vs SNFCs). It provides a high level view of how these two factors are increasing/decreasing each year in comparison to one another. After Section 3, the IMPACT comparisons between SFCs and SNFCs are presented, for selected most relevant attributes, under the following headings, given here with their section numbers:

- 4.0 Geographic and Harmful Event Factors,
- 5.0 Time Factors,
- 6.0 Factors Affecting Severity,
- 7.0 Driver and Vehicle Demographics, and
- 8.0 Driver Behavior.

See the Table of Contents above for a guide to sections of interest.

1.0 Summary of Findings and Recommendations

This section comes immediately after the Introduction in this report for two reasons: (1) for those who do not have time to go through all of the IMPACT analyses, and/or (2) as an introduction to the more detailed IMPACT studies. These summaries are referenced to the more detailed analyses so that any questions regarding their sources can be accessed easily. The following section numbers: (1.1), (1.2), and (1.3), are omitted in this section to maintain consistency with the numbering of the analytical sections (Sections 4-8).

There will be an additional analytical section (9) that will compare the Youth results with the Senior results in order to demonstrate the role of risk taking and risk avoidance in distinguishing between the causes of Youth and Senior fatal crashes. This same identical summary section appears in both the Youth Fatal crashes analysis and the Senior Fatal crashes Special Reports..

Findings and recommendations are organized into the areas of: (1.4) Geographical Factors, (1.5) Time Factors, (1.6) Severity Factors, (1.7) Driver and Vehicle Demographics, (1.8) Driver Behavior. The ordering of these recommendations, either generally or within their respective categories, is not meant to imply priority. However, the detailed information given should be quite useful in the further prioritization and allocation of traffic safety resources. This process of optimization should consider balancing costs of all of the recommendations, which can be validated against the information presented in the IMPACT Sections 4.0-8.0 (source section references for these summaries are given in this section in parenthesis). For a special report on traffic safety resource optimization, please see:
http://www.safehomealabama.gov/wp-content/uploads/2019/03/Traffic-Safety-Innov-2017-04.pdf

Terminology: *Expected proportions* (AKA *expectations*) of the SFCs are obtained from the comparison of their proportions with the proportions for their corresponding SNFC control classifications. The IMPACT analyses in this study enables the determination of over-representations in either the SFCs or the SNFCs, which would be an under-representation of the SFCs,

Note: subsection numbers 1.1, 1.2 and 1.3 have been omitted below in order to keep the subsection numbering system in this Section consistent with that of the IMPACT displays that follow. Findings are from the IMPACT analyses in Sections 4-8 that compare SFCs vs SNFCs over the five years of the study (CY2018-2022). Recommendations for each of the findings are given in the bullet list below:

- **1.4 Geographical Factors (4.0)**
  - County (4.1, C001) - Generally, the over-represented fatal crashes in counties are rural with (or near) large population centers. The large population centers

increase the traffic and thus the crashes, while being rural generally make a larger proportion of these crashes fatal. Placed in Max Gain order, the six SFC-over-represented counties with the highest Max Gain – potential for fatality reductions – are (with their frequencies): Limestone 16, Morgan 21, Cherokee 9, Jackson 10, Covington 8, and Winston 6. (Note that the ordering by Max Gain often does not match the ordering by frequency.) The SNFC-over-represented counties with the highest potential for fatality reduction with their fatal crash frequencies are: Jefferson 36, Baldwin 9, Mobile 35, Shelby 9, Madison 26, and Montgomery 18. It is recommended that these and the over-represented counties be given special attention for both fatality and crash reduction. Generally, the countermeasures recommended to be applied to specific geographical areas, to be determined by hotspot analysis, are selective enforcement for Speed, Seatbelts, and Impaired Driving, since these three violations have the highest fatal crash causation. Other driver faults are given in Section 8.

- City (4.2, C002) -- Comparisons of SFCs to SNFCs view rural areas of counties as separate "virtual cities." There is little surprise in the number of rural areas in this output. In Section 4.2, City (and rural virtual city) comparisons are presented in the IMPACT table for all areas that had Max Gains greater than 4.5. The top 6 SFC-over-represented Cities are: Rural Limestone 13, Rural Montgomery 12, Rural Morgan 10, Rural Madison 14, Rural Etowah 9, and Rural Mobile 12. The top six SNFC-over-represented Cities with their expected fatal crash numbers are: Birmingham 8, Montgomery 6, Mobile 17, Huntsville 11, Dothan 3, and Tuscaloosa 7. It is recommended that the cities with a high frequencies of fatal crashes be given special guidance, and perhaps additional funding, along with the most over-represented cities. Many such large city areas have a considerable amount of Open Country that tends to increase their fatality count, as will be discussed in the Locale attribute in Section 4.4.
- Rural/Urban (4.3, C010) Senior Fatal Crash (SFC) Proportion – SFCs occurred in 57.79% Rural and 42.21% Urban areas. This attribute is determined by the city limits boundaries as opposed to the speed limits or other environmental factors (see Locale immediately below). For SNFCs, these proportions came out to be 20.00% Rural and 80.00% Urban. Concentration for fatality reduction is recommended in Rural areas where hotspot analyses determines that there are concentrations of fatal crashes. Recommendations to reduce fatalities within any of these areas include:
    - Implement a larger police presence in the more critical areas,
    - Lower the speed limits in frequent crash areas, and
    - Add special speed yellow warning signs in speed-vulnerable areas. This is especially effective for older drivers since they avoid risks.

Anyone wishing analysis of different additional cities, counties, or other areas, please contact CAPS – email brown@cs.ua.edu.

- Locale (4.4, C033) – Open Country shows a high level of over-representation in the SFCs (326, 64.30%). Those countermeasures recommended for rural areas would be applicable to Open Country areas within city limits, which are literally equivalent to rural areas, as illustrated in the next display in Section 4.5. While their proportions were not over-represented, the following had very high frequencies: Shopping or Business 105, and Residential 65.
- Cross-tabulation of Locale (4.5, C033) by Rural/Urban (C010) for SFCs (fatal crashes). The largest number of fatalities were in the Rural, Open Country specifications, with 266 SFCs. This illustrates that the Locale attribute is more definitive in specifying the surrounding areas of potential crashes than is the Rural/Urban attribute. The recommendations given above for rural areas apply equally to Open Country Locales.
- Highway Classifications (4.6, C011) – in order of Max Gains, the largest was County 125, followed by State 158, Federal 110, and Interstate 40, which was under-represented. These results are closely related to the number of Fatal Crashes per mile on the respective Highway Classifications, which closely reflect the traffic volume.
- Most Harmful Event (4.7, C019) – ordered by Max Gain. The following items had the largest number of fatality occurrences (listed in Max Gain order with their fatal crash frequencies):

SENIOR FATAL CRASH (SFC)	**FREQUENCY**
Overturn/Rollover	53
Collision with Tree	51
Collision with Non-Motorist: Pedestrian	8
Collision with Culvert Headwall	7
Collision with Embankment	6
Collision with Ditch	13

  Recommendations to reduce the various most harmful events need to be quite broad to cover all of the various types of crashes listed. For more information on this, see the Driver Behavior recommendations in Sections 8.1-8.4.
- Roadway Curvature and Grade (4.8, C407). The following items were the most significantly over-represented (given with frequencies):

Senior Fatal Crashes (SFCs)	**FREQUENCY**
Curve Left and Level	33
Straight with Down Grade	56
Curve Left and Downgrade	19
Curve Right and Level	23
Curve Right and Down Grade	16
Curve Left and Upgrade	13

Recommendations include selective enforcement and speed-limit-reduction (e.g., advisory speed and curve warning signs) concentrating on all of the curve types given above. The application of Advisory Speed Limits for Curves might be improved by considering the recent release of GDOT_16-31 (trb.org) entitled: *An Enhanced Network-Level Curve Safety Assessment and Monitoring Using Mobile Devices*; GDOT_16-31 (trb.org). This report appears at:

http://www.safehomealbama.gov/tag/road-improvements

Other engineering recommendations should evaluate crashes at curves based on hotspot analyses, especially those curves with grades.

- **1.5 Time Factors (5.0)**
  - Year (5.1, C003) – Variations in proportions between the SFCs and the SNFCs were not found to be significant in 2018-2022, but SFCs were significantly over-represented in 2022. While under-represented in 2019 through 2021, they became over-represented in years 2022. The reason for this increased SFC proportion is not definitive, but this increase should be watched to determine the cause in future years. The reason for this increased SFC proportion is not definitive, but it is recommended that this be watched to determine a cause in future years, since this might be an early indication that the proportions of Senior Fatal Crashes (SFCs) per year are increasing over time.
  - Month (5.2, C004) – The proportions of SFCs and SNFCs correlated with each other closely in all months (no significant over-representations found). January, May, July, and October all had positive Odds Ratios. May and October were the highest, and it is recommended that they be given special selective enforcement concentration, with specific Senior locations determined by hotspot analyses.
  - Day of the Week (2.3, 5.7 C006) – Sunday had the highest significant over-representation, with Saturday following with a lower Odds Ratio that was not statistically significant. The over-representations on Saturday and Sunday would give some indication of Impaired Driving (Alcohol and/or Non-Alcohol Drugs) being involved, and the low sample sizes for the SFCs could account for the absence of significance for other days. It will be shown in Sections 8.3 and 8.4 the degree that ID accounts for some of the higher proportions of weekend fatal crashes. This being the case, it is recommended that the countermeasures for ID be emphasized in the times and places indicated by hotspot analysis. See Sections 8.3 and 8.4 for further ID analyses.
  - Time of Day (5.5-5.6, C008) – In *Natural Time Order*. In addition to Impaired Driving (ID), some of the late-night crashes are due to drowsiness causing, among other things, a diminished ability to see road edge lines. The ID

recommendations apply particularly to these over-represented times. See Sections 5.6- 5.7 next for more on time of day implications.

- Time of Day by Day of the Week (5.6-5.7, C008 x C006) – *For all Senior fatal crashes.* This quantifies the extent of the fatal crash concentrations do not appear as they would if Impaired Driving (DUI alcohol and/or drugs), which would typically be on Friday nights, early Saturday mornings and nights, and Sunday mornings. Recommendations here are to adjust the selective enforcement times to the days of the week and times of day using this cross-tabulation along with hotpot analysis. See further discussion of these findings in Section 5.6.

- **1.6 Factors Affecting Severity (6.0)**
  - Severity for All Highway Classifications (6.1, C025, C011) – This cross-tabulation was performed for <u>*all Senior crash records*</u> so that the various severities on the different Highway Classifications could be seen. Note the high fatal over-representations on Federal, State and County roads. For Senior fatality reduction, the enforcement priority is recommended on the State, Federal and County roads. If drivers have the option, this chart could be helpful in assisting them in choosing the safest routes for their trips.
  - Speed at Impact (6.2, C224) – Impact speeds below 21 MPH are generally over-represented for SNFCs. SNFCs are over-represented at slower impact speeds, and the low sample sizes for the SFCs at these speeds prevented their statistical tests for these speeds. Above 40 MPH, it becomes clear that fatal crash probability is increasing exponentially with speed. Several analyses over the past decade have found the general rule of thumb that for every 10 MPH increase in impact speeds, the probability of the crash being fatal doubles. Thus, the reduction in just 5-10 MPH impact speed will have a major reduction in fatalities. This was validated in the discussion below of the cross-tabulation of impact speeds by severity (Section 6.4). The recommendation here is to perform selective enforcement along with the various PI&E programs that go with it – in other words, use whatever resources are available to bring about an overall speed reduction, and especially those speeds that are violating speed laws. At the same time, additional enforcement is essential to eliminate the other dangerous driver behaviors, which are discussed in Section 8.
  - Crash Severity (C025) by Impact Speed (6.3, C224). <u>*for all Senior crashes.*</u> This cross-tabulation gives an idea of the risks involved with increased speed on all highway classifications. The red backgrounds in the first column (Fatal Injury) indicates those speeds that had a significantly higher number of fatal crashes. This is further discussed in the next section.

- Discussion of severity by Impact Speed (6.4. C025, C244). The speed to death relationship was further validated in the discussion of this cross-tabulation. This topic is given elaboration in Section 6.4, which is a discussion of the Probability of Being Killed crossed by Speed at Impact. The recommendation here is that the information of Section 6.4 be an essential part of the training in all traffic safety educational programs, and especially those involving younger drivers. Emphasize: to save lives, slow down to the speed limit and have all passengers fasten their seat belts. The rule of thumb is that each additional 10 MPH of speed doubles the probability of the crash being a fatality.
- Restraint Use by Drivers in Senior Collisions (6.5, C323) – The proportion of failure to use proper restraints is 28.40% for Senior Fatal Crashes. The Odds Ratio is a large 16.712, showing that their failure to use restraints is close to 17 times that of the Non-Fatal Senior crashes. Shoulder and Lap Bel Used is over-represented by SNFCs in about double (Odds Ratio 1/0.650 = 1.54 times the expected use in comparison to Fatal Senior Crash (SFC) seatbelt usage. Clearly, being unrestrained contributes heavily to chances of a senior crash resulting in death. Restraint use programs have been quite successful in Alabama. It is recommended that the financial support to these programs be increased to assure that their effectiveness will continue. In particular, special concentration needs to be given to convince all drivers of their additional vulnerability, and how severity might be abated by seatbelts when crashes occur. The probability of a crash causing death is 1 in 8.6 crashes when restraints are not used – it is 1 in 68.8 crashes when using restraints. So the chances of death are 8 times greater when not restrained. See Section 6.6 for more information on the effectiveness of restraints.
- Cross-tabulation: Crash Severity (6.6, C025) by Restraint Use (C323) for All Injury Crashes. A comparison of the probability of a fatal crash indicates that a fatality in an injury crash is 8.0 times more likely if the involved occupants are not using proper restraints (see text under the cross-tabulation in Section 6.6). This multiplier would increase as speeds of impact increase. Because current restraint-use programs are quite effective, consideration should be given to increase their funding to make them even more universally effective. Restraint effectiveness information should be part of all traffic safety educational programs, and consideration should be given to increasing the fines of having unrestrained passengers.
- Number of Vehicles Involved (6.7, C052) – The number of vehicles involved ranged from one to four, but the large majority were either one- or two-vehicle crashes. The 3- and 4-vehicle Odds Ratios indicate that generally, the more vehicles involved, the greater the probability that the crash is a fatality. However, single-vehicle crashes had the most proportion and frequency of fatal crashes.

We know of no way for drivers to control how many vehicles will be involved, and so no recommendations are being made for this attribute. Avoiding a 2-car crash also avoids all other higher number vehicles being involved.

- Police Arrival Delay (6.8, C036) – Police response times to SFCs were less than 21 minutes in 55.86% of the SFC police runs. There can be little doubt that the longer delay times has to do with the proportion of these crashes that were located in rural areas (see C033) and at night. The shorter police responses would generally be expected in those responses to crashes in the urban areas. Recommended is that PI&E programs stress the need to call first responders without delay.
- EMS Arrival Delay (6.9, C039) – Probably because of (1) the severity of the crashes (all being fatal for the test column), (2) the swiftness/urgency in getting called, and (3) the urgency in getting to the scene, much shorter delay times were recorded than that of the police delays. Generally, we can conclude that very few of the fatalities were caused by excessive EMS delays, since the SFC frequencies drop off rapidly after 30 minutes. It is recognized that first responders are currently doing an excellent job in getting to the scene of the crash as quickly as possible without jeopardizing safety. Delays, if any, are usually caused by a failure to report the crash immediately. Recommendation: PI&E programs should promote quicker notification to EMS and law enforcement.

- **1.7 Driver and Vehicle Demographics (7.0)**
  - Driver Raw Age (7.1, C107) – All Senior drivers are aged 16-20. This comparison of SFC causal driver age with those of the SNFCs looks at the specific ages. None of these ages were significantly different for the two subsets. Both show increases in over-representation with age, which is probably highly correlated with miles driven and survivability.
  - Crash Driver Gender (7.2, C109) – the breakdown in SFC causal drivers is 69.63% male and 30.37% female. For SNFC cashes, the percentage is 55.83% male and 43.80 female, which is probably more reflective of their driving times. These gender differences certainly indicate that males are a greater cause of the fatalities in Senior Crashes (as they are in most crash types), and the recommendation is that, if countermeasures can be developed specifically for male fatal crashes, this would be much more cost-effective than those directed equally toward all drivers.
  - Cross-tabulation of Driver Gender (7.2, C109) by Speed at Impact (7.3, C224) for *<u>All Senior Fatal Crashes</u>*. To get better insight into the reason for male drivers causing more fatal crashes, this analysis shows that males had impact speeds in excess of the 60 MPH is 55 for Senior Fatal crashes, while the female number for

comparable speeds was 10. Thus, all of the recommendations for speed reduction apply much more to males than to females, especially in this age range.

- Causal Unit (Vehicle) Type (7.4, C101) – This result was based on a comparison of SFC Causal Unit Type against the same for SNFCs. The highest over-representations for SFCs were Pick-Ups 146, Motorcycles 33, and Mini-vans 28. The proportion of Sport Utility Vehicles (19.53%, 99) and Passenger Cars (35.90%, 182) resulted in their placement at the bottom of the list, indicating that they were under-represented in SFCs despite their high frequency numbers (reason: their SNFC proportions were even greater). It is recommended that countermeasure programs that are currently in effect be continued and augmented to emphasize the special issues that the vehicle types noted above have in Senior fatal crashes.
- Number of Pedestrians (7.5, C057) – Single pedestrian SFC pedestrian crashes occur at a proportion 1.38%. which is 4.313 times greater than their Senior Non-Fatal proportion. See the reference at the end of this blurb for a study that concentrated on pedestrians. Both ID (Impaired Driving) and Impaired Walking, contribute to pedestrian collisions, as well as pedestrians not taking the maximum means for being seen at all times, but especially at night. Wearing reflective clothing, and keeping a flashlight lit at night to be seen of vehicle drivers are two of the most important recommendations since lack of visibility was cited for several pedestrian fatal crashes. Both day and night visibility needs to be emphasized in the lower school grades and continued through the young adult years. Pedestrian training needs to be increased to include the advantages of walking against traffic, wearing of reflective clothing at night, and all the other rules for pedestrian safety, including a strong prohibition of walking while intoxicated with either alcohol or other drugs. Additional pedestrian recommendations are in: http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf
- Driver License Status (7.6, C114) – Only 16 were Suspended, Revoked or Expired, which is not enough to draw any conclusions other than that no inferences can be made of this attribute.
- Driver Employment Status (7.7, C120) – No conclusions can be drawn from these results in that it would seem that in most cases, the driver's age itself accounts for their being in the various categories.

- **1.8 Driver Behavior (8.0)**
  - Primary Contributing Circumstances – PCC (8.1 and 8.2, C015) Driver behaviors that are concurrent with Senior Fatal Crashes might provide ideas for countermeasure development. Those behaviors that were most highly over-represented in SFCs are given below with their SFC and SNFC percentages:

SFCs PCC Overrepresented/Freq	**SFC%**	**SNFC%**
Failed to Yield ROW from Stop 77	19.20%*	12.35%
Ran off Road 36	8.98%**	2.87%
Crossed Centerline 33	8.23%**	2.13%
DUI 20	4.99%**	1.22%
Traveling Wrong Way/Side 16	3.99%	0.65%
Over Speed Limit 13	3.24%	0.47%
Ran Stop Sign 16	3.99%	1.51%
Over Correcting/Over Steering 12	2.99%	1.27%
Driving too Fast for Conditions 14	3.49%	1.98%
Failed to Yield ROW-Left or U 45	11.22%	9.81%

* Statistically significant difference

** Highly significant difference (more than 10%)

It is recommended that special consideration in training and enforcement be given to the issues above. Other information for DUI is given in Sections 8.3 and 8.4.

Risk-Taking. It is important to recognize that this age group (and especially seen in males) is quite susceptible to the tendency of risk-taking. This is partially caused because the part of thei brains that has a realistic perception of the consequences of risk-taking is not developed until age 25 for most people. It is recommended that the detailed study of risk-taking be given special consideration; this was conducted and is available at:

http://www.safehomealabama.gov/wp-content/uploads/2019/10/Senior-Risk-Taking-Analysis-v08.pdf

Recommendations are given in the categories of: family, schools, peer groups, legislation and law enforcement, and the Traffic Safety Community. More information is given on this in Section 9, which compares the results above with those of Youth Fatal Crashes.

- CU Officer's Opinion Impaired Driving – CU Officer's Opinion Impaired Driving – Alcohol (8.3-8.4, C122-C123). We saw some evidence for fatal crashes being caused by Impaired Driving (ID) in the time of day and day of the week attributes. The two ID attributes (alcohol, C122. and non-alcohol drugs, C123) indicate the degree that ID was involved in Senior Fatal Crashes (SFCs). For alcohol, the proportion of ID fatal crashes was 8.71 times the non-alcohol fatality probability. For drugs this number was 12.53 times as many in crashes that were fatal (SFCs). It is quite clear that both ID types dramatically increase the probability of the crash resulting in a fatality. For alcohol, the ID multiplier is 8.71 times the probability that the crash will result in a fatality. For non-alcohol drugs, the multiplier is even worse, at 12.53 times as many. The traffic safety community has long since described the problem as be a combination of inexperieced drivers and inexperienced drinkers, to which we can now add inexperienced drug users.

  Recommended countermeasures to reduce both ID types are:

  - Perform additional ID enforcement at locations determined by Senior hotspot analysis as well as general ID hotspot analysis.

- Mandate breath-alcohol ignition interlock devices for all convicted of alcohol ID.
- Perform an in-depth study to determine if problems exist within the current programs, e.g., how the use of interlock devices can be expanded to be made more generally effective.
- Since the presence of drugs/alcohol often do not reach the reporting threshold, especially in cases involving prescription drugs, continue officer training to produce more accurate reporting, especially for non-alcohol drugs.
- Drug/Alcohol Diversion Programs should continue (or new programs adopted) that concentrate on keeping the age 25 through 35 (typically *social users*) from becoming habitual to the point where they become part of the 36-55-year-old over-representation of predominantly *problem users* (see 7.1 for driver ages).
- Combinations of recreational or medical drugs and alcohol can be particularly lethal, and medical practitioners should warn against such problems and discourage all alcohol and additional drug use for their patients who have indicated either of these combinations, or who are taking other prescription drugs.
- Provide additional publicity on the fact that legalized recreational drugs are not a good alternative to alcohol use. The advertising as such should be outlawed. PI&E programs should take the opposite approach to warn drivers that legalization does not relax their responsibilities.

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http://www.safehomealabama.gov/wp-content/uploads/2019/10/Senior-Risk-Taking-Analysis-v08.pdf
Recommendations are given in the categories of: family, schools, peer groups, legislation and law enforcement, and the Traffic Safety Community. More information on this in **Section 9**, which compares the results above with those of Youth Fatal Crashes.

2.0 Filter and IMPACT Set-ups

Generally, the analyses performed in this study used IMPACT (See Section 2.1) to compare attributes of Senior Fatal Crashes (SFCs) against the same attributes of Senior Non-Fatal Crashes (SNFCs) over a 5-year time period (FY2018-2022). The objective was to determine all significant differences between key attributes within these two subsets of data in order to get an improved understanding as to the fatality crash causes (i.e., who, what, where, when, how, causal driver demographics, etc.). This is accomplished by pinpointing common factors that could be used to address any major inconsistencies between these two subsets of crash data. The findings that are presented should be taken into consideration when optimizing the large variety of countermeasures that exist to reduce both crash frequency and severity for SFCs.

Sections 2 and 3 of this report contain information that will be useful in obtaining a high level orientation toward the IMPACT results that follow (in Sections 4 through 8). This introduction will consist of: (2.1) Introduction to IMPACT, (2.2) Definitions of Filters Used, (2.3) Example IMPACT: Year comparison, and (3.0) Annual Fatal Crashes by Severity. Section 3 presents another IMPACT example for purposes of further orientation.

2.1 Introduction to IMPACT

The findings of Sections 4.0-8.0 are in displays of comparisons for the various attributes that might have an influence on crashes, and especially fatal crashes, countermeasure development. The CARE analytical technique employed to generate these comparisons is called Information Mining Performance Analysis Control Technique (IMPACT). Unless otherwise indicated in the IMPACT "Order" box, the outputs will be listed in the order of highest *Max Gain* first. (Exception: Time attributes are often in their Natural Ordering.) *Max Gain* is the number of crashes that would be reduced if the respective attribute proportion was not over-represented (i.e., had an Odds Ratio of 1.000). An *over-represented* value of an attribute is a situation found where that attribute has a greater share (proportion) of crashes in SFCs than would be expected from that given in the SNFCs. Similarly, an *under-represented* value of an attribute is a situation found where that attribute has a smaller share of crashes than what would be expected. Please notice that *expectations* involve a comparison of proportions, not frequencies.

IMPACT will display comparisons of SFCs against their SNFC counterparts. In summary, the SNFC Crashes are serving as a control to which the SFCs are being compared. In this way any inconsistencies related to the SFCs surfaces, and this can be subjected to further analyses. For a detailed description of the meaning of each element of the IMPACT outputs, see:

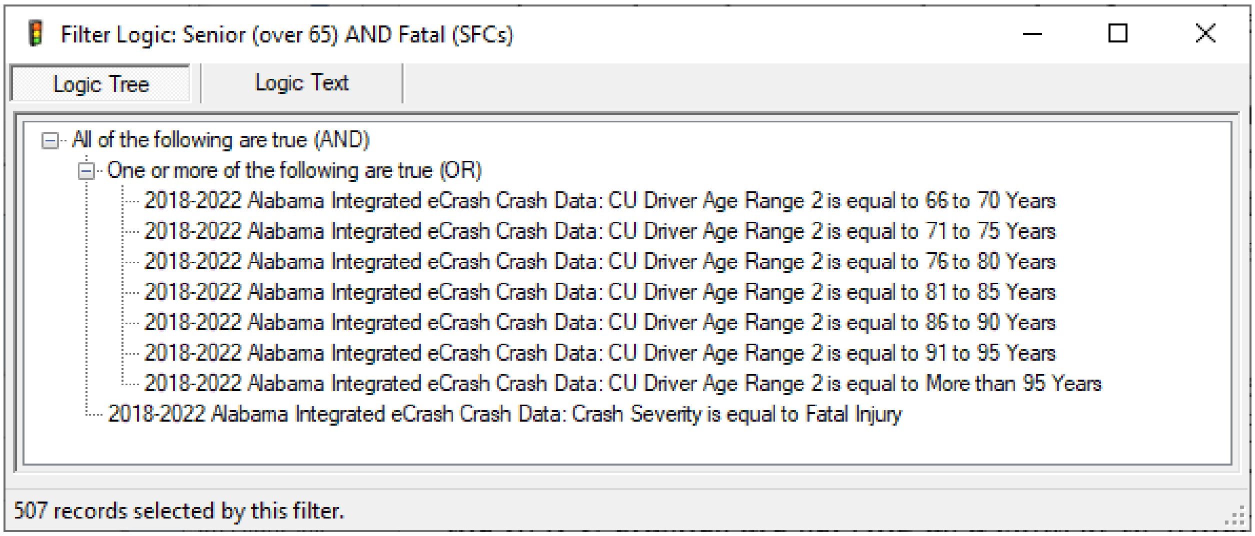
http://www.caps.ua.edu/software/care/

The IMPACT analses are grouped as follow in each of their Sections: 4. Geographical and Harmful Events, 5. Time, 6. Severity, 7. Demographics, and 8. Driver Behavior.

2.2 Filter Definitions for the SFC IMPACT Analyses

The IMPACT analyses will compare Senior Fatal Crashes (SFCs) vs Senior Non-Fatal Crashes (SNFCs). The standard filter for all fatal crashes based on C025 Crash Severity was applied, and separate filters for the SFC and SNFC subsets were obtained, where the formal definitions for these two filters are given below.

Formal Definition of Senior Fatal Crashes (SFCs)

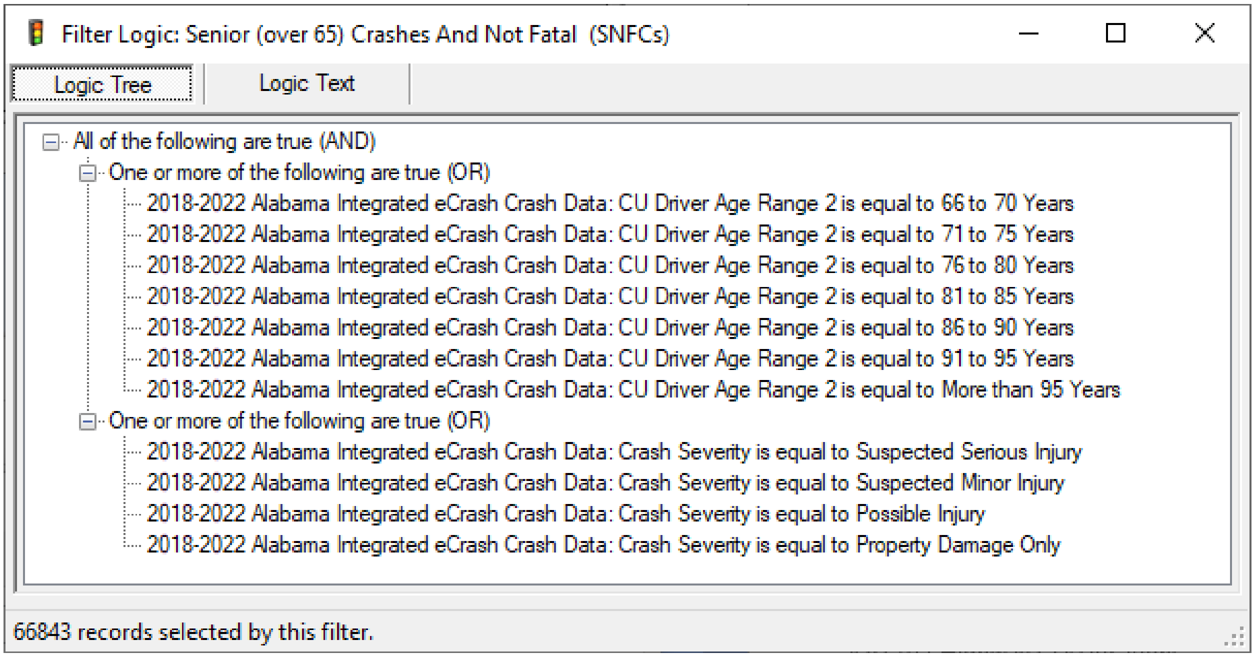


In plain English, the above indicates that all of the *test* crashes (SFCs) to be compared by IMPACT have the following characteristics:

1. They must all be fatal crashes; and
2. They must all be caused by drivers 66 and above years of age.

507 Crashes Qualified as SFCs for FY2018-2022

Formal Definition of Senior Non-Fatal Crashes (SNFCs)



In plain English, the above indicates that all of the *control* (Other) crashes to be compared by IMPACT have the following characteristics:

1. They must all be non-fatal *injury* or Property Damage Only (PDO) crashes; and
2. They must all be caused by drivers in the 66 and above age range.

66,843 Crashes Qualified as SNFCs in FY2018-2022.

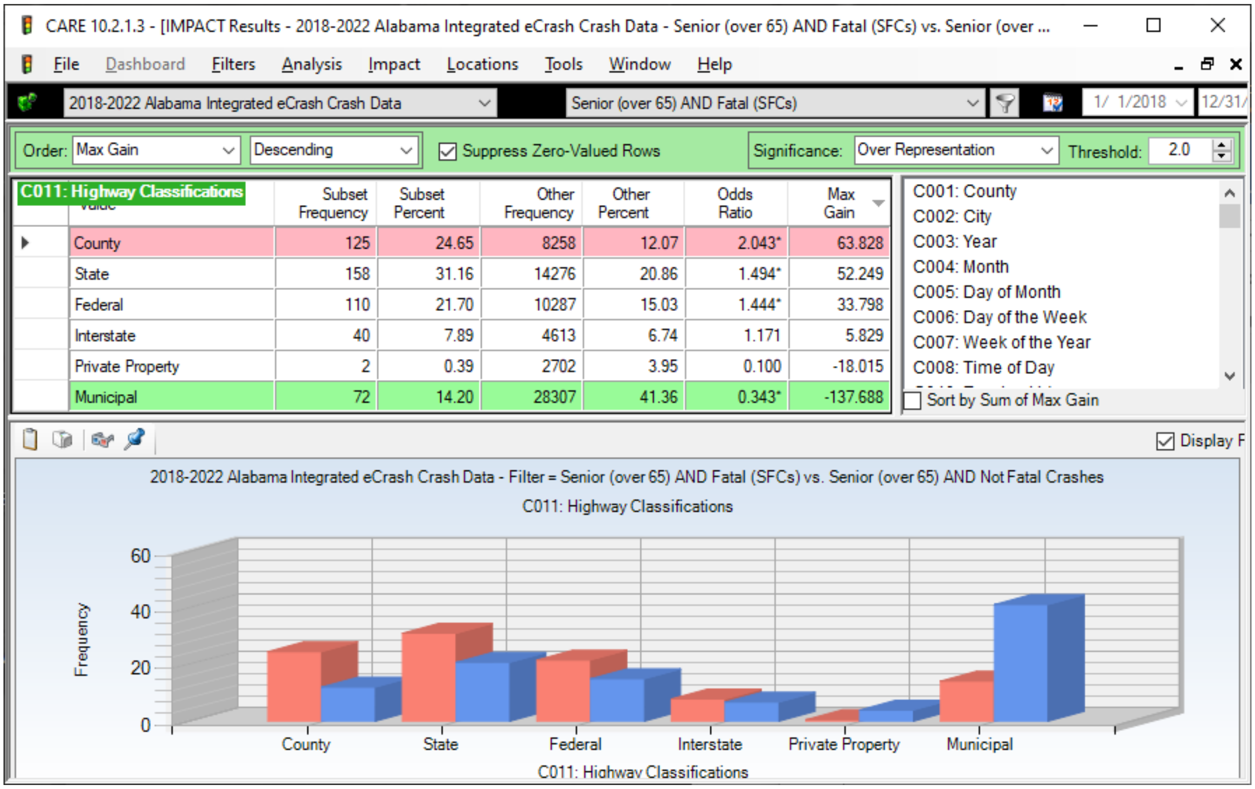
The IMPACT analyses in Section 4 through 8 below will compare the 507 SFCs with the corresponding attributes of the 66,843 SNFCs in order to pinpoint the attribute values that are most likely to be causing death in Senior-caused crashes.

The following provide reasons for selecting SFCs as the *test subset* and SNFCs as the *control subset* (called "Other" in the IMPACTs):

- To determine what causes fatal crashes, the fatal crashes have to be compared against similar non-fatal crashes; to accomplish this:
- The test subset was all Senior Fatal Crashes (SFCs), and
- The control subset was all Senior Non-Fatal Crashes (SNFCs).

Note the filter of the IMPACT analyses two *subset* columns in Sections 4 through 8 are SFCs (column labeled "Subset"), and the comparative, called "Other Subsets" (also called the *control* subsets) are SNFCs.

2.3 Highway Classification (4.6, C011); Comparison of SFCs and SNFCs



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
County	125	24.65	8258	12.07	2.043*	63.828
State	158	31.16	14276	20.86	1.494*	52.249
Federal	110	21.70	10287	15.03	1.444*	33.798
Interstate	40	7.89	4613	6.74	1.171	5.829
Private Property	2	0.39	2702	3.95	0.100	-18.015
Municipal	72	14.20	28307	41.36	0.343*	-137.688

Reminder: Senior Fatal Crashes (SFCs) = **Red bars**;

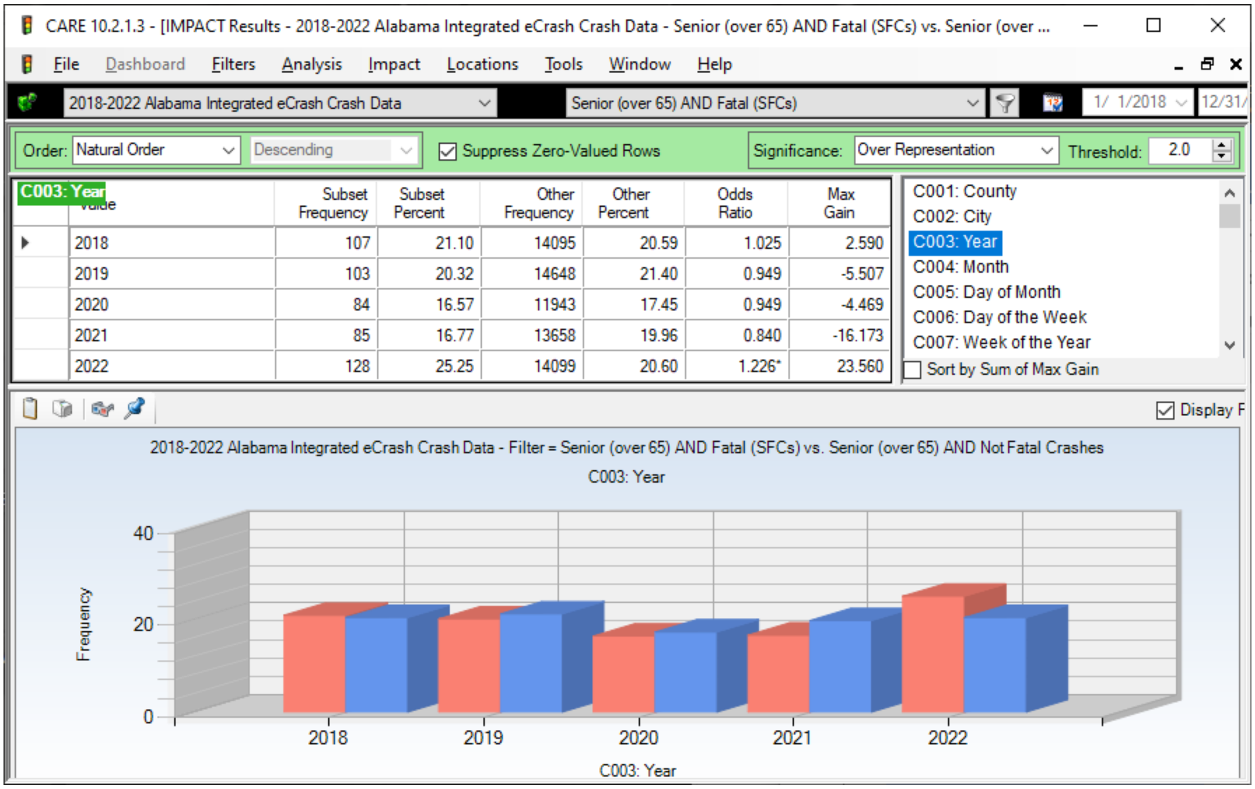
Senior Non-Fatal Crashes (SNFCs) = **Blue bars**.

In this IMPACT display, as well of those in Sections 4 through 8, the Subset (given by the red bars) is the Senior Fatal Crashes (SFCs). The "Other" crashes are those that were Senior Non-Fatal Crashes (SNFCs). This IMPACT (and those below) will use both of the filters defined above to compare the SFCs directly with the SNFCs. The above shows that County, State and Federal highway classifications are *significantly* over-represented in SFCs, as shown by the asterisk (*) on their Odds Ratios. Interstate highways are also over-represented, but not significantly so. Municipal roads are *highly* significantly under-represented, as indicated not only by the asterisk but also by the green background. County road classifications were *highly* significantly over-represented, as indicate by the red background.

These IMPACT results will be given additional discussion in Section 4.6.

3.0 Fatal to Non-Fatal Senior Crash Comparison by Year

SFCs vs SNFCs by Year



C003: Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2018	107	21.10	14095	20.59	1.025	2.590
2019	103	20.32	14648	21.40	0.949	-5.507
2020	84	16.57	11943	17.45	0.949	-4.469
2021	85	16.77	13658	19.96	0.840	-16.173
2022	128	25.25	14099	20.60	1.226*	23.560

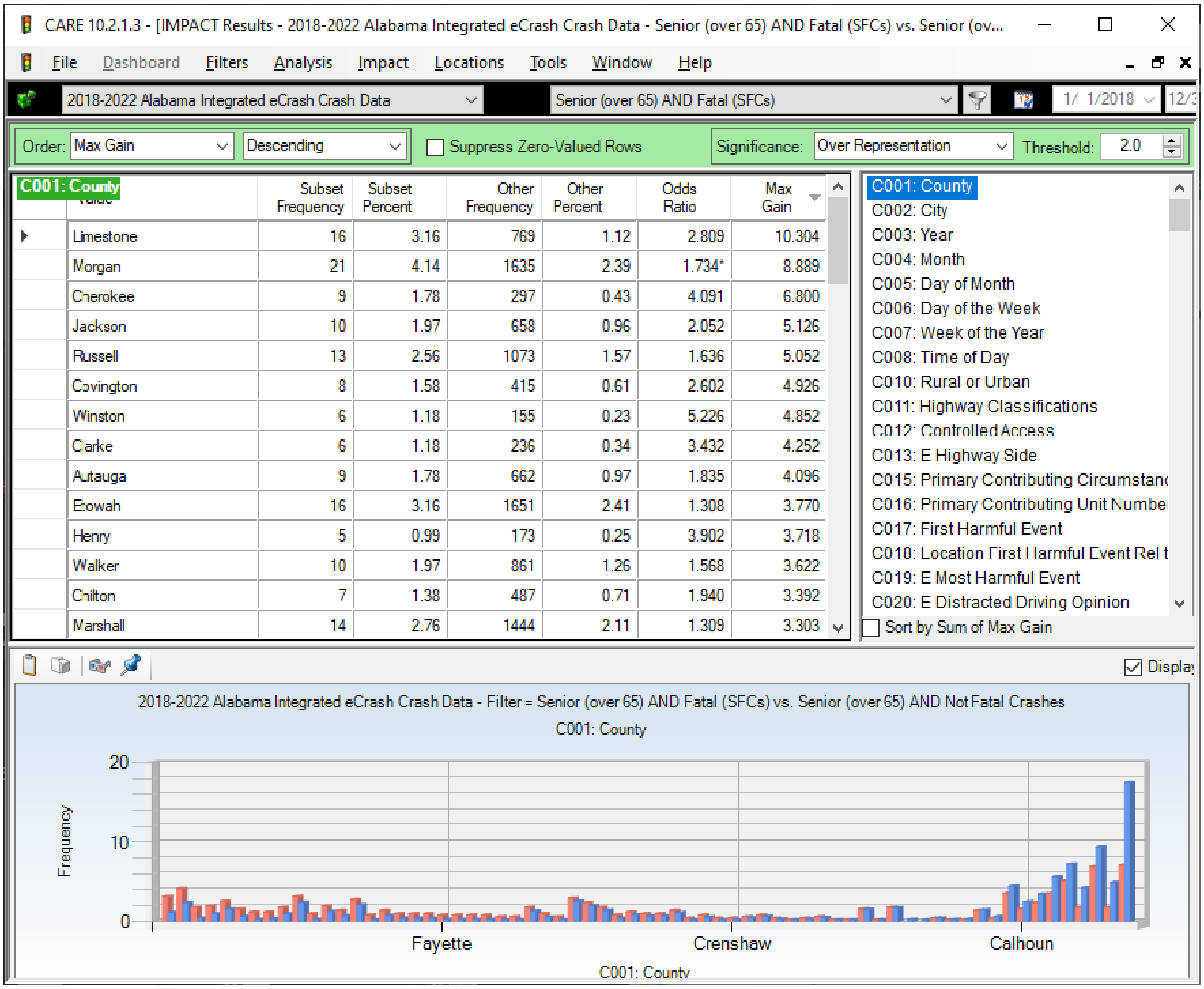
Reminder: SFCs= Senior Fatal=**Red bars**; SNFCs=Senior Non-Fatal=**Blue bars**.

This is an example to further demonstrate the IMPACT displays. The only year the showed any statistically significant differences between the fatal and non-fatal crashes was 2022. The years 2019 through 2021 are under-represented in fatal crashes, meaning the proportion of SFCs is lower than the proportion of SNFCs. The other two years, 2018 and 2021 are over-represented, but 2018 was not statistically significantly.

See Section 5.1 for additional comments on changes by year.

4.0 Geographic and Harmful Event Factors

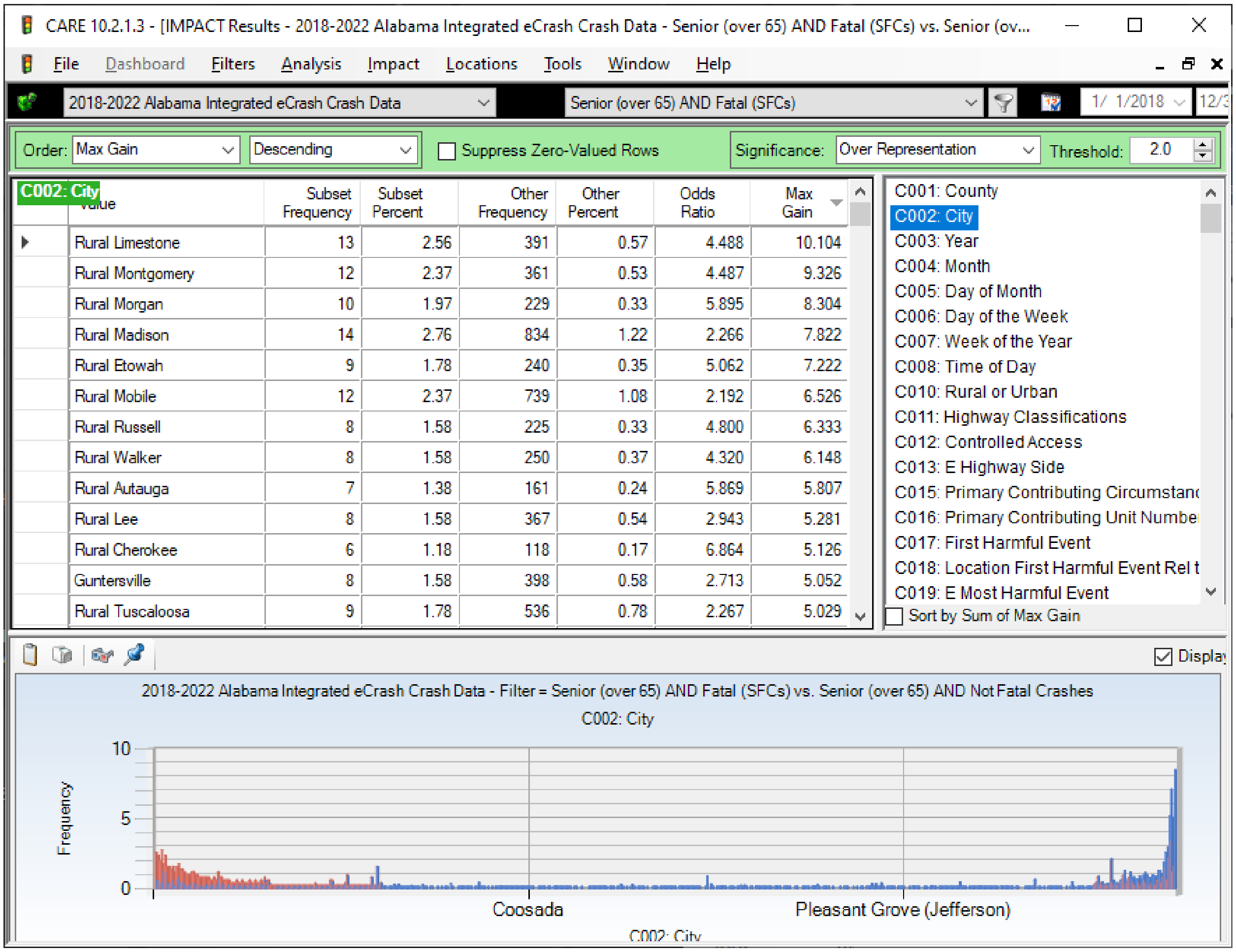
4.1 C001 County SFCs vs SNFCs (top 14 counties) ordered by Max Gain



C001: County	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Limestone	16	3.16	769	1.12	2.809	10.304
Morgan	21	4.14	1635	2.39	1.734*	8.889
Cherokee	9	1.78	297	0.43	4.091	6.800
Jackson	10	1.97	658	0.96	2.052	5.126
Russell	13	2.56	1073	1.57	1.636	5.052
Covington	8	1.58	415	0.61	2.602	4.926
Winston	6	1.18	155	0.23	5.226	4.852
Clarke	6	1.18	236	0.34	3.432	4.252
Autauga	9	1.78	662	0.97	1.835	4.096
Etowah	16	3.16	1651	2.41	1.308	3.770
Henry	5	0.99	173	0.25	3.902	3.718
Walker	10	1.97	861	1.26	1.568	3.622
Chilton	7	1.38	487	0.71	1.940	3.392
Marshall	14	2.76	1444	2.11	1.309	3.303

Each line of table above gives both SFC and SNFC crashes. So, Morgan County, second to the top. had 21 Senior Fatal Crashes (SFCs) and 1,635 Senior Non-Fatal Crashes (SNFCs). Their proportions (4.14% and 2.39%) are used to obtain the Odds Ratio of 1.734. Statistical significance is not calculated if either of the frequencies are less than 20. Proportions are calculated from the attribute frequency divided by the total number of crashes in each column. The Max Gain (8.889) is the number of Senior Fatal Crashes (SFCs) that would be reduced if the 4.14% was reduced to 2.39%. The above display has been arranged in Max Gain order to indicate the counties that have the highest potential for gain in reducing their SFC proportions to their SNFC proportions. The display above contains all of the counties with Max Gains greater than 3.300.

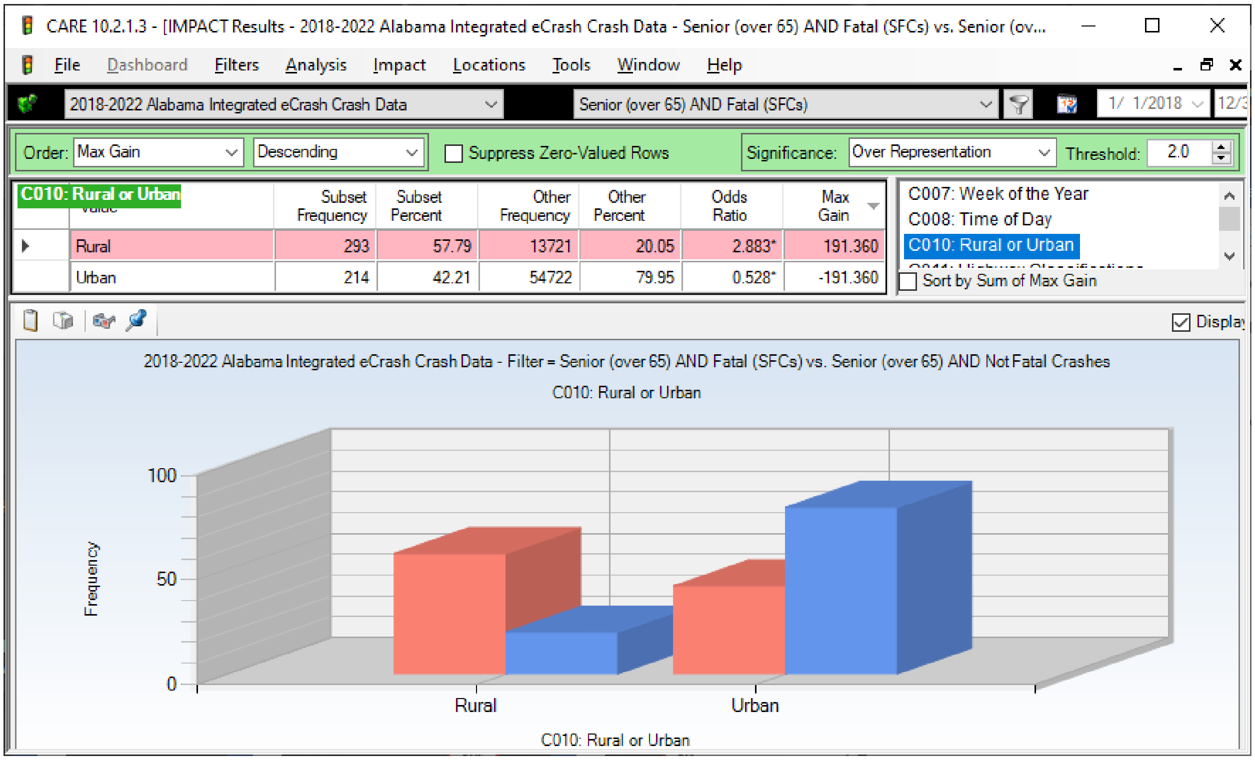
4.2 C002 Cities (top 13) with Highest Max Gains (Rural Areas = Virtual Cities)



C002: City Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Rural Limestone	13	2.56	391	0.57	4.488	10.104
Rural Montgomery	12	2.37	361	0.53	4.487	9.326
Rural Morgan	10	1.97	229	0.33	5.895	8.304
Rural Madison	14	2.76	834	1.22	2.266	7.822
Rural Etowah	9	1.78	240	0.35	5.062	7.222
Rural Mobile	12	2.37	739	1.08	2.192	6.526
Rural Russell	8	1.58	225	0.33	4.800	6.333
Rural Walker	8	1.58	250	0.37	4.320	6.148
Rural Autauga	7	1.38	161	0.24	5.869	5.807
Rural Lee	8	1.58	367	0.54	2.943	5.281
Rural Cherokee	6	1.18	118	0.17	6.864	5.126
Guntersville	8	1.58	398	0.58	2.713	5.052
Rural Tuscaloosa	9	1.78	536	0.78	2.267	5.029

For comparison purposes, the rural areas of counties are considered to be "virtual cities," and crashes that occur there are listed as "Rural [County Name]" so that these crashes can be effectively accounted for and compared. The high rural areas are generally adjacent to (or partially contain) significant urban areas that have a high traffic density. The display for this is in Max Gain ordering to put those (possibly virtual) cities that have the highest potential for Senior Fatal Crash (SFC) reduction at the top. The display is for all Max Gains > 5.000. It is no surprise that the rural areas have relatively more fatal crashes than their urban city counterparts, as will be shown in the next attribute below. The eight highest (virtual) cities according to their Max Gains are: Rural Limestone 13, Rural Montgomery 12, Rural Morgan 10, Rural Madison 14, Rural Etowah 9, Rural Mobile 12, Rural Russell 8, and Rural Walker 8. Birmingham 8, Montgomery 6, Mobile 17 and Huntsville 11 also had high frequencies, but their proportions were less than the SNFCs proportions in these cities.

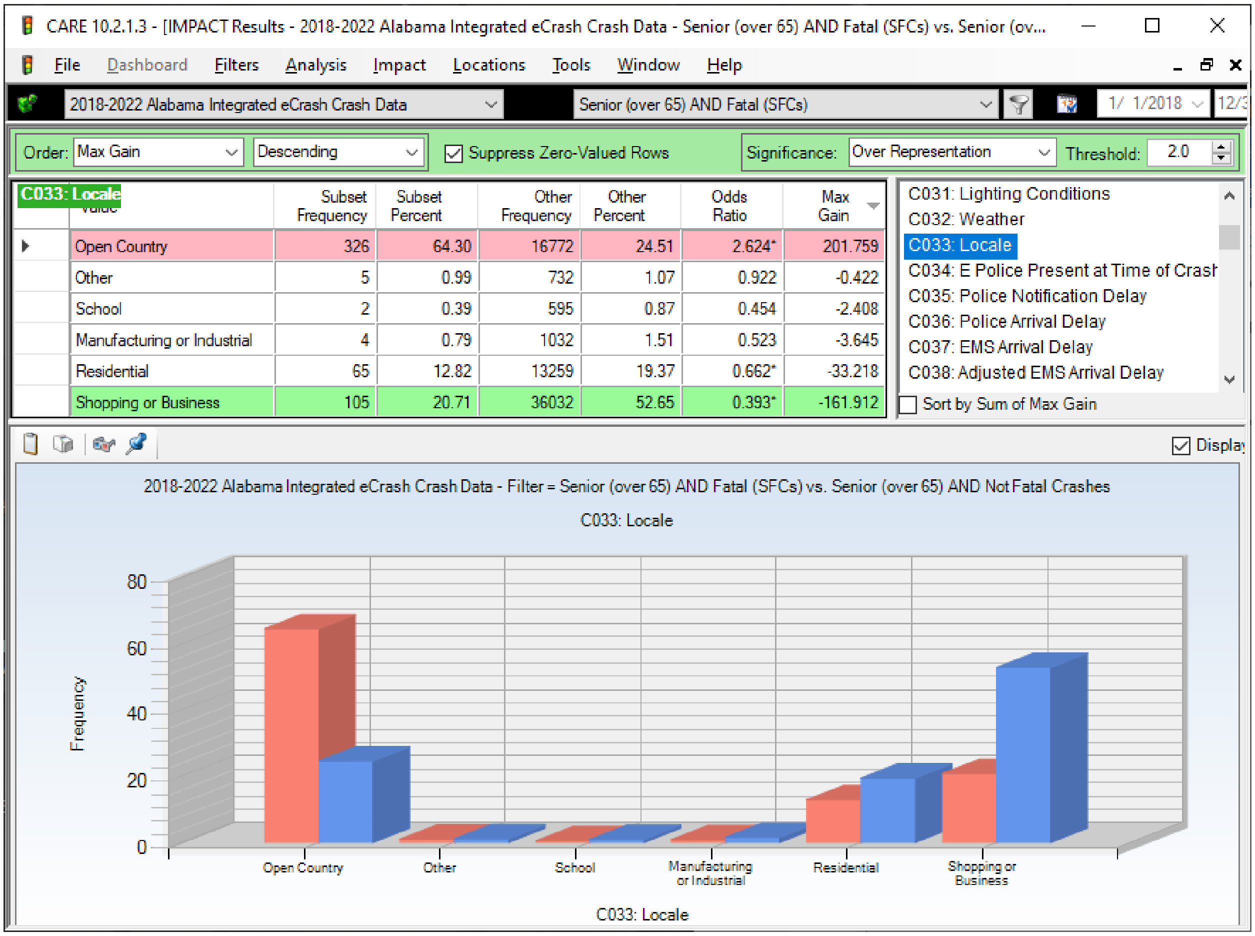
4.3 C010 Rural or Urban



The Senior Fatal Crashes (SFCs) had 57.79% of their fatal crashes in Rural areas, as compared to only 20.05% in the Urban areas. The SNFCs were highly urban, with 79.95% of their crashes in the urban areas. The proportion of rural SFCs was highly significant, and they illustrate how relatively lethal Rural crashes generally are, as compared to those on Urban roadways. This is attributed to the comparative speed at impact on the Rural roads. Speed will be considered again in Section 6.2, C224, Speed at Impact. Speed not only can cause a crash, but it also dramatically increases its severity.

Some Open Country areas are within city limits (see Sections 4.4 and 4.5 below).

4.4 C033 Locale



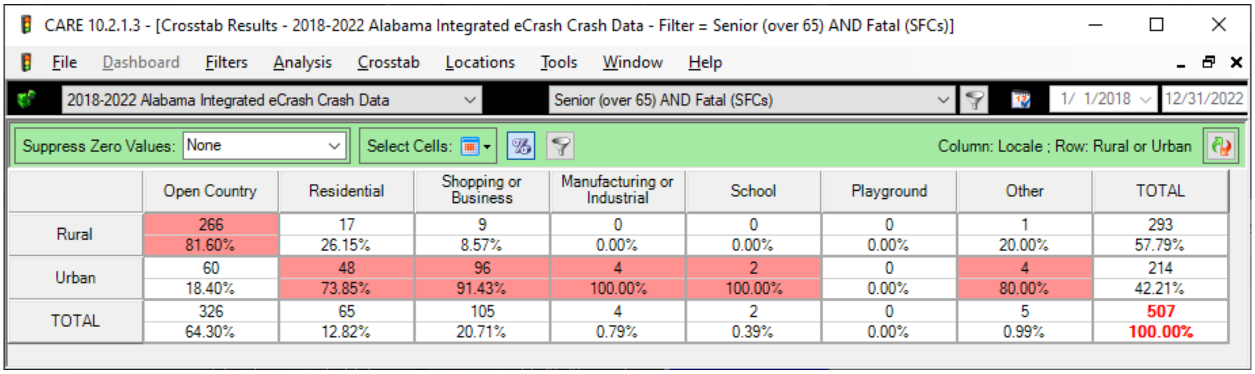
Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Open Country	326	64.30	16772	24.51	2.624*	201.759
Other	5	0.99	732	1.07	0.922	-0.422
School	2	0.39	595	0.87	0.454	-2.408
Manufacturing or Industrial	4	0.79	1032	1.51	0.523	-3.645
Residential	65	12.82	13259	19.37	0.662*	-33.218
Shopping or Business	105	20.71	36032	52.65	0.393*	-161.912

Open Country showed significant differences between SFCs and SNFCs. The SFC proportion for Open Country was 64.30%, and its Odds Ratio was 2.624. Shopping or Business was highly significantly under-represented in fatal crashes, although it had a fairly high frequency (105). Residential was also significantly under-represented with a fatal crash count of 68. They are at the bottom of the list because their proportions were considerably lower than those of their corresponding SNFCs. This demonstrates a significantly larger proportion of Open Country in the urban roadway system. The two factors that contribute to the Open Country results are its being proximal to urban areas, which increase the traffic flow, and the greater speeds on the Open Country roads, which increase the number of fatalities.

See Section 4.5 below for a breakdown of Open Country by Rural/Urban.

4.5 C033 Locale by C010 Rural-Urban for SFCs

It is obvious in the above outputs that SFCs are greatly over-represented in the Rural and Open Country areas. It is interesting to perform a cross-tabulation for Locale over the Rural and Urban areas to further define this relationship. The following, *which is only for <u>SFCs</u>*, gives one such analysis.

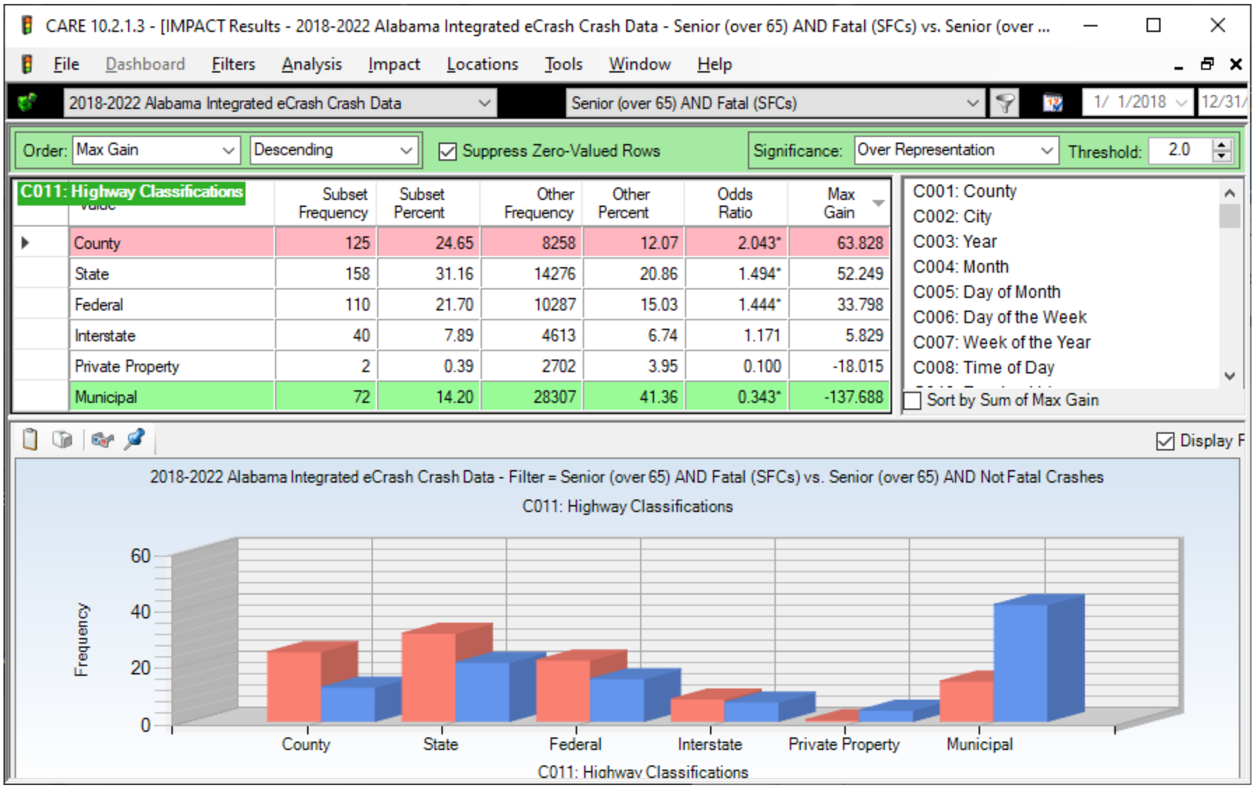


	Open Country	Residential	Shopping or Business	Manufacturing or Industrial	School	Playground	Other	TOTAL
Rural	266 81.60%	17 26.15%	9 8.57%	0 0.00%	0 0.00%	0 0.00%	1 20.00%	293 57.79%
Urban	60 18.40%	48 73.85%	96 91.43%	4 100.00%	2 100.00%	0 0.00%	4 80.00%	214 42.21%
TOTAL	326 64.30%	65 12.82%	105 20.71%	4 0.79%	2 0.39%	0 0.00%	5 0.99%	507 100.00%

The red-backed cells in CARE cross-tabulations indicate a cell over-representation by more than 10%. Those that are over-represented, but by less than 10% would have a yellow background (none qualify here). The white background indicates that the cell is under-represented. For example, while 57.79% of all SFCs were Rural, the Open Country Locale had a percentage of 81.60%. Since this is greater than a 10% difference, this cell has a red background.

This shows that the Rural/Urban attribute may not be as definitive as is Locale in categorizing crash locations by their general environmental factors. The higher speed limits within some city limits would cause the higher number of SFCs in Open Country areas.

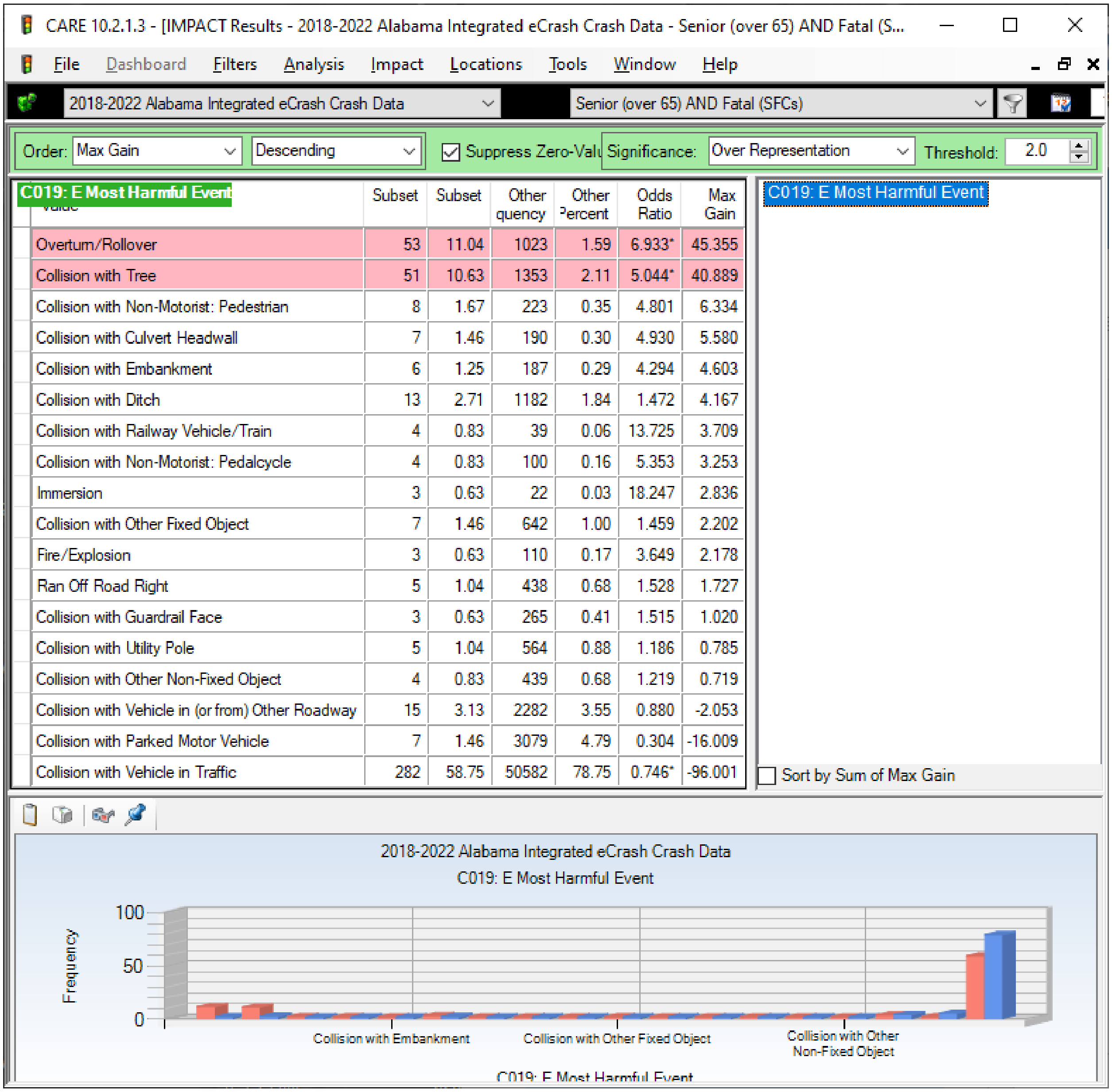
4.6 C011 Highway Classifications



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
County	125	24.65	8258	12.07	2.043*	63.828
State	158	31.16	14276	20.86	1.494*	52.249
Federal	110	21.70	10287	15.03	1.444*	33.798
Interstate	40	7.89	4613	6.74	1.171	5.829
Private Property	2	0.39	2702	3.95	0.100	-18.015
Municipal	72	14.20	28307	41.36	0.343*	-137.688

This display was introduced in Section 2.3, but little was said of its countermeasure ramifications. Clearly County (125 frequency) routes have the largest number and proportion (24.65%) of Senior Fatal Crashes (SFCs). The other major roadway systems fall in the following max gain order (given with the frequencies): State (158), Federal (110), and Interstate (40). County was highly significantly over-represented. State and Federal were also significantly over-represented. Interstate was also over-represented, but not significantly so. While significantly under-represented (0.343*) from its proportion point of view, Municipal still had a substantial number of fatal crashes (72), which was more than Interstate.

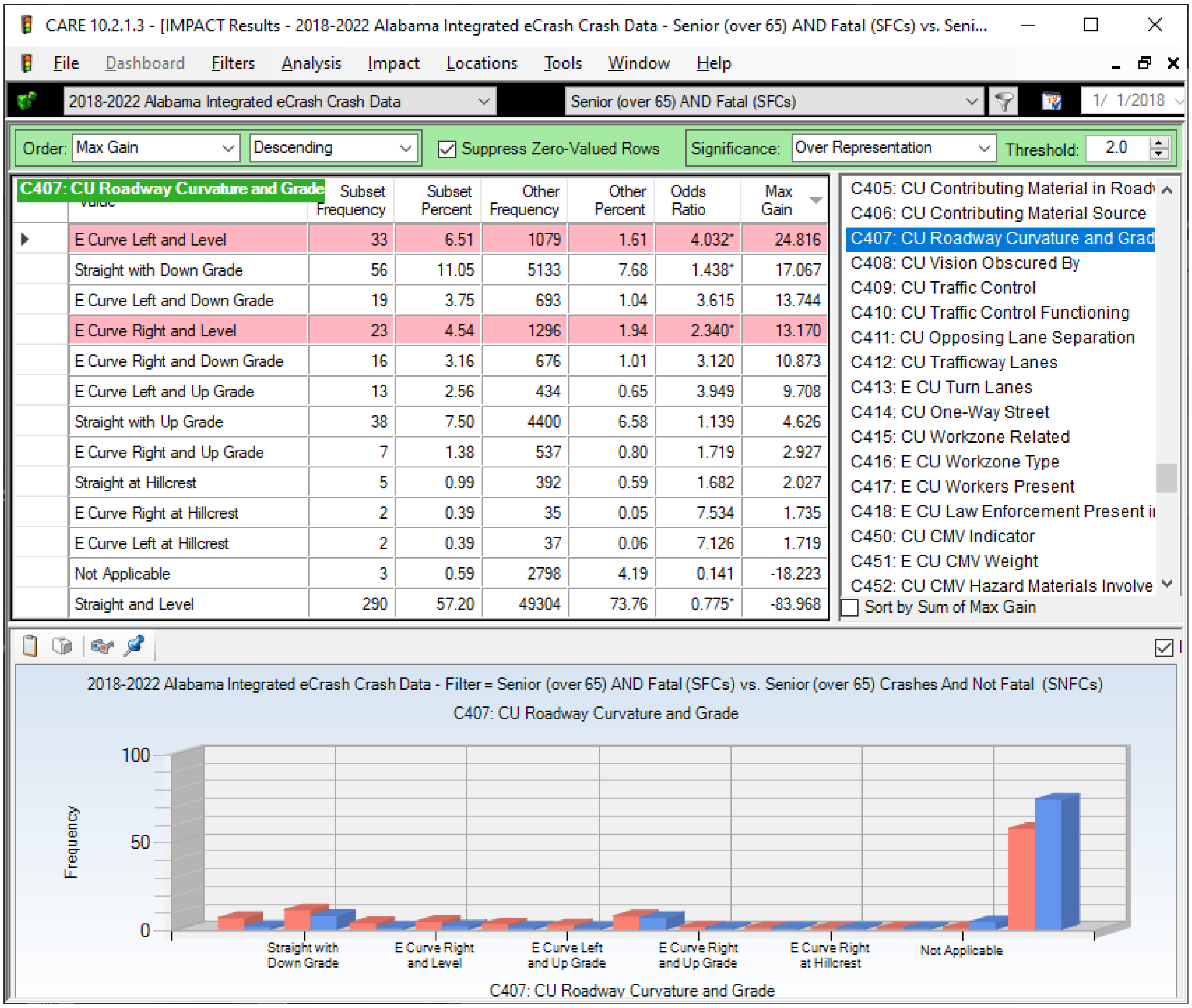
4.7 C019 Most Harmful Event (>2 ceashes in MaxGain order)



C019: E Most Harmful Event	Subset	Subset	Other quency	Other Percent	Odds Ratio	Max Gain
Overturn/Rollover	53	11.04	1023	1.59	6.933*	45.355
Collision with Tree	51	10.63	1353	2.11	5.044*	40.889
Collision with Non-Motorist: Pedestrian	8	1.67	223	0.35	4.801	6.334
Collision with Culvert Headwall	7	1.46	190	0.30	4.930	5.580
Collision with Embankment	6	1.25	187	0.29	4.294	4.603
Collision with Ditch	13	2.71	1182	1.84	1.472	4.167
Collision with Railway Vehicle/Train	4	0.83	39	0.06	13.725	3.709
Collision with Non-Motorist: Pedalcycle	4	0.83	100	0.16	5.353	3.253
Immersion	3	0.63	22	0.03	18.247	2.836
Collision with Other Fixed Object	7	1.46	642	1.00	1.459	2.202
Fire/Explosion	3	0.63	110	0.17	3.649	2.178
Ran Off Road Right	5	1.04	438	0.68	1.528	1.727
Collision with Guardrail Face	3	0.63	265	0.41	1.515	1.020
Collision with Utility Pole	5	1.04	564	0.88	1.186	0.785
Collision with Other Non-Fixed Object	4	0.83	439	0.68	1.219	0.719
Collision with Vehicle in (or from) Other Roadway	15	3.13	2282	3.55	0.880	-2.053
Collision with Parked Motor Vehicle	7	1.46	3079	4.79	0.304	-16.009
Collision with Vehicle in Traffic	282	58.75	50582	78.75	0.746*	-96.001

The display above is intended to show safety engineers factors that are involved with senior fatal collisions. The top five over-represented crash types (with frequencies) are: Overturn/Rollover 53, Collision with Tree 51, Collision with Non-Motorist: Pedestrian 8, Collision with Culvert Headwall 7, Collisions with Embankment 6, and Collision with Ditch 13. Collision with Vehicle in Traffic had the highest frequency (282), but its proportion (58.75%) was considerably less than that of SNFCs (78.75%)

4.8 C407 CU Roadway Curvature and Grade



C407: CU Roadway Curvature and Grade Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Curve Left and Level	33	6.51	1079	1.61	4.032*	24.816
Straight with Down Grade	56	11.05	5133	7.68	1.438*	17.067
E Curve Left and Down Grade	19	3.75	693	1.04	3.615	13.744
E Curve Right and Level	23	4.54	1296	1.94	2.340*	13.170
E Curve Right and Down Grade	16	3.16	676	1.01	3.120	10.873
E Curve Left and Up Grade	13	2.56	434	0.65	3.949	9.708
Straight with Up Grade	38	7.50	4400	6.58	1.139	4.626
E Curve Right and Up Grade	7	1.38	537	0.80	1.719	2.927
Straight at Hillcrest	5	0.99	392	0.59	1.682	2.027
E Curve Right at Hillcrest	2	0.39	35	0.05	7.534	1.735
E Curve Left at Hillcrest	2	0.39	37	0.06	7.126	1.719
Not Applicable	3	0.59	2798	4.19	0.141	-18.223
Straight and Level	290	57.20	49304	73.76	0.775*	-83.968

SFCs are over-represented in all curve types except Straight and Level. Over-represented SFCs with the highest frequencies (in Max Gain order):

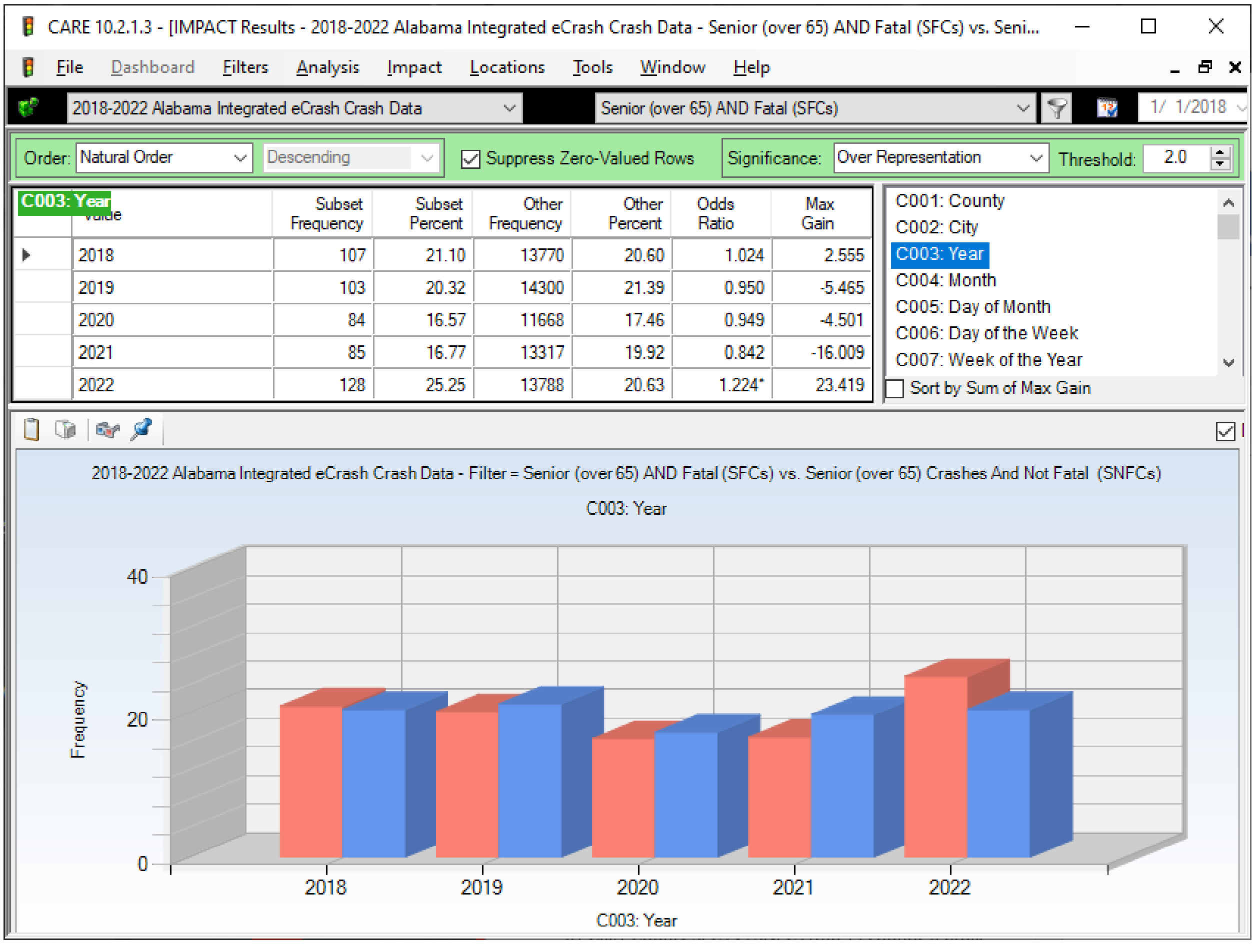
Curve Left and Level	33
Straight with Down Grade	56
Curve Left and Down Grade	19
Curve Right and Level	23
Curve Right and Down Grade	16
Curve Left and Up Grade	13
Straight with Up Grade	38

The only curvature that was under-represented in SFCs was Straight and Level 290. Clearly this had the most SFCs but its fatality proportion was lower than their SNFC proportions.

5.0 Time Factors

5.1 C003 Year – IMPACT duplicated from Section 3.0 for ease of reference

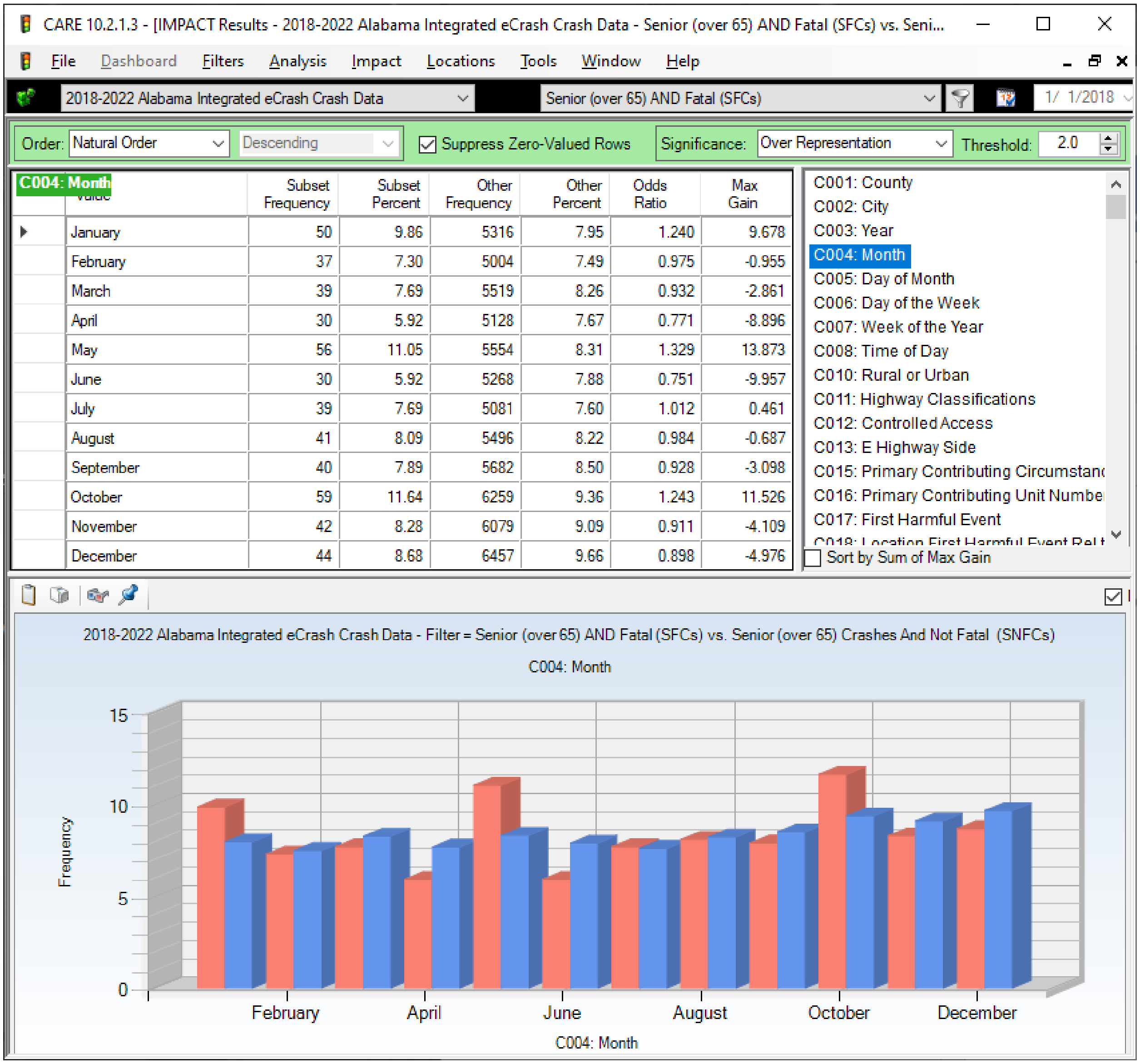
Year: Senior Fatal Crashes (SFCs) vs Senior Non-Fatal Crashes (SNFCs)



C003: Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
2018	107	21.10	13770	20.60	1.024	2.555
2019	103	20.32	14300	21.39	0.950	-5.465
2020	84	16.57	11668	17.46	0.949	-4.501
2021	85	16.77	13317	19.92	0.842	-16.009
2022	128	25.25	13788	20.63	1.224*	23.419

Variations in proportions between the SFCs and the SNFCs were not found to be significant in 2018-2021, but SFCs were significantly over-represented in 2022. While under-represented in 2019 through 2021, they became over-represented in the year 2022. The reason for this increased SFC proportion is not definitive, but this increase should be watched to determine the cause in future years.

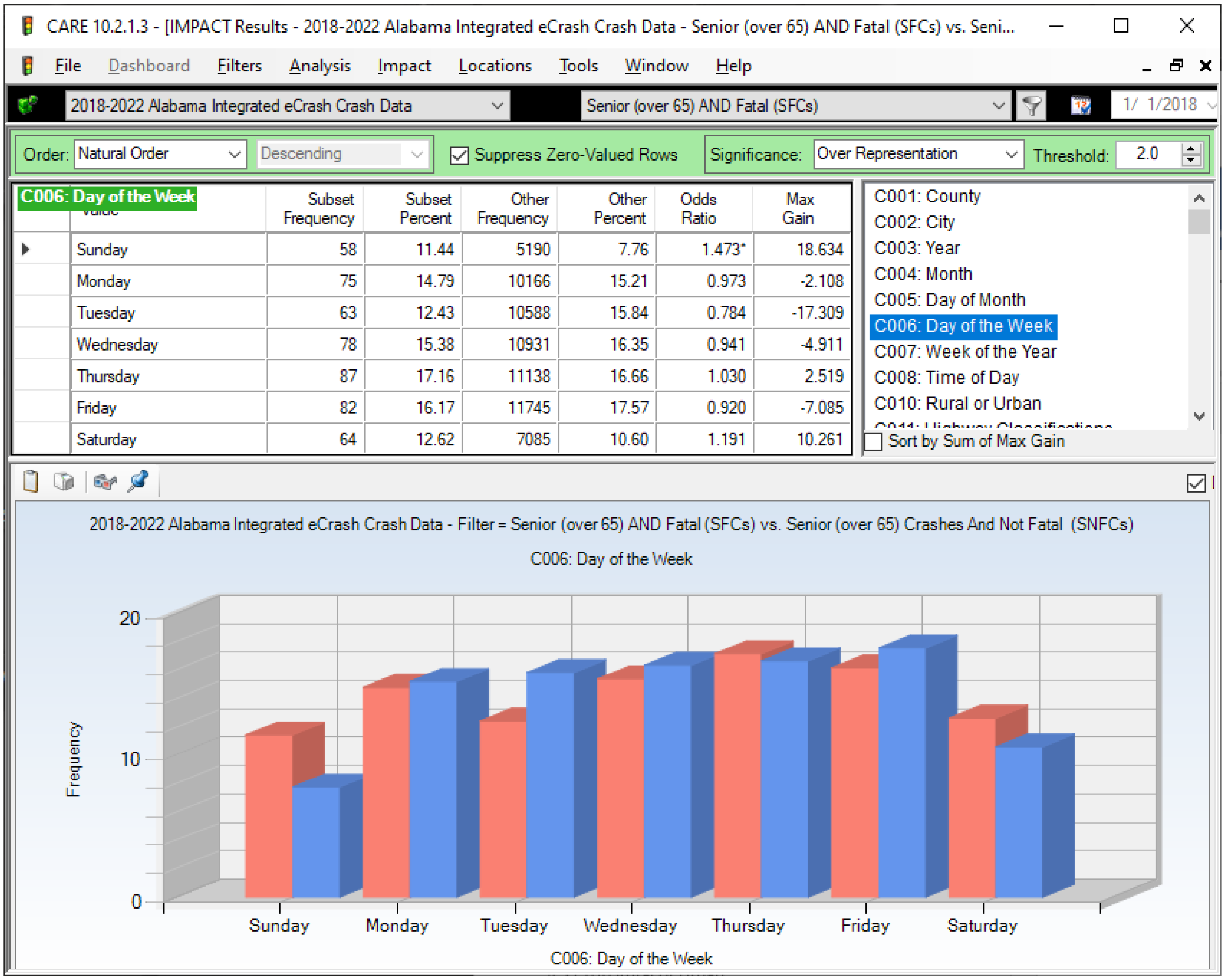
5.2 C004 Month



C004: Month Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
January	50	9.86	5316	7.95	1.240	9.678
February	37	7.30	5004	7.49	0.975	-0.955
March	39	7.69	5519	8.26	0.932	-2.861
April	30	5.92	5128	7.67	0.771	-8.896
May	56	11.05	5554	8.31	1.329	13.873
June	30	5.92	5268	7.88	0.751	-9.957
July	39	7.69	5081	7.60	1.012	0.461
August	41	8.09	5496	8.22	0.984	-0.687
September	40	7.89	5682	8.50	0.928	-3.098
October	59	11.64	6259	9.36	1.243	11.526
November	42	8.28	6079	9.09	0.911	-4.109
December	44	8.68	6457	9.66	0.898	-4.976

The ordering of the displays above is according to the natural ordering of months. None of the months had statistically significant over-representations or under-representations, although it is obvious that May and October are noteworthy. SFC months generally fell in line with their SNFC counterparts. The largest over-representations were in May and October, which had Odds Ratios of 1.329 and 1.243, which were relatively large, but not large enough to qualify as statistically significant. No sequential collective over-representations were found. This indicates that the times of year do not seem to cause any increases in Senior crashes being fatal. The low SFC sample sizes also work against any indication of statistical significance.

5.3 C006 Day of the Week Comparison SFCs and SNFCs



C006: Day of the Week	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Sunday	58	11.44	5190	7.76	1.473*	18.634
Monday	75	14.79	10166	15.21	0.973	-2.108
Tuesday	63	12.43	10588	15.84	0.784	-17.309
Wednesday	78	15.38	10931	16.35	0.941	-4.911
Thursday	87	17.16	11138	16.66	1.030	2.519
Friday	82	16.17	11745	17.57	0.920	-7.085
Saturday	64	12.62	7085	10.60	1.191	10.261

Sunday was the only significantly over-represented in SFCs as compared to their SNFC counterparts. Saturday was the only other over-represented day, but its proportion was not high enough to make it statistically significant. Because weekends are over-represented in ID (DUI Alcohol or Drugs) this gives us an early indication that SFCs might have an ID causation. If true, this will be validated in Section 8.

5.4 Day of the Week Discussion [covered above.]

Also, relevant Day of the Week information is given in Section 5.6.

5.5 C008 Time of Day

CARE 10.2.1.3 - [IMPACT Results - 2018-2022 Alabama Integrated eCrash Crash Data - Senior (over 65) AND Fatal (SFCs) vs. Seni...

File Dashboard Filters Analysis Impact Locations Tools Window Help

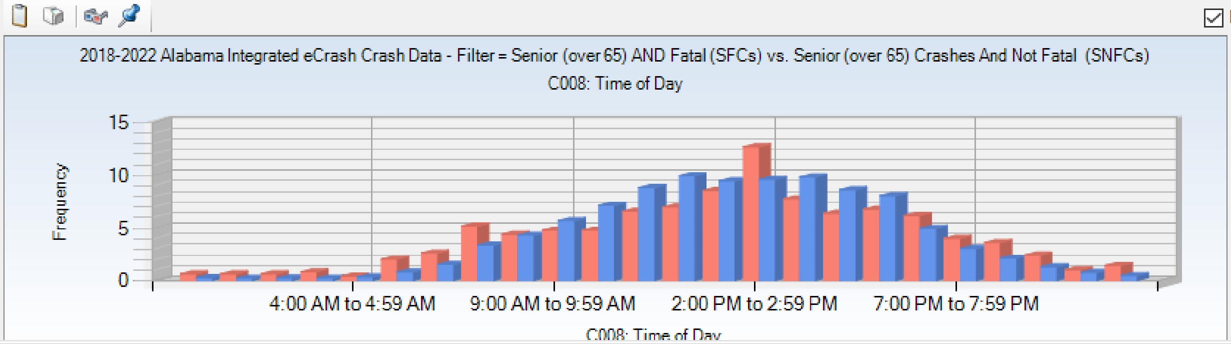
2018-2022 Alabama Integrated eCrash Crash Data | Senior (over 65) AND Fatal (SFCs) | 1/ 1/2018

Order: Natural Order | Descending | Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C008: Time of Day Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
12:00 Midnight to 12:59 ...	3	0.59	170	0.25	2.327	1.711
1:00 AM to 1:59 AM	3	0.59	127	0.19	3.114	2.037
2:00 AM to 2:59 AM	3	0.59	136	0.20	2.908	1.968
3:00 AM to 3:59 AM	4	0.79	129	0.19	4.088	3.022
4:00 AM to 4:59 AM	2	0.39	207	0.31	1.274	0.430
5:00 AM to 5:59 AM	10	1.97	520	0.78	2.535	6.056
6:00 AM to 6:59 AM	13	2.56	990	1.48	1.731	5.491
7:00 AM to 7:59 AM	26	5.13	2223	3.33	1.542	9.139
8:00 AM to 8:59 AM	22	4.34	2833	4.24	1.024	0.512
9:00 AM to 9:59 AM	24	4.73	3765	5.63	0.840	-4.557
10:00 AM to 10:59 AM	24	4.73	4730	7.08	0.669	-11.877
11:00 AM to 11:59 AM	33	6.51	5849	8.75	0.744	-11.364
12:00 Noon to 12:59 PM	35	6.90	6607	9.88	0.698	-15.114
1:00 PM to 1:59 PM	43	8.48	6272	9.38	0.904	-4.573
2:00 PM to 2:59 PM	64	12.62	6363	9.52	1.326*	15.737
3:00 PM to 3:59 PM	39	7.69	6527	9.76	0.788	-10.507
4:00 PM to 4:59 PM	32	6.31	5715	8.55	0.738	-11.348
5:00 PM to 5:59 PM	34	6.71	5347	8.00	0.838	-6.557
6:00 PM to 6:59 PM	31	6.11	3282	4.91	1.245	6.106
7:00 PM to 7:59 PM	20	3.94	2007	3.00	1.314	4.777
8:00 PM to 8:59 PM	18	3.55	1391	2.08	1.706	7.449
9:00 PM to 9:59 PM	12	2.37	840	1.26	1.883	5.629
10:00 PM to 10:59 PM	5	0.99	486	0.73	1.356	1.314
11:00 PM to 11:59 PM	7	1.38	290	0.43	3.182	4.800

C001: County
C002: City
C003: Year
C004: Month
C005: Day of Month
C006: Day of the Week
C007: Week of the Year
C008: Time of Day
C010: Rural or Urban
C011: Highway Classifications
C012: Controlled Access
C013: E Highway Side
C015: Primary Contributing Circumstanc
C016: Primary Contributing Unit Numbe
C017: First Harmful Event
C018: Location First Harmful Event Rel t
C019: E Most Harmful Event
C020: E Distracted Driving Opinion
C021: Distance to Fixed Object
C022: E Type of Roadway Junction/Featu
C023: E Manner of Crash
C024: School Bus Related
C025: Crash Severity
C026: Intersection Related
C027: At Intersection
C028: Mileposted Route
C029: National Highway System
C030: Functional Class
C031: Lighting Conditions
C032: Weather

Sort by Sum of Max Gain



The time of day distribution pattern is consistent with the hours that are typically associated with Impaired Driving (ID). See the further discussion in Section 5.6.

5.6 C008 Discussion on Time of Day by Day of the Week

Refer to the Time of Day (Section 5.5 above) and the Day of the Week by Time of Day cross-tabulation *for all senior fatal crashes* display (Section 5.7 below). The large Time of Day over-representations on 6:00 PM to 8:59 AM are indicative of ID, fatigue and lack of sleep. The lack of significance indicators prior to 7 AM could be attributed to the sample sizes being less than 20 for the SFCs.

The *Time of Day by Day of the Week* cross-tabulation (given in the next section *for all fatal crashes* (not subdivided by SFCs and SNFCs) shows the optimal times for Senior selective enforcement. Generally, the highest proportion of times in any day are given in red for that day. Notice that this works well for Friday evenings, Saturdays from 8 AM through 3:59 PM, and Sunday mid days (11:00 AM through 7:59 PM).

The interpretation of the cross-tabulation in Section 5.7 shows a moderate ID component. However, the following additional factors might help to explain the concentrations:

- Friday Night/Saturday Mid-day – ID, but also fatigue and sleep,
- Saturday Night/Sunday Morning – Times when ID would be expected, but they do not materialize for the Senior drivers.
- Sunday 5:00 PM to 11:59 PM – Fatigue getting home after weekends.
- Weekdays 10:00 AM to 7:59 PM – Fatigue during long drives during the day.

The expected proportion for all cells in a given row is given at the extreme right in the total row percentage column for each row. If there were absolutely no over-representations across the columns (days), then all of the proportions for those cells would be identical to the one for the total.
Cells that are lower than the average value (given in the TOTAL column) have a neutral (white) background. Those that are higher, but not more than 10% of the proportion are yellow; and those above 10% more than that expected from the TOTAL (right column) have a red background.

For example, the 10:00 AM to 10:59 AM row has a total percentage value of 4.73% for the Senior Fatal Crashes (SFCs) during this hour. The red cells to the left (Tuesday and Sunday) have percentages of 7.94% and 6.25. Since these are more than10% above the 4.73%, they have a red background. The yellow cells for Monday and Friday are both above the 4.73%, but not by a 10% difference. All the rest of the cells have white background indicating that their percentages are less than 4.73%.

5.7 C008 Time of Day x C006 Day of the Week for SFCs

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Senior (over 65) AND Fatal (SFCs)]

Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	1 1.72%	1 1.33%	0 0.00%	0 0.00%	0 0.00%	1 1.22%	0 0.00%	3 0.59%
1:00 AM to 1:59 AM	1 1.72%	0 0.00%	1 1.59%	0 0.00%	1 1.15%	0 0.00%	0 0.00%	3 0.59%
2:00 AM to 2:59 AM	1 1.72%	0 0.00%	0 0.00%	1 1.28%	0 0.00%	1 1.22%	0 0.00%	3 0.59%
3:00 AM to 3:59 AM	0 0.00%	0 0.00%	0 0.00%	2 2.56%	1 1.15%	0 0.00%	1 1.56%	4 0.79%
4:00 AM to 4:59 AM	1 1.72%	0 0.00%	0 0.00%	1 1.28%	0 0.00%	0 0.00%	0 0.00%	2 0.39%
5:00 AM to 5:59 AM	1 1.72%	2 2.67%	3 4.76%	0 0.00%	1 1.15%	2 2.44%	1 1.56%	10 1.97%
6:00 AM to 6:59 AM	0 0.00%	1 1.33%	1 1.59%	3 3.85%	1 1.15%	4 4.88%	3 4.69%	13 2.56%
7:00 AM to 7:59 AM	4 6.90%	3 4.00%	1 1.59%	4 5.13%	7 8.05%	6 7.32%	1 1.56%	26 5.13%
8:00 AM to 8:59 AM	1 1.72%	3 4.00%	1 1.59%	3 3.85%	5 5.75%	3 3.66%	6 9.38%	22 4.34%
9:00 AM to 9:59 AM	0 0.00%	1 1.33%	3 4.76%	6 7.69%	4 4.60%	5 6.10%	5 7.81%	24 4.73%
10:00 AM to 10:59 AM	1 1.72%	4 5.33%	5 7.94%	3 3.85%	3 3.45%	4 4.88%	4 6.25%	24 4.73%
11:00 AM to 11:59 AM	5 8.62%	4 5.33%	4 6.35%	4 5.13%	6 6.90%	5 6.10%	5 7.81%	33 6.51%
12:00 Noon to 12:59 PM	5 8.62%	3 4.00%	5 7.94%	5 6.41%	7 8.05%	4 4.88%	6 9.38%	35 6.90%
1:00 PM to 1:59 PM	6 10.34%	4 5.33%	6 9.52%	8 10.26%	6 6.90%	5 6.10%	8 12.50%	43 8.48%
2:00 PM to 2:59 PM	5 8.62%	12 16.00%	10 15.87%	9 11.54%	12 13.79%	10 12.20%	6 9.38%	64 12.62%
3:00 PM to 3:59 PM	3 5.17%	8 10.67%	3 4.76%	6 7.69%	5 5.75%	6 7.32%	8 12.50%	39 7.69%
4:00 PM to 4:59 PM	0 0.00%	12 16.00%	4 6.35%	4 5.13%	5 5.75%	6 7.32%	1 1.56%	32 6.31%
5:00 PM to 5:59 PM	6 10.34%	3 4.00%	5 7.94%	6 7.69%	6 6.90%	6 7.32%	2 3.13%	34 6.71%
6:00 PM to 6:59 PM	5 8.62%	5 6.67%	4 6.35%	6 7.69%	5 5.75%	3 3.66%	3 4.69%	31 6.11%
7:00 PM to 7:59 PM	5 8.62%	1 1.33%	2 3.17%	1 1.28%	7 8.05%	4 4.88%	0 0.00%	20 3.94%
8:00 PM to 8:59 PM	3 5.17%	3 4.00%	4 6.35%	3 3.85%	1 1.15%	4 4.88%	0 0.00%	18 3.55%
9:00 PM to 9:59 PM	1 1.72%	2 2.67%	0 0.00%	3 3.85%	2 2.30%	2 2.44%	2 3.13%	12 2.37%
10:00 PM to 10:59 PM	2 3.45%	1 1.33%	0 0.00%	0 0.00%	1 1.15%	0 0.00%	1 1.56%	5 0.99%
11:00 PM to 11:59 PM	1 1.72%	2 2.67%	1 1.59%	0 0.00%	1 1.15%	1 1.22%	1 1.56%	7 1.38%
Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	58 11.44%	75 14.79%	63 12.43%	78 15.38%	87 17.16%	82 16.17%	64 12.62%	507 100.00%

See the discussion in Section 5.6 above.

6.0 Factors Affecting Severity

6.1 C011 Highway Classification by C025 Severity (all Senior crashes)

This is performed to get an initial feeling for the severity of crashes on the different Highway Classifications.

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Senior (over 65) causal Crashes (SCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

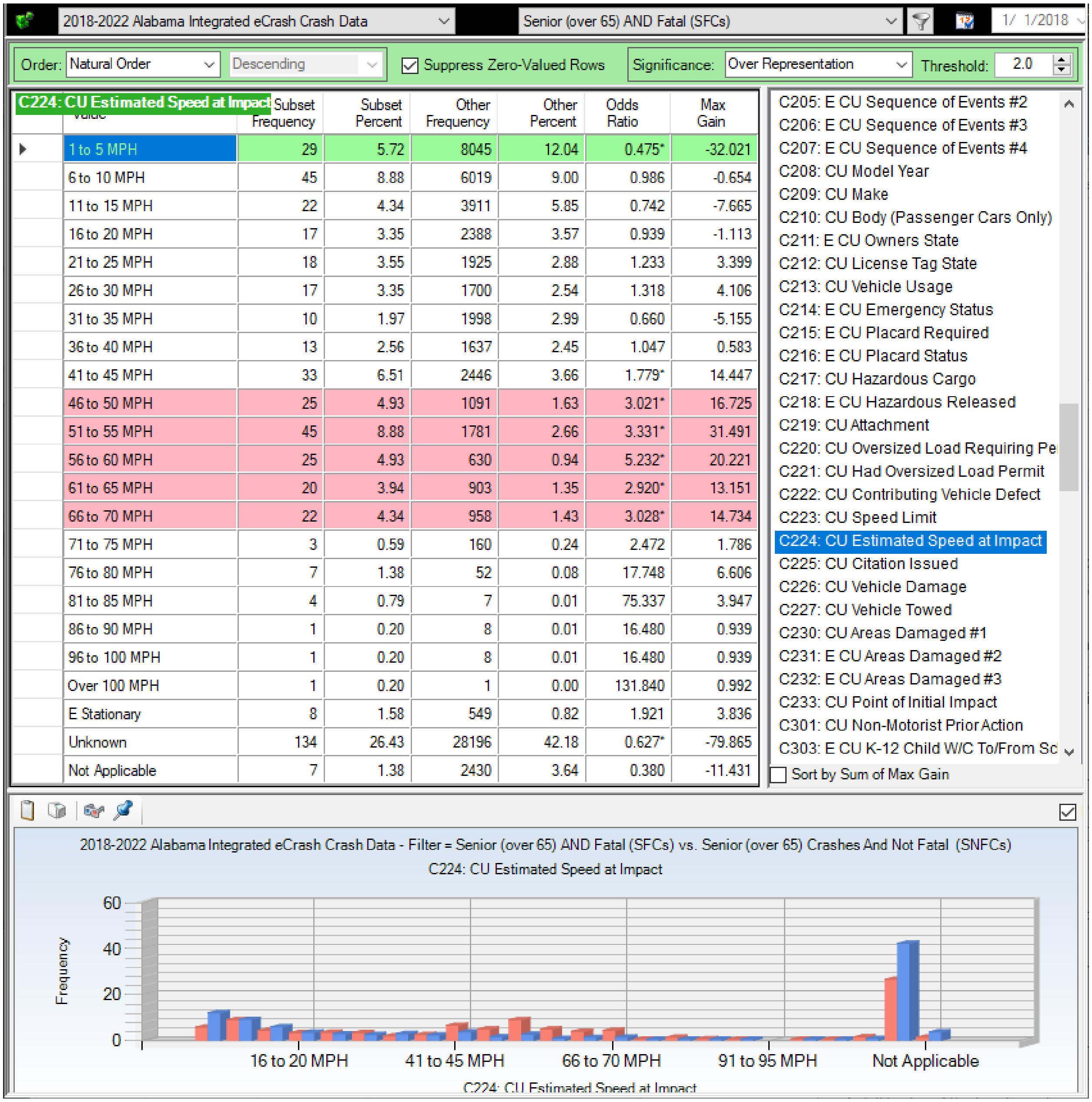
2018-2022 Alabama Integrated eCrash Crash Data | Senior (over 65) causal Crashes (SCs) | 1/ 1/2018 | 12/

Suppress Zero Values: Columns | Select Cells: | Column: Highway Classifications ; Row: Crash Severity

	Interstate	Federal	State	County	Municipal	Private Property	TOTAL
Fatal Injury	40 0.86%	110 1.06%	158 1.09%	125 1.49%	72 0.25%	2 0.07%	507 0.74%
Suspected Serious Injury	121 2.60%	369 3.55%	594 4.12%	411 4.90%	384 1.35%	21 0.78%	1900 2.76%
Suspected Minor Injury	369 7.93%	1126 10.83%	1480 10.25%	962 11.48%	1903 6.71%	97 3.59%	5937 8.61%
Possible Injury	346 7.44%	1121 10.78%	1433 9.93%	652 7.78%	2602 9.17%	129 4.77%	6283 9.11%
Property Damage Only	3726 80.08%	7530 72.42%	10349 71.70%	5971 71.23%	22780 80.27%	2367 87.54%	52723 76.47%
Unknown	51 1.10%	141 1.36%	420 2.91%	262 3.13%	638 2.25%	88 3.25%	1600 2.32%
TOTAL	4653 6.75%	10397 15.08%	14434 20.93%	8383 12.16%	28379 41.16%	2704 3.92%	68950 100.00%

Notice that the basis for this cross-tabulation is all 68,950 Senior crashes, for all severities, not just fatal crashes. Fatal Senior Crashes *only* would restrict this output to just the top row. This verifies the results presented for fatal Senior crashes in Section 4.6, and it also shows the comparable results for the lesser severities for all of the Highway Classifications. Speed and the failure to wear seatbelts are the primary cause of fatalities caused by all ages. These will be given additional consideration in the attributes described below.

6.2 SFCs vs SNFCs for C224 Speed at Impact



C224: CU Estimated Speed at Impact Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 to 5 MPH	29	5.72	8045	12.04	0.475*	-32.021
6 to 10 MPH	45	8.88	6019	9.00	0.986	-0.654
11 to 15 MPH	22	4.34	3911	5.85	0.742	-7.665
16 to 20 MPH	17	3.35	2388	3.57	0.939	-1.113
21 to 25 MPH	18	3.55	1925	2.88	1.233	3.399
26 to 30 MPH	17	3.35	1700	2.54	1.318	4.106
31 to 35 MPH	10	1.97	1998	2.99	0.660	-5.155
36 to 40 MPH	13	2.56	1637	2.45	1.047	0.583
41 to 45 MPH	33	6.51	2446	3.66	1.779*	14.447
46 to 50 MPH	25	4.93	1091	1.63	3.021*	16.725
51 to 55 MPH	45	8.88	1781	2.66	3.331*	31.491
56 to 60 MPH	25	4.93	630	0.94	5.232*	20.221
61 to 65 MPH	20	3.94	903	1.35	2.920*	13.151
66 to 70 MPH	22	4.34	958	1.43	3.028*	14.734
71 to 75 MPH	3	0.59	160	0.24	2.472	1.786
76 to 80 MPH	7	1.38	52	0.08	17.748	6.606
81 to 85 MPH	4	0.79	7	0.01	75.337	3.947
86 to 90 MPH	1	0.20	8	0.01	16.480	0.939
96 to 100 MPH	1	0.20	8	0.01	16.480	0.939
Over 100 MPH	1	0.20	1	0.00	131.840	0.992
E Stationary	8	1.58	549	0.82	1.921	3.836
Unknown	134	26.43	28196	42.18	0.627*	-79.865
Not Applicable	7	1.38	2430	3.64	0.380	-11.431

Generally, the travel speeds at roads that have the most SNFCs have speed limits of 45 MPH or lower, and it is the speeds below 41 MPH that are under-represented for the SFCs (thus, over-represented for SNFCs). Those speeds above 41 MPH are over-represented in fatal crashes (SFCs), and the Odds Ratios generally increase systematically as these speeds increase. Insufficient data exists above 90 MPH. Speed relationship to fatality is discussed below.

6.3 Cross-tab: C025 Severity by C224 Speed at Impact (all Senior crashes)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Senior (over 65) causal Crashe...

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Senior (over 65) causal Crashes (SCs) | 1/ 1/2018

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Crash Severity ; Row: CU Estimated Speed at Impact

	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
1 to 5 MPH	29 5.72%	105 5.53%	413 6.96%	526 8.37%	7001 13.28%	135 8.44%	8209 11.91%
6 to 10 MPH	45 8.88%	163 8.58%	507 8.54%	554 8.82%	4795 9.09%	67 4.19%	6131 8.89%
11 to 15 MPH	22 4.34%	114 6.00%	387 6.52%	359 5.71%	3051 5.79%	54 3.38%	3987 5.78%
16 to 20 MPH	17 3.35%	72 3.79%	222 3.74%	243 3.87%	1851 3.51%	28 1.75%	2433 3.53%
21 to 25 MPH	18 3.55%	62 3.26%	192 3.23%	183 2.91%	1488 2.82%	26 1.63%	1969 2.86%
26 to 30 MPH	17 3.35%	52 2.74%	167 2.81%	207 3.29%	1274 2.42%	22 1.38%	1739 2.52%
31 to 35 MPH	10 1.97%	74 3.89%	221 3.72%	211 3.36%	1492 2.83%	33 2.06%	2041 2.96%
36 to 40 MPH	13 2.56%	69 3.63%	206 3.47%	191 3.04%	1171 2.22%	25 1.56%	1675 2.43%
41 to 45 MPH	33 6.51%	174 9.16%	405 6.82%	262 4.17%	1605 3.04%	33 2.06%	2512 3.64%
46 to 50 MPH	25 4.93%	82 4.32%	187 3.15%	98 1.56%	724 1.37%	13 0.81%	1129 1.64%
51 to 55 MPH	45 8.88%	195 10.26%	325 5.47%	169 2.69%	1092 2.07%	19 1.19%	1845 2.68%
56 to 60 MPH	25 4.93%	57 3.00%	107 1.80%	54 0.86%	412 0.78%	3 0.19%	658 0.95%
61 to 65 MPH	20 3.94%	85 4.47%	120 2.02%	67 1.07%	631 1.20%	4 0.25%	927 1.34%
66 to 70 MPH	22 4.34%	62 3.26%	104 1.75%	62 0.99%	730 1.38%	3 0.19%	983 1.43%
71 to 75 MPH	3 0.59%	15 0.79%	17 0.29%	12 0.19%	116 0.22%	0 0.00%	163 0.24%
76 to 80 MPH	7 1.38%	7 0.37%	13 0.22%	6 0.10%	26 0.05%	0 0.00%	59 0.09%
81 to 85 MPH	4 0.79%	2 0.11%	1 0.02%	1 0.02%	3 0.01%	0 0.00%	11 0.02%
86 to 90 MPH	1 0.20%	2 0.11%	2 0.03%	2 0.03%	2 0.00%	0 0.00%	9 0.01%
96 to 100 MPH	1 0.20%	0 0.00%	1 0.02%	1 0.02%	6 0.01%	0 0.00%	9 0.01%
Over 100 MPH	1 0.20%	0 0.00%	0 0.00%	0 0.00%	1 0.00%	0 0.00%	2 0.00%
E Stationary	8 1.58%	21 1.11%	45 0.76%	43 0.68%	440 0.83%	24 1.50%	581 0.84%
Unknown	134 26.43%	447 23.53%	2146 36.15%	2897 46.11%	22706 43.07%	965 60.31%	29295 42.49%
Not Applicable	7 1.38%	40 2.11%	149 2.51%	135 2.15%	2106 3.99%	146 9.13%	2583 3.75%
TOTAL	507 0.74%	1900 2.76%	5937 8.61%	6283 9.11%	52723 76.47%	1600 2.32%	68950 100.00%

6.4 Dicussion: C025 Probability of being killed x C224 Speed at Impact

The display above presents information on the effect of increased impact speed on the severity of all Senior crashes. Notice the red in the Fatality cells as speeds increase. What is more interesting is the probability that an injury crash results in a fatality as a function of impact speed. This is given in the following table using 31-35 MPH as the base speed for the third column, which is the fatality probability multiplier from this base as the speeds increase.

Speed at Impact	Fatality Odds (1 in …)	Increase Probability above 31-35
31 to 35 MPH	204.1	1
36 to 40 MPH	128.8	1.6
41 to 45 MPH	76.1	2.7
46 to 50 MPH	42.2	4.5
51 to 55 MPH	41.0	5.0
56 to 60 MPH	26.3	7.8
61 to 65 MPH	46.4	****
66 to 70 MPH	44.7	****
71 to 75 MPH	54.3	****
76 to 80 MPH	8.4	24.2
81 to 85 MPH	2.8	74.2
86 to 90 MPH	****	****
91 to 95 MPH	****	****
96 to 100 MPH	****	****
Over 100 MPH	****	****

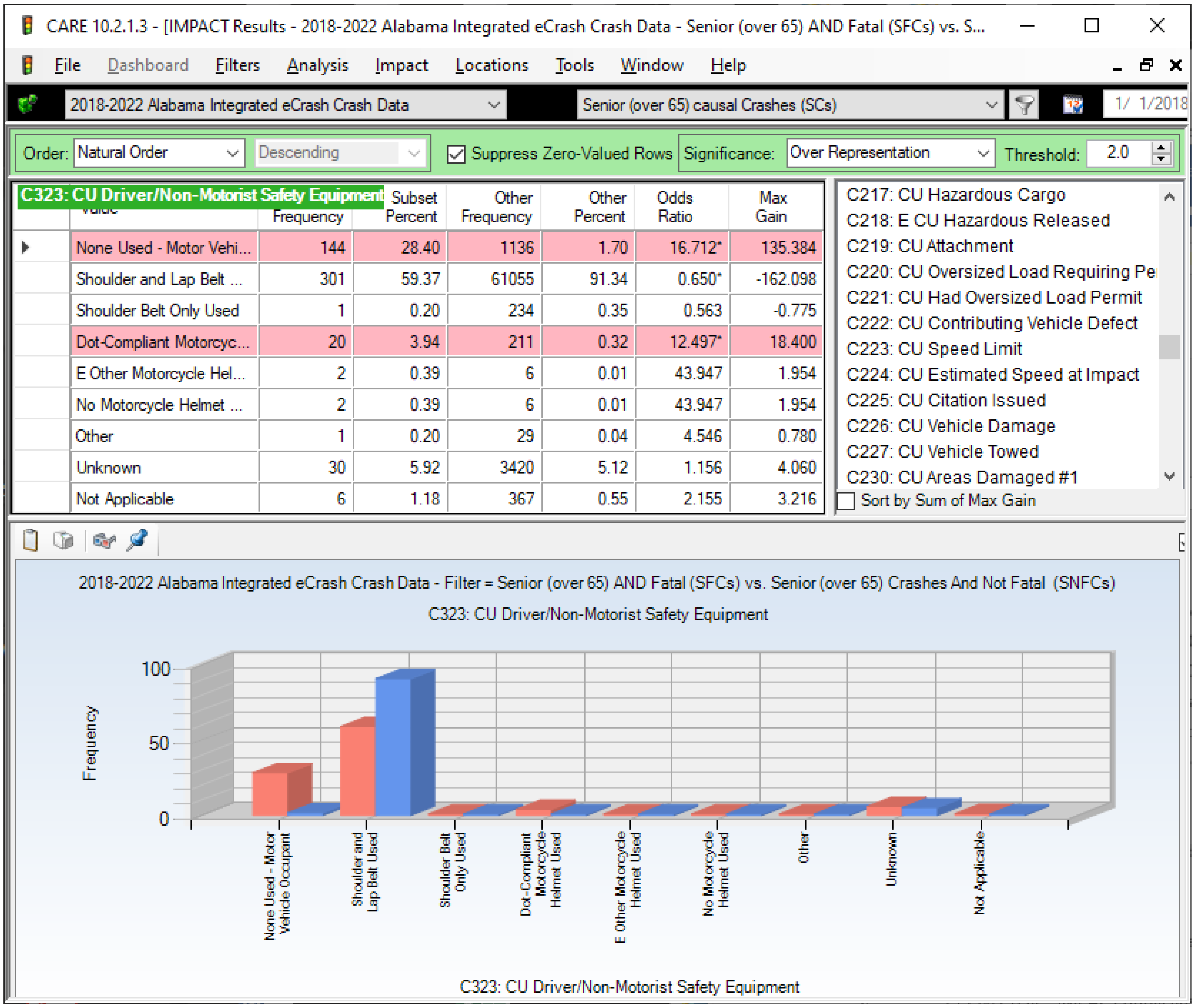
**** Insufficient Data to Calculate

The last column of the above table gives the fatality probability multiplier based on the lowest probability (31-35 MPH), to which the relative value of 1.0 (not a probability) was assigned. The probabilities in the form of "**1 in X**" are given in the middle column. For example, the probability of a Senior crash at 46-50 MPH being fatal is one in 42.2 Senior crashes. This is 4.5 times the probability of the impact speed in the 31 to 35 range. A crash at 81-85 MPH has 74.2 times the probability of being fatal as does one at 31-35 MPH.

Obviously, speed kills, and a reduction in speed at impact by as little as 5 MPH can have a major effect on whether or not that crash is fatal. On average, the reduction in impact speeds by 10 MPH cuts the number of fatal crashes in half. This is one reason that selective enforcement is effective – even officer presence generally causes some speed reduction. However, there is another major factor in effect here as well – the failure of SFC and SNFC drivers to be properly restrained, which will be covered in the next separate attribute below (6.5; Restraint Use by Causal Drivers …). This is further multiplied by Impaired Driving because Impaired Drivers have been found to have a much lower restraint use than those not impaired

6.5 C323 Restraint Use by Drivers in SFCs vs SNFCs

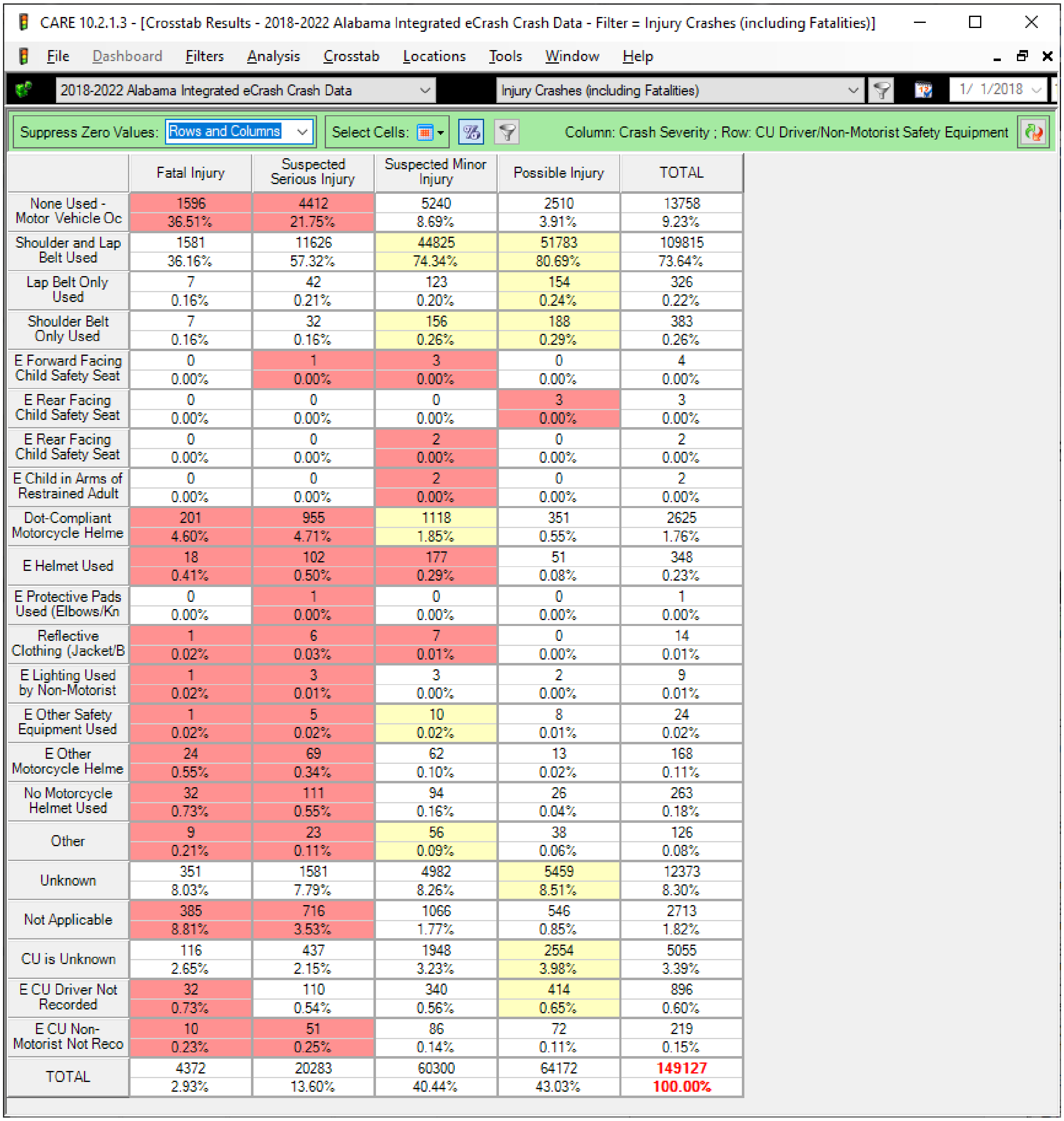
The following display presents a restraint-use comparison of SFCs driver safety belt use compared to that for all drivers in SNFCs, over the same five-year time period.



C323: CU Driver/Non-Motorist Safety Equipment	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
None Used - Motor Vehi...	144	28.40	1136	1.70	16.712*	135.384
Shoulder and Lap Belt ...	301	59.37	61055	91.34	0.650*	-162.098
Shoulder Belt Only Used	1	0.20	234	0.35	0.563	-0.775
Dot-Compliant Motorcyc...	20	3.94	211	0.32	12.497*	18.400
E Other Motorcycle Hel...	2	0.39	6	0.01	43.947	1.954
No Motorcycle Helmet ...	2	0.39	6	0.01	43.947	1.954
Other	1	0.20	29	0.04	4.546	0.780
Unknown	30	5.92	3420	5.12	1.156	4.060
Not Applicable	6	1.18	367	0.55	2.155	3.216

The proportion of failure to use proper restraints is 28.40% for Senior Fatal Crashes. The Odds Ratio is a large 16.712, showing that their failure to use restraints is close to 17 times that of the Non-Fatal Senior crashes. Shoulder and Lap Belt Used is over-represented by SNFCs in about double (Odds Ratio 1/0.650 = 1.54 times the expected use in comparison to Fatal Senior Crash (SFC) seatbelt usage. Clearly, being unrestrained contributes heavily to chances of a senior crash resulting in death.

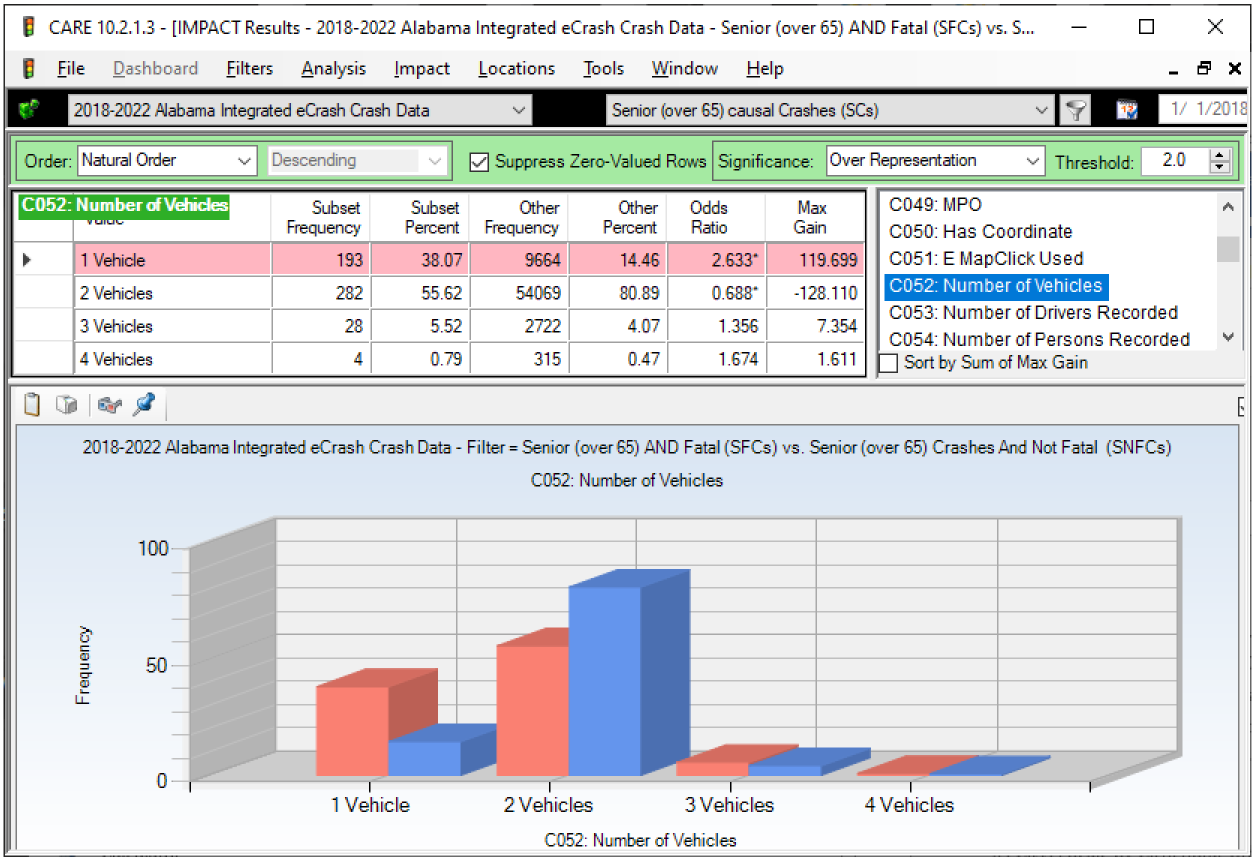
6.6 Crosstabulation: C025 Crash Severity x C323 Restraint Use (all injury)



	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	TOTAL
None Used - Motor Vehicle Oc	1596 36.51%	4412 21.75%	5240 8.69%	2510 3.91%	13758 9.23%
Shoulder and Lap Belt Used	1581 36.16%	11626 57.32%	44825 74.34%	51783 80.69%	109815 73.64%
Lap Belt Only Used	7 0.16%	42 0.21%	123 0.20%	154 0.24%	326 0.22%
Shoulder Belt Only Used	7 0.16%	32 0.16%	156 0.26%	188 0.29%	383 0.26%
E Forward Facing Child Safety Seat	0 0.00%	1 0.00%	3 0.00%	0 0.00%	4 0.00%
E Rear Facing Child Safety Seat	0 0.00%	0 0.00%	0 0.00%	3 0.00%	3 0.00%
E Rear Facing Child Safety Seat	0 0.00%	0 0.00%	2 0.00%	0 0.00%	2 0.00%
E Child in Arms of Restrained Adult	0 0.00%	0 0.00%	2 0.00%	0 0.00%	2 0.00%
Dot-Compliant Motorcycle Helme	201 4.60%	955 4.71%	1118 1.85%	351 0.55%	2625 1.76%
E Helmet Used	18 0.41%	102 0.50%	177 0.29%	51 0.08%	348 0.23%
E Protective Pads Used (Elbows/Kn	0 0.00%	1 0.00%	0 0.00%	0 0.00%	1 0.00%
Reflective Clothing (Jacket/B	1 0.02%	6 0.03%	7 0.01%	0 0.00%	14 0.01%
E Lighting Used by Non-Motorist	1 0.02%	3 0.01%	3 0.00%	2 0.00%	9 0.01%
E Other Safety Equipment Used	1 0.02%	5 0.02%	10 0.02%	8 0.01%	24 0.02%
E Other Motorcycle Helme	24 0.55%	69 0.34%	62 0.10%	13 0.02%	168 0.11%
No Motorcycle Helmet Used	32 0.73%	111 0.55%	94 0.16%	26 0.04%	263 0.18%
Other	9 0.21%	23 0.11%	56 0.09%	38 0.06%	126 0.08%
Unknown	351 8.03%	1581 7.79%	4982 8.26%	5459 8.51%	12373 8.30%
Not Applicable	385 8.81%	716 3.53%	1066 1.77%	546 0.85%	2713 1.82%
CU is Unknown	116 2.65%	437 2.15%	1948 3.23%	2554 3.98%	5055 3.39%
E CU Driver Not Recorded	32 0.73%	110 0.54%	340 0.56%	414 0.65%	896 0.60%
E CU Non-Motorist Not Reco	10 0.23%	51 0.25%	86 0.14%	72 0.11%	219 0.15%
TOTAL	4372 2.93%	20283 13.60%	60300 40.44%	64172 43.03%	149127 100.00%

Calculations are based on <u>all injury</u> (including fatal) crashes and all ages.
Odds of death <u>not using</u> restraints = 13,758 fatal crashes/1,596 deaths = one in 8.6 injury crashes.
Odds of death <u>using</u> restraints = 109,815 fatal crashes/1,581 deaths = one in 68.8 injury crashes.
Risk of death is increased by an average factor of 8.0 times when not using proper restraints.

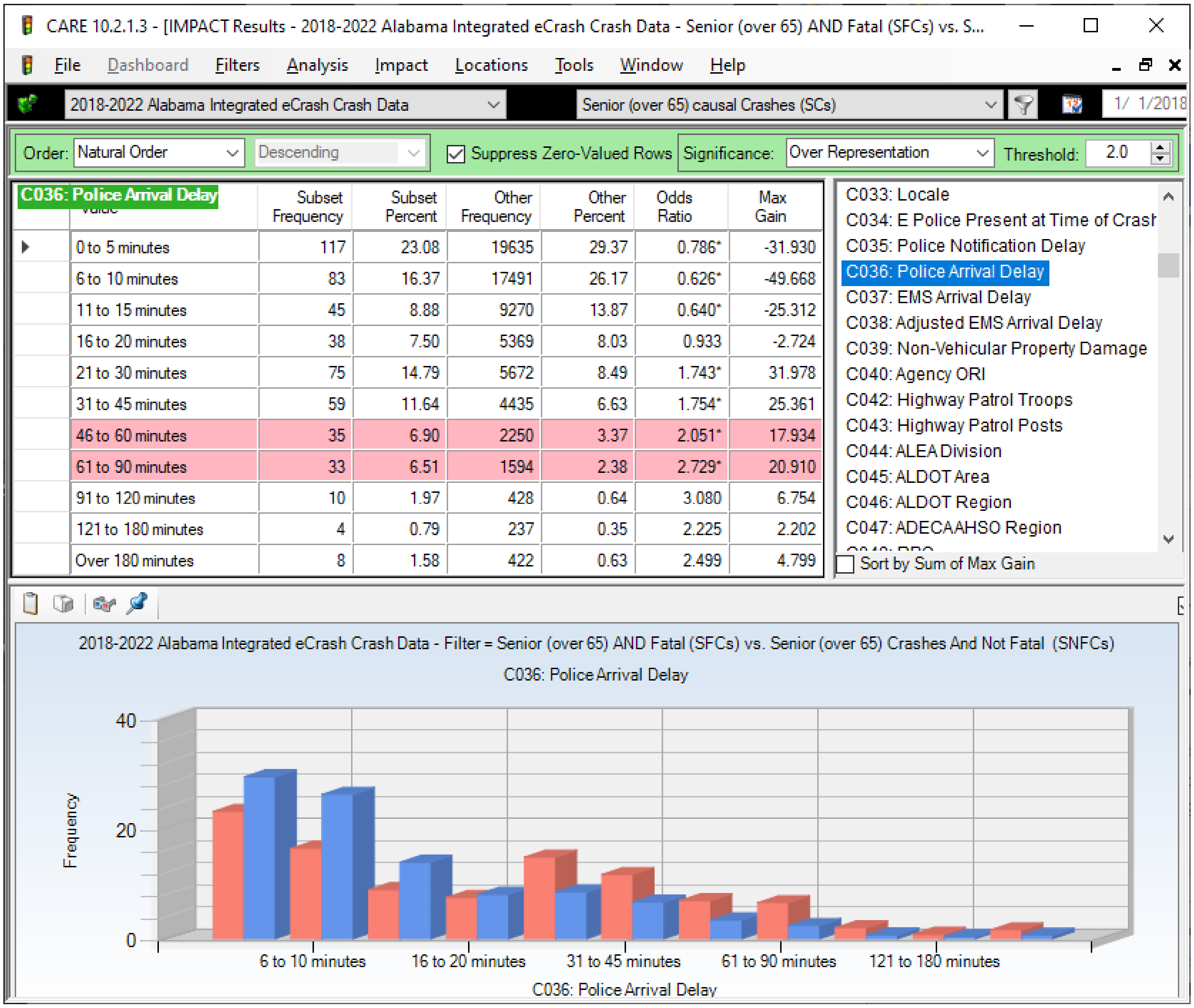
6.7 C052 Number of Vehicles Involved (SFCs vs SNFCs)



C052: Number of Vehicles	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	193	38.07	9664	14.46	2.633*	119.699
2 Vehicles	282	55.62	54069	80.89	0.688*	-128.110
3 Vehicles	28	5.52	2722	4.07	1.356	7.354
4 Vehicles	4	0.79	315	0.47	1.674	1.611

The Number of Vehicles in the table above are in their natural order. One and two vehicle crashes both showed significant differences, but for the opposite reason. Two vehicles had fewer SFCs than expected, while single vehicle crashes had more than expected. This is not calculated if the sample size is less than 20. However, the Odds Ratio is an indication of the probability of a crash being fatal, and it generally increases with the number of vehicles involved in the crash.

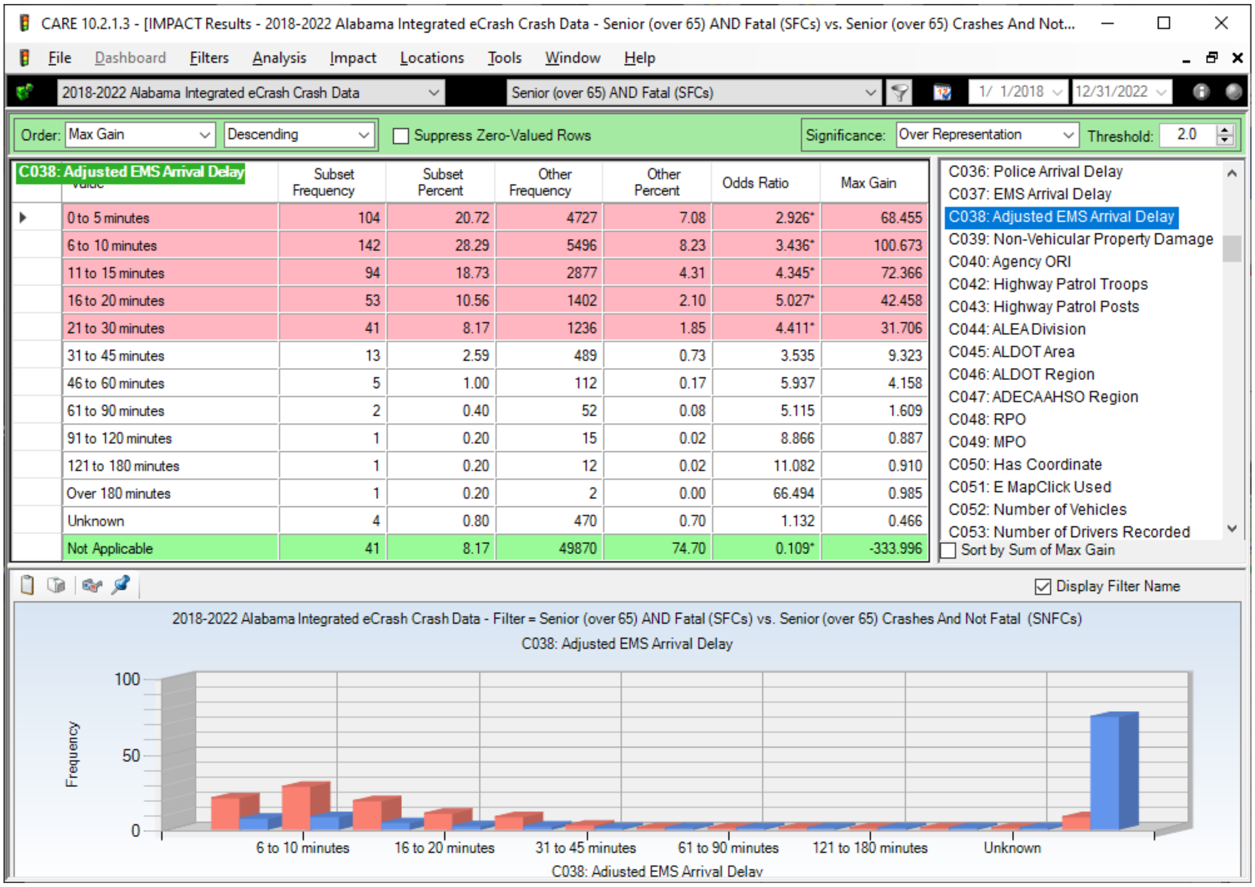
6.8 C036 Police Arrival Delay (SFCs vs SNFCs)



C036: Police Arrival Delay	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	117	23.08	19635	29.37	0.786*	-31.930
6 to 10 minutes	83	16.37	17491	26.17	0.626*	-49.668
11 to 15 minutes	45	8.88	9270	13.87	0.640*	-25.312
16 to 20 minutes	38	7.50	5369	8.03	0.933	-2.724
21 to 30 minutes	75	14.79	5672	8.49	1.743*	31.978
31 to 45 minutes	59	11.64	4435	6.63	1.754*	25.361
46 to 60 minutes	35	6.90	2250	3.37	2.051*	17.934
61 to 90 minutes	33	6.51	1594	2.38	2.729*	20.910
91 to 120 minutes	10	1.97	428	0.64	3.080	6.754
121 to 180 minutes	4	0.79	237	0.35	2.225	2.202
Over 180 minutes	8	1.58	422	0.63	2.499	4.799

SFC police arrival delays reflect the issues in finding out about the crash and getting to the scene, especially at night. All of the delay times of 21 minutes or more were over-represented for SFCs, most with high Odds Ratios. SFCs are under-represented in all delay times below 21 minutes, of which three of the four were statistically significant. The analysis below shows that EMS arrival delay times are generally of much shorter duration.

6.9 C038 Adjusted EMS Arrival Delay

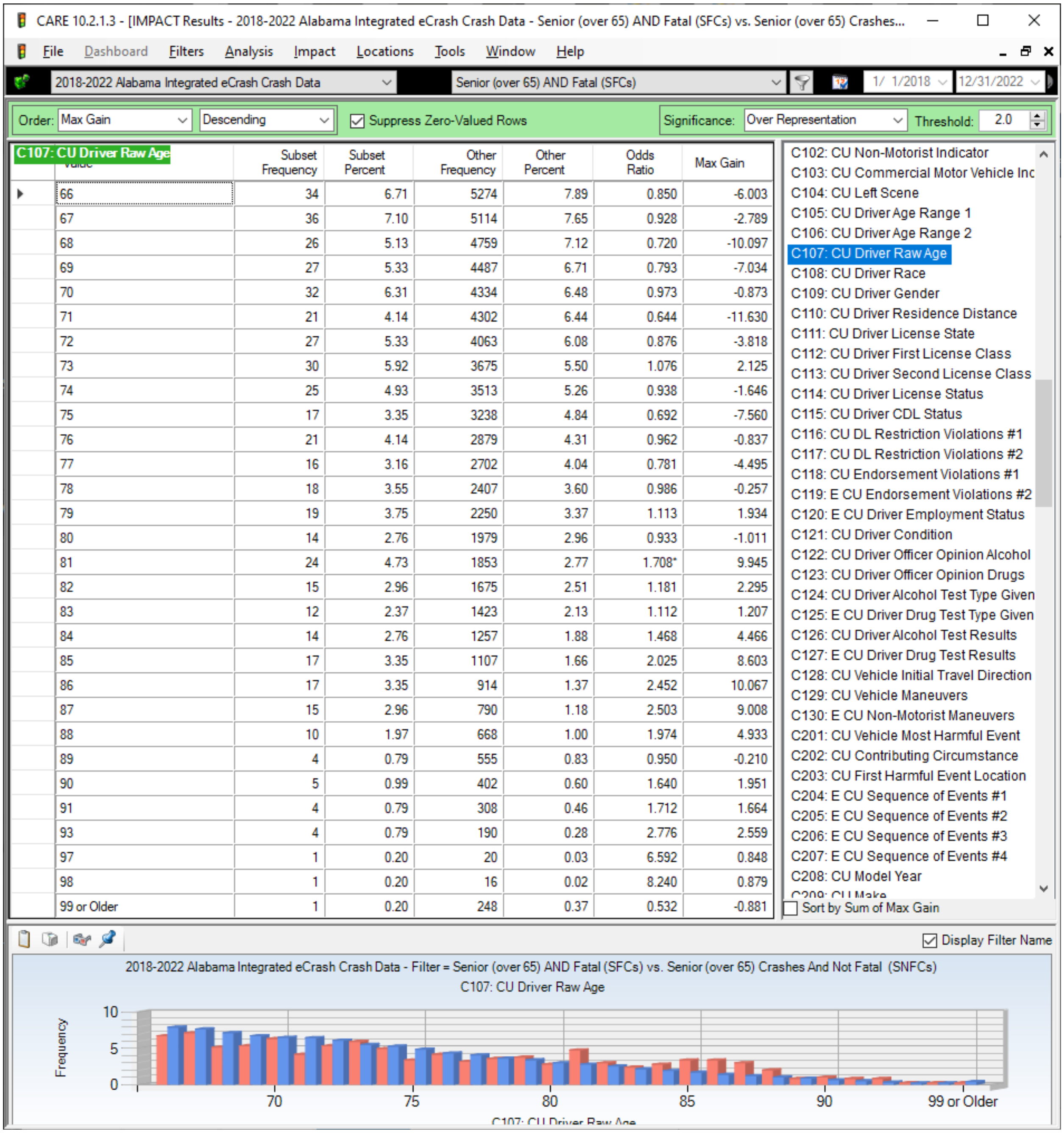


C038: Adjusted EMS Arrival Delay Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	104	20.72	4727	7.08	2.926*	68.455
6 to 10 minutes	142	28.29	5496	8.23	3.436*	100.673
11 to 15 minutes	94	18.73	2877	4.31	4.345*	72.366
16 to 20 minutes	53	10.56	1402	2.10	5.027*	42.458
21 to 30 minutes	41	8.17	1236	1.85	4.411*	31.706
31 to 45 minutes	13	2.59	489	0.73	3.535	9.323
46 to 60 minutes	5	1.00	112	0.17	5.937	4.158
61 to 90 minutes	2	0.40	52	0.08	5.115	1.609
91 to 120 minutes	1	0.20	15	0.02	8.866	0.887
121 to 180 minutes	1	0.20	12	0.02	11.082	0.910
Over 180 minutes	1	0.20	2	0.00	66.494	0.985
Unknown	4	0.80	470	0.70	1.132	0.466
Not Applicable	41	8.17	49870	74.70	0.109*	-333.996

The vast majority of the ambulance delay times for SFCs are highly statistically significant in having proportions in the 0- to 30-minute range. Those few in the higher delay ranges probably occurred later on into the night, and some might not have been immediately discovered. A cross-tabulation of EMS delay times by roadway lighting conditions showed that 48 of the crashes with delay times over 10 minutes occurred in the Dark with the Roadway Not Lighted.

7.0 Driver and Vehicle Demographics

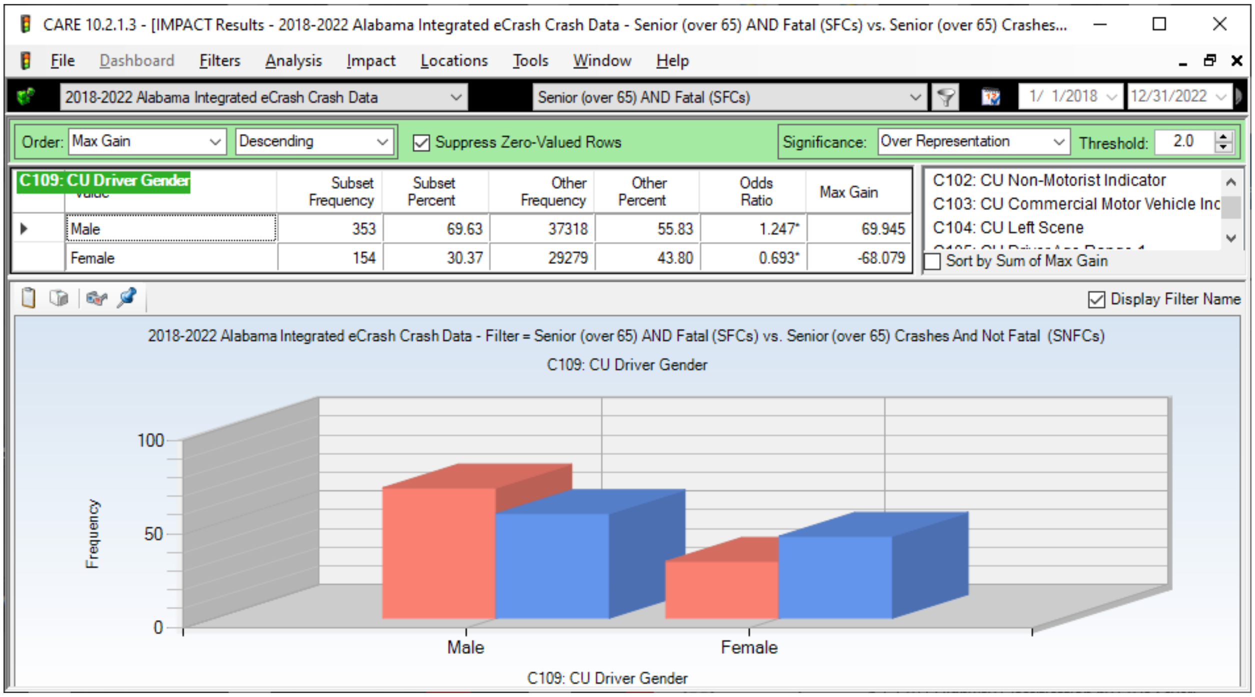
7.1 C107 Driver Raw Age



C107: CU Driver Raw Age Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
66	34	6.71	5274	7.89	0.850	-6.003
67	36	7.10	5114	7.65	0.928	-2.789
68	26	5.13	4759	7.12	0.720	-10.097
69	27	5.33	4487	6.71	0.793	-7.034
70	32	6.31	4334	6.48	0.973	-0.873
71	21	4.14	4302	6.44	0.644	-11.630
72	27	5.33	4063	6.08	0.876	-3.818
73	30	5.92	3675	5.50	1.076	2.125
74	25	4.93	3513	5.26	0.938	-1.646
75	17	3.35	3238	4.84	0.692	-7.560
76	21	4.14	2879	4.31	0.962	-0.837
77	16	3.16	2702	4.04	0.781	-4.495
78	18	3.55	2407	3.60	0.986	-0.257
79	19	3.75	2250	3.37	1.113	1.934
80	14	2.76	1979	2.96	0.933	-1.011
81	24	4.73	1853	2.77	1.708*	9.945
82	15	2.96	1675	2.51	1.181	2.295
83	12	2.37	1423	2.13	1.112	1.207
84	14	2.76	1257	1.88	1.468	4.466
85	17	3.35	1107	1.66	2.025	8.603
86	17	3.35	914	1.37	2.452	10.067
87	15	2.96	790	1.18	2.503	9.008
88	10	1.97	668	1.00	1.974	4.933
89	4	0.79	555	0.83	0.950	-0.210
90	5	0.99	402	0.60	1.640	1.951
91	4	0.79	308	0.46	1.712	1.664
93	4	0.79	190	0.28	2.776	2.559
97	1	0.20	20	0.03	6.592	0.848
98	1	0.20	16	0.02	8.240	0.879
99 or Older	1	0.20	248	0.37	0.532	-0.881

Discussion on Raw Ages
The table display above presents SFCs compared to SNFCs given in single-year age increments. No significant over- or under-representation were found except in the 81 year old category, which was the only age found to have a statistically significant over-representation. Also, the chart above indicates that 84- through 88-year-olds could have a collective over-representation.

7.2 C109 Driver Gender SFCs vs SNFCs



The male and female red and blue bar proportions each individually sum very close to 100%. So the breakdown in SFCs causal drivers is 69.63% male and 30.37% female. For "Other," SNFCs, the percentage is 55.83% male and 43.80% female. These differences in proportions certainly indicate that males are a greater cause of Senior Fatal Crashes (SFCs) than crashes in general, although their proportion of causing crashes in general is also quite high. If there are countermeasures that can be directed toward males, doing so would be much more cost-effective than those directed toward all drivers.

What makes women drivers so much safer in fatal crash comparisons? No doubt it has something to do with speed. See Section 7.3 immediately below.

7.3 Cross-tab C109 Driver Gender x C224 Speed at Impact (all SFCs)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Senior (over 65) AND Fatal (SFCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Senior (over 65) AND Fatal (SFCs) | 1/ 1/2018

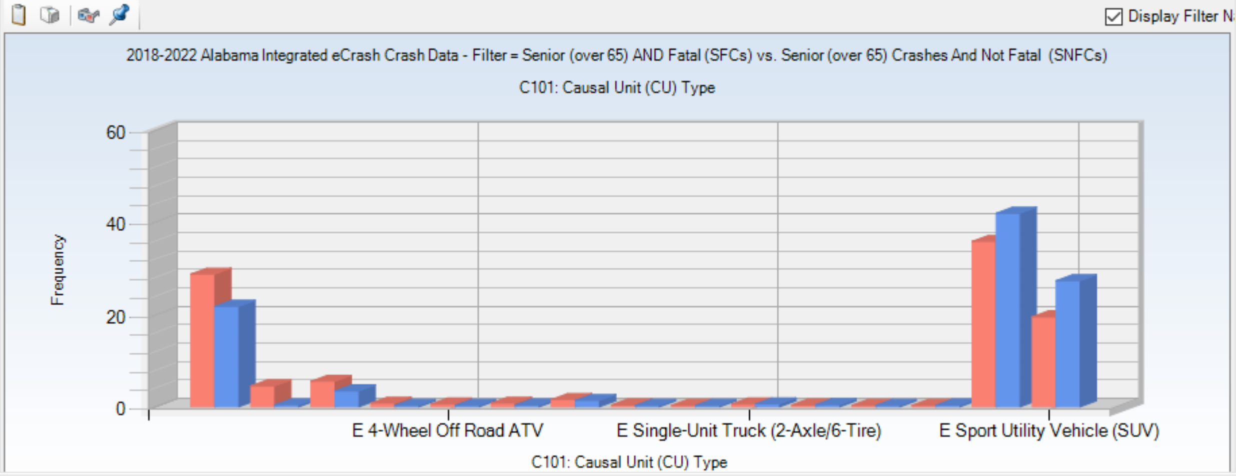
Suppress Zero Values: Rows and Columns | Select Cells: | Column: CU Driver Gender ; Row: CU Estimated Speed at Impact

	Male	Female	TOTAL
1 to 5 MPH	15 4.25%	14 9.09%	29 5.72%
6 to 10 MPH	25 7.08%	20 12.99%	45 8.88%
11 to 15 MPH	15 4.25%	7 4.55%	22 4.34%
16 to 20 MPH	10 2.83%	7 4.55%	17 3.35%
21 to 25 MPH	12 3.40%	6 3.90%	18 3.55%
26 to 30 MPH	10 2.83%	7 4.55%	17 3.35%
31 to 35 MPH	9 2.55%	1 0.65%	10 1.97%
36 to 40 MPH	9 2.55%	4 2.60%	13 2.56%
41 to 45 MPH	23 6.52%	10 6.49%	33 6.51%
46 to 50 MPH	21 5.95%	4 2.60%	25 4.93%
51 to 55 MPH	38 10.76%	7 4.55%	45 8.88%
56 to 60 MPH	19 5.38%	6 3.90%	25 4.93%
61 to 65 MPH	14 3.97%	6 3.90%	20 3.94%
66 to 70 MPH	20 5.67%	2 1.30%	22 4.34%
71 to 75 MPH	3 0.85%	0 0.00%	3 0.59%
76 to 80 MPH	5 1.42%	2 1.30%	7 1.38%
81 to 85 MPH	4 1.13%	0 0.00%	4 0.79%
86 to 90 MPH	1 0.28%	0 0.00%	1 0.20%
96 to 100 MPH	1 0.28%	0 0.00%	1 0.20%
Over 100 MPH	1 0.28%	0 0.00%	1 0.20%
E Stationary	6 1.70%	2 1.30%	8 1.58%
Unknown	88 24.93%	46 29.87%	134 26.43%
Not Applicable	4 1.13%	3 1.95%	7 1.38%
TOTAL	353 69.63%	154 30.37%	507 100.00%

Number of males and females involved in SFCs over 60 MPH: 55 Male and 10 Female. The number of male fatal crashes over 60 MPH is 5.5 times than that of the females.

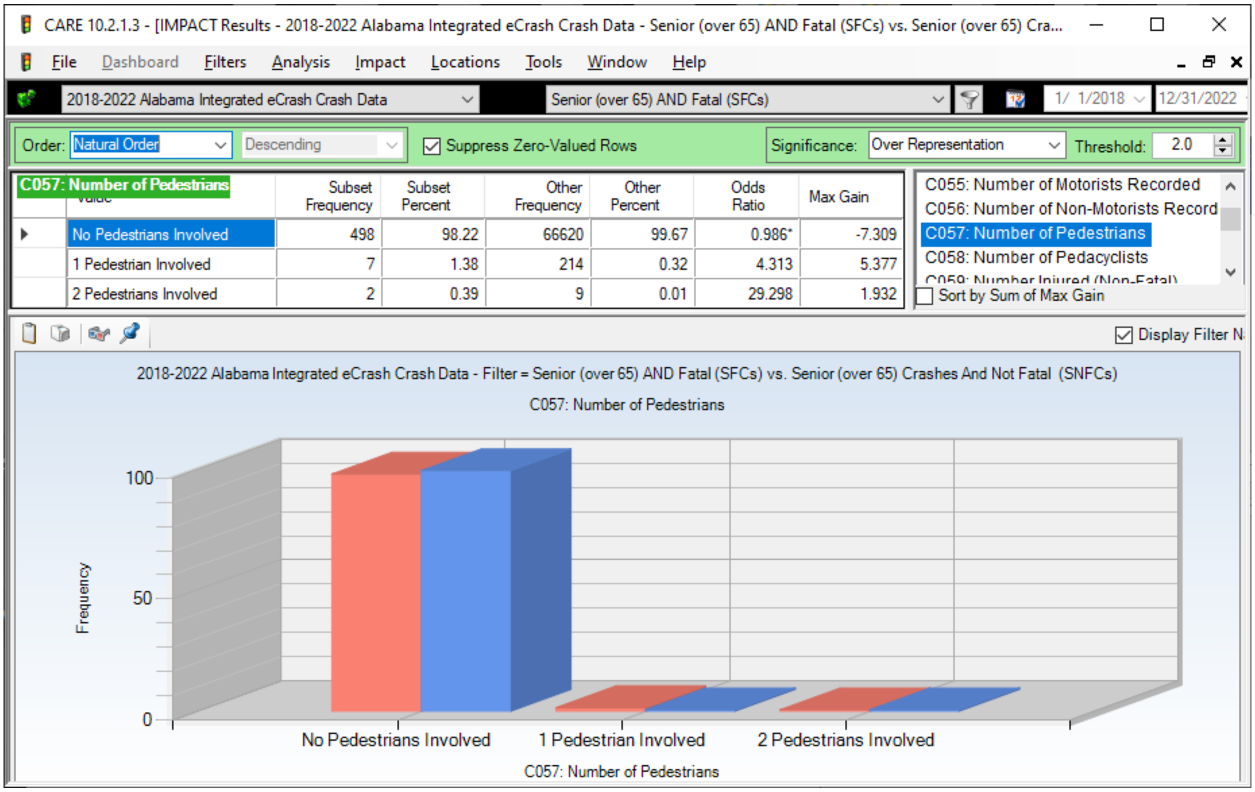
7.4 C101 Causal Vehicle Type SFCs vs SNFCs

C101: Causal Unit (CU) Type Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Pick-Up (Four-Tire Light Truck)	146	28.80	14563	21.79	1.322*	35.541
Motorcycle	23	4.54	272	0.41	11.148*	20.937
E Mini-van	28	5.52	2312	3.46	1.597*	10.464
E Other Motorized Cycle/Lo...	4	0.79	15	0.02	35.157	3.886
E 4-Wheel Off Road ATV	3	0.59	24	0.04	16.480	2.818
E Single-Unit Truck (3 Axles ...	4	0.79	252	0.38	2.093	2.089
E Tractor/Semi-Trailer	8	1.58	920	1.38	1.146	1.022
E Truck (6 or 7) with Trailer	2	0.39	145	0.22	1.818	0.900
E Other Heavy Truck (Cann...	1	0.20	43	0.06	3.066	0.674
E Single-Unit Truck (2-Axle/...	3	0.59	414	0.62	0.955	-0.140
E Cargo Van (10000 lbs or L...	2	0.39	311	0.47	0.848	-0.359
Station Wagon	1	0.20	192	0.29	0.687	-0.456
E Other Bus (Seats More tha...	1	0.20	243	0.36	0.543	-0.843
Passenger Car	182	35.90	28080	42.01	0.855*	-30.985
E Sport Utility Vehicle (SUV)	99	19.53	18301	27.38	0.713*	-39.812



Pick Ups 146, Motorcycles 23, and Mini-vans 28 had the highest proportional over-representations for SFCs. The proportion of Sport Utility Vehicles (19.53%, 99) and Passenger Cars (35.90%, 182) resulted in their placement at the bottom of the list, indicating that they were under-represented in SFCs despite their high frequencies.

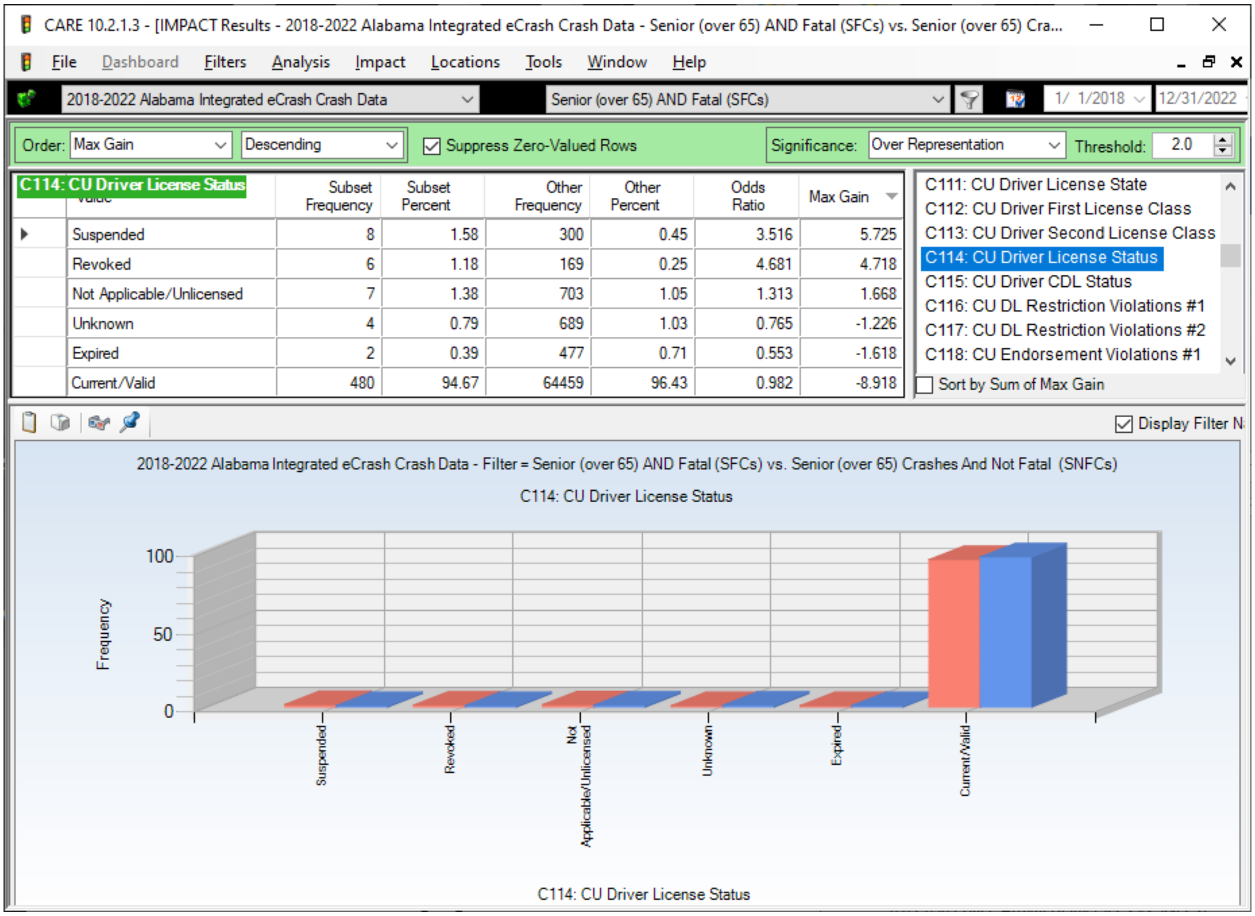
7.5 C057 Number of Pedestrians



Pedestrians were not nearly as significant in Senior Fatal Crashes as they were with the younger driver ages and most other crash types.

For a detailed study of pedestrian crashes in Alabama, please see:
http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf

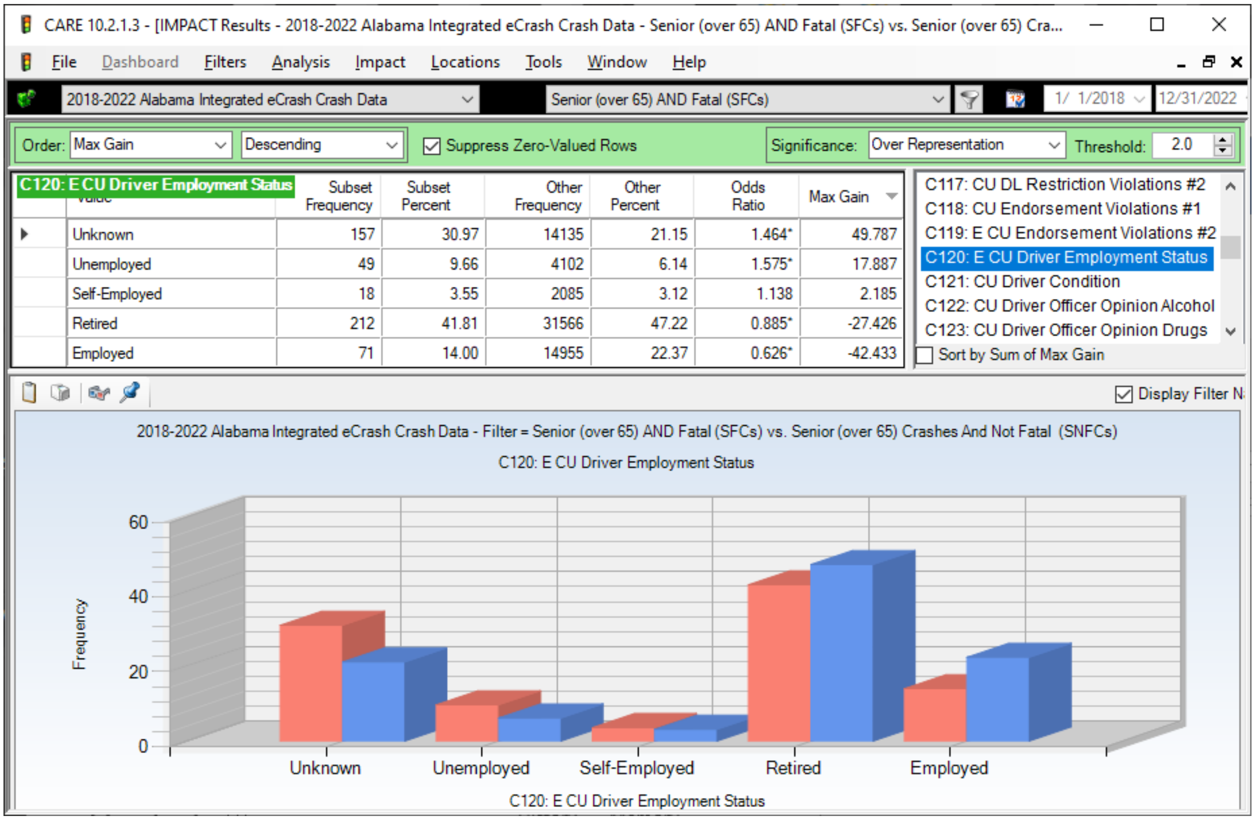
7.6 C114 Driver License Status



C114: CU Driver License Status Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Suspended	8	1.58	300	0.45	3.516	5.725
Revoked	6	1.18	169	0.25	4.681	4.718
Not Applicable/Unlicensed	7	1.38	703	1.05	1.313	1.668
Unknown	4	0.79	689	1.03	0.765	-1.226
Expired	2	0.39	477	0.71	0.553	-1.618
Current/Valid	480	94.67	64459	96.43	0.982	-8.918

Driver's License Status is not nearly the issue with Senior drivers as it is in many other crash types. Only 16 were Suspended, Revoked or Expired, which is not enough to draw any conclusions.

7.7 C120 Driver Employment Status

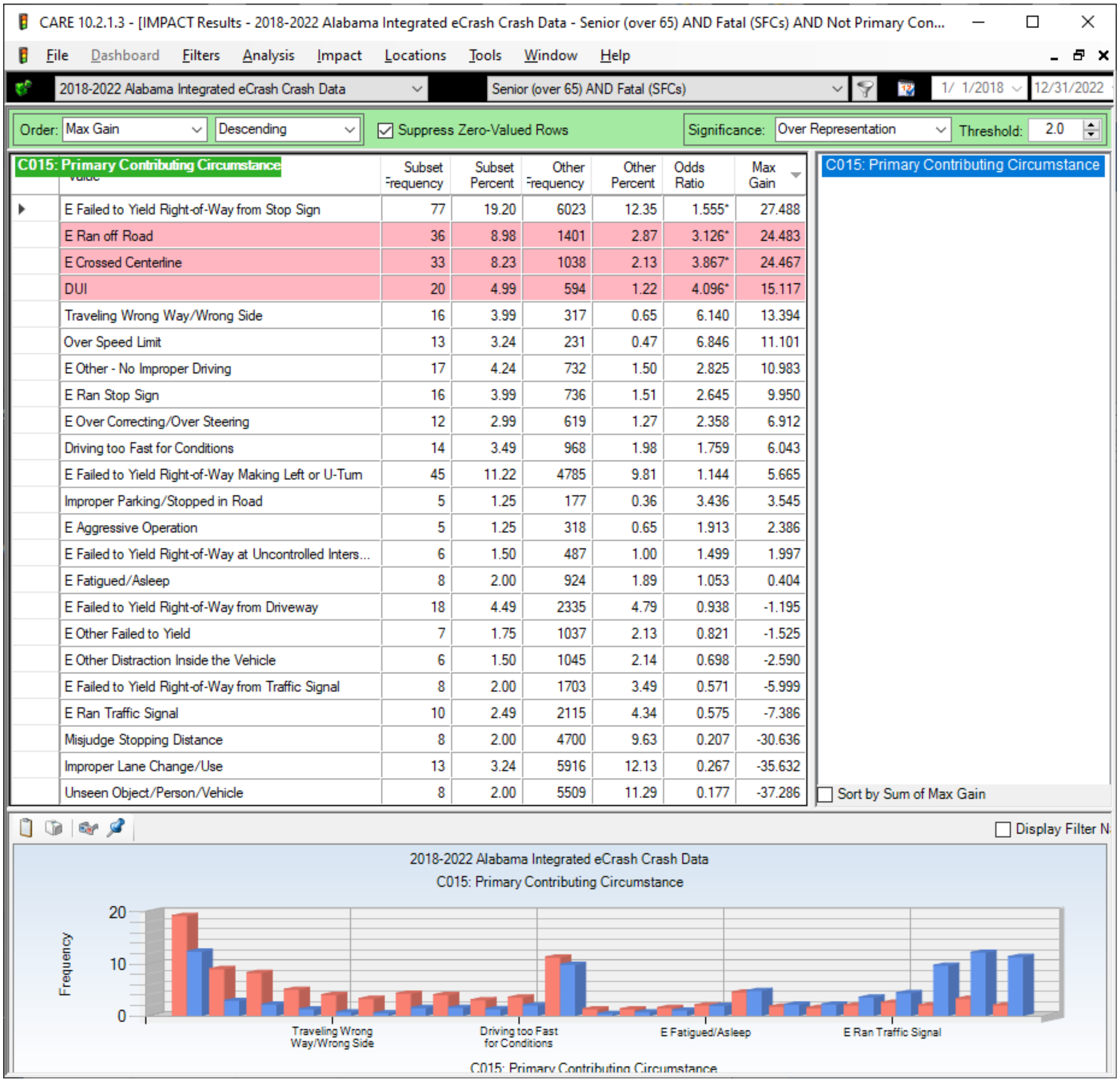


C120: E CU Driver Employment Status	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Unknown	157	30.97	14135	21.15	1.464*	49.787
Unemployed	49	9.66	4102	6.14	1.575*	17.887
Self-Employed	18	3.55	2085	3.12	1.138	2.185
Retired	212	41.81	31566	47.22	0.885*	-27.426
Employed	71	14.00	14955	22.37	0.626*	-42.433

No conclusions can be drawn from these results in that it would seem that the driver's age itself accounts for their being in most of the various categories.

8.0 Driver Behavior

8.1 C015 Primary Contributing Circumstances (Items < 5 Crashes Removed)



C015: Primary Contributing Circumstance Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Failed to Yield Right-of-Way from Stop Sign	77	19.20	6023	12.35	1.555*	27.488
E Ran off Road	36	8.98	1401	2.87	3.126*	24.483
E Crossed Centerline	33	8.23	1038	2.13	3.867*	24.467
DUI	20	4.99	594	1.22	4.096*	15.117
Traveling Wrong Way/Wrong Side	16	3.99	317	0.65	6.140	13.394
Over Speed Limit	13	3.24	231	0.47	6.846	11.101
E Other - No Improper Driving	17	4.24	732	1.50	2.825	10.983
E Ran Stop Sign	16	3.99	736	1.51	2.645	9.950
E Over Correcting/Over Steering	12	2.99	619	1.27	2.358	6.912
Driving too Fast for Conditions	14	3.49	968	1.98	1.759	6.043
E Failed to Yield Right-of-Way Making Left or U-Turn	45	11.22	4785	9.81	1.144	5.665
Improper Parking/Stopped in Road	5	1.25	177	0.36	3.436	3.545
E Aggressive Operation	5	1.25	318	0.65	1.913	2.386
E Failed to Yield Right-of-Way at Uncontrolled Inters...	6	1.50	487	1.00	1.499	1.997
E Fatigued/Asleep	8	2.00	924	1.89	1.053	0.404
E Failed to Yield Right-of-Way from Driveway	18	4.49	2335	4.79	0.938	-1.195
E Other Failed to Yield	7	1.75	1037	2.13	0.821	-1.525
E Other Distraction Inside the Vehicle	6	1.50	1045	2.14	0.698	-2.590
E Failed to Yield Right-of-Way from Traffic Signal	8	2.00	1703	3.49	0.571	-5.999
E Ran Traffic Signal	10	2.49	2115	4.34	0.575	-7.386
Misjudge Stopping Distance	8	2.00	4700	9.63	0.207	-30.636
Improper Lane Change/Use	13	3.24	5916	12.13	0.267	-35.632
Unseen Object/Person/Vehicle	8	2.00	5509	11.29	0.177	-37.286

8.2 Discussion of Primary Contributing Circumstances (PCC) Results Above

These results demonstrate the driver behaviors as they were defined by the C015, Primary Contributing Circumstances (PCCs), which accompanied SFCs and SNFCs. All SFC over-representations in their expected proportion are as follows, with percentages:

SFCs PCC Overrepresented/Freq	SFC%	SNFC%
Failed to Yield ROW from Stop 77	19.20%*	12.35%
Ran off Road 36	8.98%**	2.87%
Crossed Centerline 33	8.23%**	2.13%
DUI 20	4.99%**	1.22%
Traveling Wrong Way/Side 16	3.99%	0.65%
Over Speed Limit 13	3.24%	0.47%
Ran Stop Sign 16	3.99%	1.51%
Over Correcting/Over Steering 12	2.99%	1.27%
Driving too Fast for Conditions 14	3.49%	1.98%
Failed to Yield ROW-Left or U 45	11.22%	9.81%

* Statistically significant difference
** Highly significant difference (more than 10%)

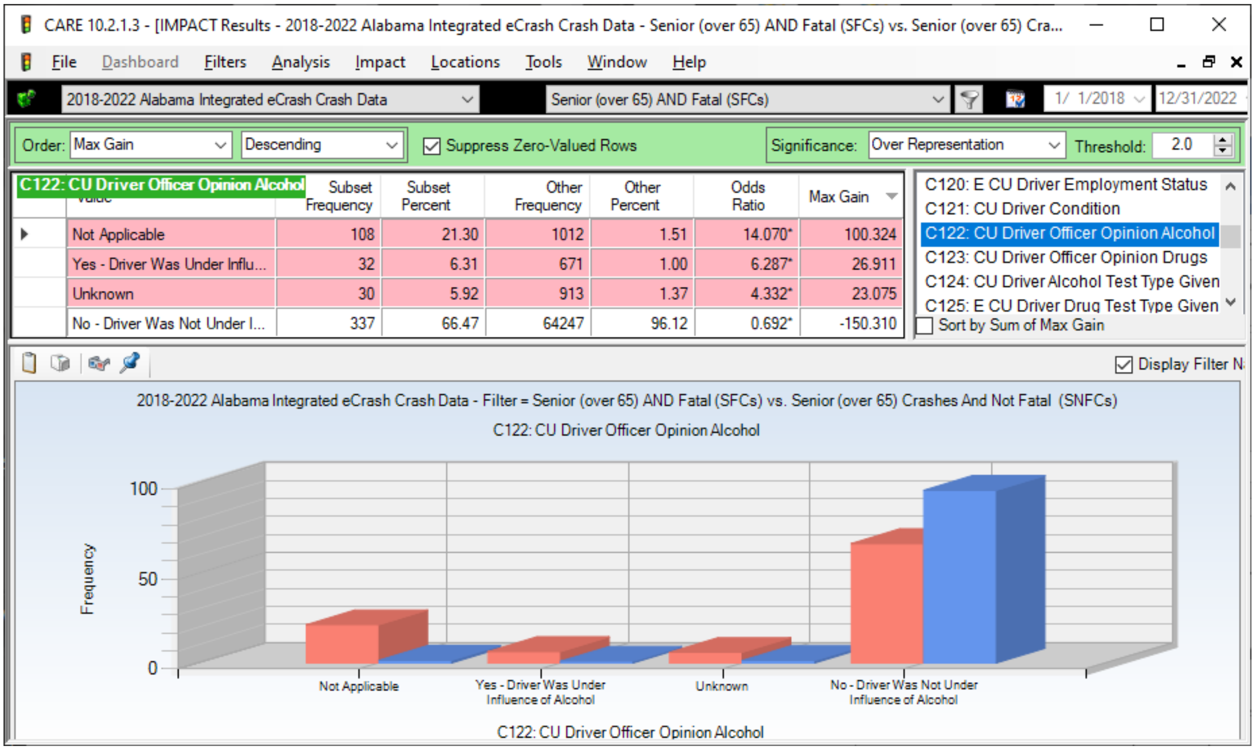
None of the items listed here or in the IMPACT table are necessarily mutually exclusive from the others. Each should be viewed in terms of their relative positions in the table as opposed to any one of them being the absolute cause.

It is clear that the big killers are Failed to Yield ROW (2 + Ran Stop Sign), Ran off Road, Crossed Centerline, Traveling Wrong Way/Side, DUI, Over Speed Limit, and Driving too Fast for Conditions.

There are some high frequency items lower down on the list, but their proportions are not as high as the corresponding SNFCs.

We will have a comparison of Young and Senior Drivers in Section 9. At that point the role that risk acceptance plays will become clearer.

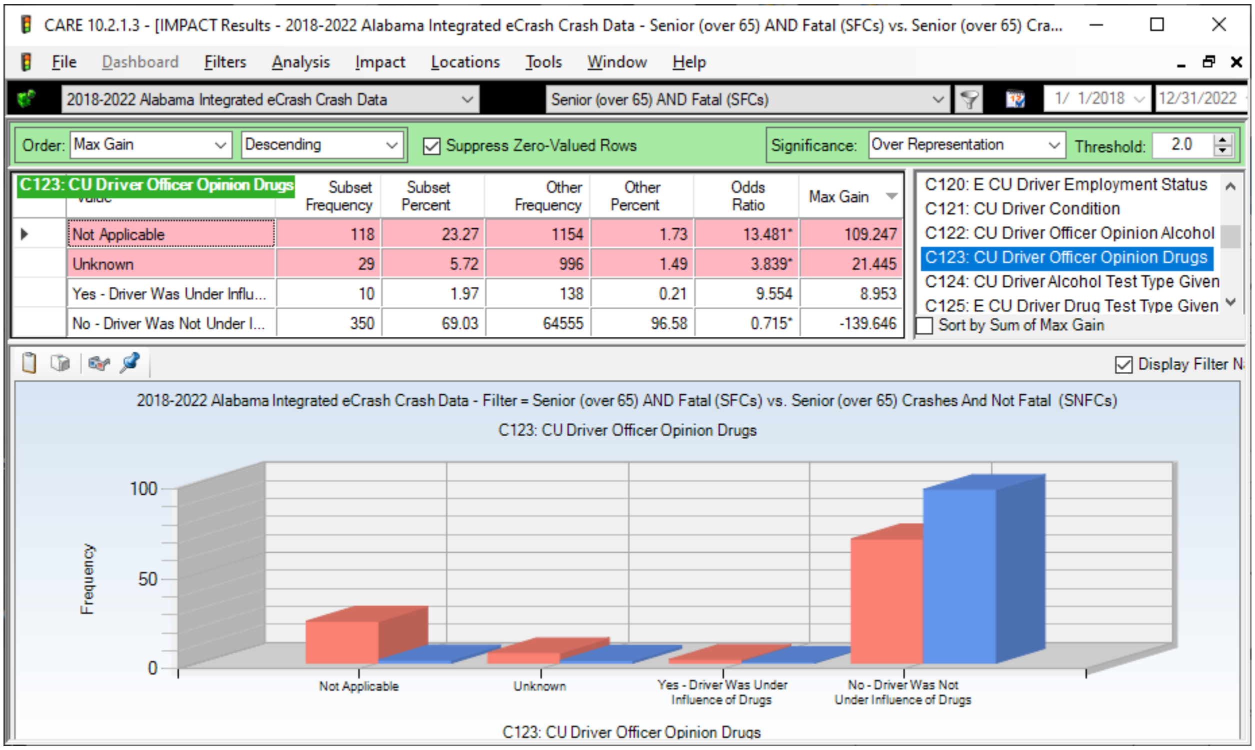
8.3 C122 CU Driver Officer's Opinion Alcohol



Impaired Driving/Alcohol was indicated as one cause of the crash for 6.31% of the SFCs, and 1.00% of the SNFCs. This gives an Odds Ratio of 6.287. ID/DUI tends to be under-reported, and there is no doubt that its reduction would have a major impact on reducing the number of fatal crashes at all hours of the day. From the positive perspective, 96.12% of the SNFCS were reported to be not ID alcohol, but only 66.47% of the SFCs were sober in this regard.

Probability of crash being fatal if causal driver is alcohol impaired (32 + 671)/32 = one in 22.00.
Probability of fatal if CU driver is not alcohol impaired = (337+64247)/337 one in 191.64.
Alcohol ID Multiplier = 191.64/22 = 8.71 times the non-alcohol probability.

8.4 C123 CU Driver Officer's Opinion Drugs (other than alcohol)



C123: CU Driver Officer Opinion Drugs	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Not Applicable	118	23.27	1154	1.73	13.481*	109.247
Unknown	29	5.72	996	1.49	3.839*	21.445
Yes - Driver Was Under Influ...	10	1.97	138	0.21	9.554	8.953
No - Driver Was Not Under I...	350	69.03	64555	96.58	0.715*	-139.646

The reported drug use proportion in the 10 SFCs affected (1.97%) was considerably less than that for alcohol (6.31%). In both cases (SFCs and SNFCs), drug use is difficult to detect compared to alcohol, which has well-established tests for the blood-alcohol level that are much easier to administer. Our conclusion is that both alcohol and non-alcohol drug use are major contributors to increasing the frequency and severity of Senior Fatal Crashes.

From the positive perspective, 96.58% of the SNFCS were not Under the Influence of Non-Alcohol Drugs, but only 69.03% of the SFCs were sober in this regard. This is amazingly consistent to the comparable results for Alcohol. Both cases indicate the increased probability of a crash being fatal if the causal driver (or pedestrian) is Impaired. Probability of crash being fatal if driver is drug impaired = 10+138)/10 = one in 14.80. Probability of fatal if driver is not drug impaired = (350+64555)/350, one in 185.44. This results in a Drug ID Multiplier of 23.31. This indicates that the non-alcohol drugs multiplier (12.53) is much higher than the alcohol multiplier (which given above was 8.71). Potential reason indicated for this is that the effects of Drugs in a senior collision tends to be much deadlier than those of alcohol as far as survival is concerned.

9.0 Risk Taking

This section was also added to the Youth Fatal Crashes special study.

This part of the study involved a comparison of Young vehicle drivers against Senior vehicle drivers to quantify the age group differences in risk acceptance. The comparison used IMPACT to compare the two subsets, where the crash subsets compared were 353 Youth Fatal Crashes (YFCs) and 507 Senior Fatal Crashes (SFCs). The table below presents a summary of the findings. It gives the values of the attributes. A consistent pattern of Youth Driver risk acceptance becomes clear. There are a few that might indicate that the Senior Drivers took some risks. These exceptions are marked with an asterisk, and they will be given additional consideration below.

Comparison of Youth and Senior Risk Indicators

Attribute	Youth Risk Indicator Over-Represented	Senior Risk Indicator Over-Represented
*C025 Crash Severity Fatal	353	507 (44% > than YFCs)
C008 Time of Day	8:00 PM – 6:59 PM	7:00 AM – 7:59 PM
C010 Rural or Urban	Rural	Urban
C011 Highway Classification	County & Interstate	State & Federal
*C015 Pri Contrib Circumstances	Speed, Aggression, DUI	Failure to Yield …
*C017 First Harmful Event	Tree, Rollover, Pedestrian	Coll Vehicle in Traffic
C023 Manner of Crash; C052	Single Vehicle Crash	Two-Vehicle Crash
C022 Manner of Crash	Single Vehicle	Side Impact
*C026 Intersection Related?	No	Yes
C032 Weather	Rain, Fog, Mist	Clear, Cloudy
C033 Locale	Open Country, Residential	Shopping or Business
C057 Pedestrians Involved	14	7
*C101 Causal Vehicle Type	205 Passenger Cars	146 Pick Ups
C104 Left Scene – Yes	6	1
C121 Driver Condition DUI	57 Under Influence	25 Under Influence
C122 Officer Opinion Alcohol	51 Yes DUI Alcohol	32 Yes DUI Alcohol
C123 Officer Opinion Drugs	27 Yes DUI Drugs	10 Yes DUI Drugs
*C129 Maneuver Left Turn	21	86
C129 Maneuver Curve	95	69
C203 1st Harmful Event Location	Roadside 130	On Roadway 208
C224 Speed at Impact > 61 MPH	149 (2.53 times 59)	59
C323 Seatbelt Use	180 Used 45.80%	301 Used 59.37%
C326 Driver Gender	302M 91F 23.16%F	353M 154F 30.37%F
C327 Total Ejected from Vehicle	63 16.03%	29 5.72%

*Exception to the youth driver risk acceptance pattern.

Discussion on Attributes that May be Ambiguous

Attributes were selected at random, and none were rejected because they did not demonstrate the risk-taking nature of either the older or younger drivers. This section will go through those attributes that need further explanation.

***C025 Crash Severity Fatal.** This attribute is shown to establish the framework for this part of the analysis. It could be reasoned (falsely) that because there are more SFCs than YFCs, that the Senior drivers are more prone to take risks. But recognize that there are only five age years in the YFCs, while there are 100-66 = 34 years in the SFCs. Even if we cut off all above 90, this still gives 24 years, so the number of fatal crashes per year is 507/24 = a little over 21 SFCs per driver in this subset. For the YFCs, this works out to 353/5 = 70.6 fatal crashes per driver age. The bottom line is that we should expect any numerical indicators to be higher for the Senior drivers than for the Youth drivers because there are more of them.

First three indicators. Just to get things started, let's take the first three attributes, which we believe clearly show the risk-taking nature of the YFC drivers. These are:

- C008 Time of Day. The risk indicator is in that the Youth drivers seem to prefer the late-night and early morning hours. As opposed to that, senior drivers are over-represented in the daytime hours.
- C010 Rural or Urban. Younger drivers have the vast majority (68.70%) of their fatal crashes on the rural roads, which typically involve more risk-taking that the urban roads, which are over-represented by the Senior drivers.
- C011 Highway Classification. While Interstate routes are the safest on a per-mile basis, youth driver over-representation (1.404 Odds Ratio) on county roads shows their risk-taking tendencies.

These are just a few examples to provide an understanding of the items in the table. While there are some exceptions that we will consider, over-representations in most of the attributes demonstrate the risk-taking tendencies of the youth drivers (ages 16-20 years).

Exceptions. The old adage "the exception proves the rule" may seem to be a contradiction in terms. However, if what seems to be a contradiction can be explained in terms of the rule, then it would provide further. We marked those attributes with an asterisk (*) if the interpretation of the results given might be ambiguous. These are the attributes we thought would warrant additional explanations:

- *C015 Primary Contributing Circumstances. Those most over-represented by the Youth subset were Speed, Aggressive Behavior and DUI. These in themselves are more than ample evidence of risky behavior. Failure to Yield the Right-of-Way might also be considered risky, but it is also possible that this error could be caused by some other physical limitations as opposed to risk-taking, on the part of the Senior drivers.

- *C017 First Harmful Event. Young drivers were over-represented in their striking trees, rolling over and striking pedestrians, all of which are evidence of risk acceptance. On the other hand, Collision with Vehicles in Traffic could well be a shared fault with the other vehicle involved and it would not carry the risk-taking implications that the Youth over-representations imply.
- *C026 Intersection Related? Similar reasoning might apply as we see the Senior drivers over-represented in intersection crashes, while this is not an over-representation for the Younger drivers. Any vision problems that Senior drivers might have could cause problems at intersections without their necessarily taking risks. Those that are not intersection related would indicate an unforced error.
- *C101 Causal Vehicle Type. This is not to infer that we believe Passenger Cars are more risky than Pickups, but since there was a major difference in the results of this attribute, we felt it would be of interest to include it.
- *C129 Maneuver Left Turn. Left turns are particularly difficult, and it is important that the drivers possess all of their capabilities, especially those related to vision. We see this as a problem of incapacity as opposed to risk taking. While the same thing might be true of curves in general, the significantly larger number of young driver crashes on curves would be an indication of risk-taking, and in particular, a failure to slow down.
- The two remaining that might be given special attention are Speed at Impact and Seatbelt Use, both of which show risk acceptance by the younger drivers.

While some of the attributes may be difficult to use in drawing conclusions, it should be obvious that those with clear implications show that younger drivers tend to be risk acceptors while the older drivers tend to be more risk averse.

It is important to recognize that the 16-20-year-old age groups (especially males) are quite susceptible to the tendency of risk-taking. This is partially caused by the parts of their brains that have a realistic perception of the consequences of risk-taking are not fully developed for most people until age 25.

A detailed study of risk-taking was conducted and is available at:

http://www.safehomealabama.gov/wp-content/uploads/2019/10/Youth-Risk-Taking-Analysis-v08.pdf

Recommendations were given in the categories of: family, schools, peer groups, legislation and law enforcement, and the Traffic Safety Community. If this subject is of interest to you, please read this special study and provide us with feedback (brown@cs.ua.edu).