Single Vehicle Fatal Crashes IMPACT Special Study

Single Vehicle Fatal Crashes (SVFCs) vs Single Vehicle Non-Fatal Crashes (SVNFCs)
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See http://www.safehomealabama.gov/caps-special-studies/ for all CAPS Special Studies.

0.0 Introduction

Over the five years of data (CY2018-2022) used in this study, there were 470,984 motor vehicle crashes that involved only Single Vehicles. These resulted in the following crash severities:

Severity of Single Vehicle Crashes

Severity	Single Vehicle	Non-Single Vehicle	Percent of All Crashes
Fatal Injury	1587	4372	36.30%
Suspected Serious Injury	9179	20283	45.25%
Suspected Minor Injury	34733	60300	57.60%
Possible Injury	42297	64172	65.92%
Property Damage Only	368358	581745	63.32%
Unknown	14830	19423	76.35%

The purpose of this report is to provide information by which the total number of Single Vehicle Fatal Crashes (SVFCs) may be reduced, and to reduce the severity of the potential SVFCs that do 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 4-8 present the results of a number of IMPACT evaluations of Single Vehicle Fatal Crashes (SVFCs) compared to Single Vehicle Non-Fatal Crashes (SVNFCs) 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 Single Vehicles from Single Vehicle Non-Fatal Crashes (SVNFCs). This is different from many of the other Special Studies that have been performed, which had the goal of reducing all of a particular type of crash regardless of severity, and not just those that were fatal.

IMPACT works by surfacing "over-representations." An *over-represented* attribute is found when that attribute has a greater share of Single Vehicle Fatal Crashes (SVFCs) than would be expected if its proportion were the same as that for Single Vehicle Non-Fatal Crashes (SVNFCs). That is, the SVNFC crashes are serving as a *control* to which the SVFCs are being compared to determine over-representations that indicate causes.

As a first example, over the five years of the crash data studied (CY2018-2022), we found that SVFCs for the Highway Classification attribute value of "Federal" had a 30.7% higher proportion of crashes than did the Single Vehicle Non-Fatal Crashes (SVNFCs) on Federal roads (details in Section 2.3). When such differences are statistically significant (as in this case), this surfaces characteristics that should be given additional attention, and in some cases, further

analyses are performed for *countermeasure* development. For example, additional *selective enforcement* for SVFC-related violations (e.g., excessive speed and Impaired Driving) might concentrate more on Federal roads. The Time of Day and Day-of-the-Week attributes (as discussed in Sections 5.4-5.6) are also used to focus optimal times for enforcement implementation.

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 in SVFC reduction that could be obtained if a countermeasure were applied to reduce the proportion of the Single Vehicle Fatal Crashes (SVFCs) to the proportion of Single Vehicle Non-Fatal Crashes (SVNFCs) for the particular attribute under consideration (i.e., reduce the 12.20% to 9.33% in the Federal Road example; see Section 2.3). This is called Max Gain because it is generally the maximum gain that can be expected by implementing a countermeasure. The Max Gain for each attribute value can be found in the extreme right column of the table.

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) Single Vehicle Fatal Crash Comparison by Year. Section 3 is also introductory in that it provides another IMPACT example -- a comparison for the Year attribute. After Section 3, the IMPACT comparisons between SVFCs and SVNFCs are presented under the following headings, given here with their section numbers:

- 4.0 Geographic 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 Section 1 to maintain consistency with the numbering of the analytical sections (Sections 4-8).

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, and (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 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 parenthesis). Recommendations are given for the reduction of frequency and/or severity of Single Vehicle Fatal Crashes (SVFCs) in Alabama. They are in the same ordering as the IMPACT displays to facilitate references to Sections 4.0-8.0. For the 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 either the SVFCs or SVNFCs are obtained from the comparison of their proportions with the proportions for their corresponding SVNFC control classifications. The IMPACT analyses in this study enables the determination of over-representations in either the SVFCs or the SVNFCs.

Note: subsection numbers 1.1, 1.2 and 1.3 have been omitted below in order to keep the 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 SVFCs vs SVNFCs over the five years of the study (CY2018-2022). Recommendations, which will be given 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 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 SVFC-over-represented counties with the highest potential for fatality reduction are (with their frequencies): Limestone 64, Dallas 41, Dekalb 46, and Montgomery 112. The SVNFC-over-represented counties with the highest potential for fatality reduction with their frequencies are: Madison 102, Jefferson 252, Tuscaloosa 83, and Etowah 43. It is recommended that these and other over-represented counties be given special attention for both fatality and crash reduction. Generally, the countermeasures recommended to be applied to specific geographical areas, determined by hotspot analysis, are selective enforcement for Speed and Impaired Driving, since these two violations have the highest correlation with fatal crashes.
    - City (4.2, C002) -- Comparisons of SVFCs to SVNFCs viewing 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 7. The top 6 SVFC-over-represented Cities had highly statistically significant Odds Ratios. They are: Rural Mobile 84, Rural Limestone 50, Rural Dallas 33, Rural Dekalb 37, and Rural Butler 25. The top 4 SVNFC-over-represented Cities with their expected fatal crash numbers are: Mobile 66, Huntsville 69, Rural Madison

34, and Dothan14. It is recommended that those cities with a high frequency of fatal crashes be given special guidance, and perhaps additional funding. 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 4.6.

- Rural/Urban (4.3, C010) Single Vehicle Fatal Crash (SVFC) Proportion – SVFCs occurred in 62.41% rural and 37.59% 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 SVNFCs, these proportions came out to be 52.52% Rural and 47.48% 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; and
  - Lower the speed limits in frequent crash areas.

  Anyone wishing analysis of 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 SVFCs (1618, 67.81%). Those countermeasures recommended for rural areas would be applicable to Open Country areas within city limits, which are effectively 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 320, and Residential 376.
- Cross-tabulation of Locale (4.5, C033) by Rural/Urban (C010) for SVFCs (fatal crashes). The largest number of fatalities were in the Rural, Open Country specifications, with 1349 fatal single-vehicle crashes. This illustrates that the Locale attribute is more definitive in specifying the surrounding areas of crashes than is the Rural/Urban attribute. Recommendations for rural areas apply equally to Open Country Locales.
- Highway Classifications (4.6, C011) – in order of Odds Ratio, the largest was State 1.198*, Federal 1.307, and County 1.048. These results are correlated to the number of Single Vehicle Fatal Crashes (SVFCs) per mile on the respective Highway Classifications, since the Odds Ratios are comparing the Single Vehicle Fatal Crashes (SVFCs) against the Single Vehicle Non-Fatal Crashes (SVNFCs).
- Most Harmful Event (4.7, C019) – ordered by Max Gain. The following items had the largest number of fatality occurrences (listed with their frequencies):

SINGLE VEHICLE FATAL CRASH (SVFC)	**FREQUENCY**
Collision with Non-Motorist: Pedestrian	309
Collision with Tree	675
Collision with Vehicle in Traffic	176
Fire/Explosion	54
Collision with Railway Vehicle/Train	21

Recommendation: 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. For more details on Pedestrian crashes, see:
http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf

- Roadway Curvature and Grade (4.8, C407). The following items were the most significantly over-represented (given with frequencies):

SINGLE VEHICLE FATAL CRASHES (SVFCs)	FREQUENCY
Curve Left and Level	241
Curve right and Down Grade	129
Straight with Down Grade	256
Curve Right and Level	144

Recommendations include selective enforcement and speed-limit-reduction (e.g., advisory speed and curve warning signs) concentrating most on left curves. 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 left curves.

- **1.5 Time Factors (5.0)**
  - Year (3.1, C003) – Variations from year to year were not significant in any years except 2022. SVFCs were under-represented in 2018 and 2019, but they became over-represented in 2020-2022. The reason for these increased SVFC proportions is not definitive, but it is recommended that this consistent increase should be watched to determine a cause in future years, since this might be an early indication that the proportions of Single Vehicle Fatal Crashes (SVFCs) per year are increasing over time.
  - Month (5.2, C004) – The number of SVFCs and SVNFCs correlated with each other closely in all months (no significant over-representations). September, October and November had the highest Odds Ratios, and it is recommended that they be given special selective enforcement concentration, with specific single-vehicle locations determined by hotspot analyses.
  - Day of the Week (2.3, 5.7 C006) – Sunday was the only significantly over-represented day of the week. Friday and Saturday were also over-represented, although not significantly so. Since this day of the week distribution is quite comparable to that of Impaired Driving (ID, DUI), it is recommended that: (1) the countermeasures for ID should be emphasized in the times and places indicated

by hotspot analysis; and (2) consideration be given to using Single Vehicle Fatal Crashes (SVFCs) as a proxy measure to improve ID decisions. See Sections 8.3 and 8.4 for the 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 will be due to drowsiness causing. among other things, a diminished ability to see road edge lines. See Day of the Week (2.3, 5.7, C006) for the similarity of this distribution with that of Impaired Driving (ID = DUI alcohol and/or drugs). The ID recommendations apply particularly to these over-represented times. See Sections 8.3 and 8.4 for more on ID.
- Time of Day by Day of the Week (5.7, C008 x C006) – *For all single vehicle fatal crashes.* This quantifies the extent of the fatal crash concentrations on Friday nights, Saturday mornings and nights, and Sunday mornings. This is a very useful summary for deploying selective enforcement details, especially during the weekend hours. 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.

- **1.6 Factors Affecting Severity (6.0)**
  - Severity for All Highway Classifications (6.1, C025, C011) – This cross-tabulation was performed for *all Single Vehicle crash records* so that the various severities on the different Highway Classifications could be seen. Note the high fatal over-representations on Interstate, Federal, State and County roads. For Single Vehicle fatality reduction, the enforcement priority is recommended on the State, Federal and County roads. If drivers have the option, this chart will be helpful in assisting them in choosing the safest routes for their trips.
  - Speed at Impact (6.2, C224) – Impact speeds below 61 MPH are generally over-represented for SVNFCs. SVNFCs are significantly over-represented at slower impact speeds, with 31 to 55 being highly significant. Above 61 MPH, it becomes clear that speed is a major problem. 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 many of which are discussed in Section 8.

- Crash Severity (C025) by Impact Speed (6.3, C224). *for all Single Vehicle crashes.* This cross-tabulation gives an idea of the risks involved with increased speed on any of the highway classifications. The red backgrounds in the first column indicates those that had a relatively higher number of fatal crashes.
- 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. Each additional 10 MPH of speed doubles the probability of the crash being a fatality.
- Restraint Use by Drivers in Fatal Collisions (6.5, C323) – 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. 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 on average 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) – not relevant, since all subsets were strictly single-vehicle crashes.
- Police Arrival Delay (6.8, C036) – Police response times to SVFCs were greater than 20 minutes in 39% of the SVFC police runs. There can be little doubt that this has to do with the large proportion of these that were located in rural areas. The shorter police responses would generally be expected in those responses to crashes in the urban areas.
- 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 SVFC 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 Age Range 2 (7.1, C106) –A comparison of SVFC causal driver age with those of the SVNFCs shows the most under-represented in the SVFCs are in 16-40 years of age, while the most over-represented SVFC causal driver ages are 51-90 years of age. Although not over-represented, it is clear from the chart that ages 16-45 have a relatively high proportion of SVFCs. It is recommended that, to the extent possible, the PI&E efforts focus on drivers of all ages.
  - Crash Driver Gender (7.2, C109) – the breakdown in SVFC causal drivers is 65.47% male and 17.23% female. For SVNFC cashes, the percentage is 57.43% male and 25.97% female. These gender differences certainly indicate that males are a greater cause of the fatalities in Single Vehicle Crashes (as they are in most crash types), and the recommendation is that, if there are countermeasures that can be directed toward males, 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 *All Single Vehicle Fatal Crashes*. 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 70 MPH in 23.01% of their Single Vehicle Fatal crashes, while comparable speeds for females was about 15.93%. Thus, all of the recommendations for speed reduction apply much more to males than to females.
  - Causal Unit (Vehicle) Type (7.4, C101) – This analysis was based on a comparison of SVFC Causal Unit Type against the same for SVNFCs. Pedestrians (12.74%, 304) and Pick Ups (18.73%, 447) were significantly over-represented in SVFCs. The proportion of Sport Utility Vehicles (16.90%, 391) and Passenger Cars (34.85%, 806) resulted in their placement at the bottom of the list, indicating that they were (in this case significantly) under-represented in SVFCs despite their high frequency numbers (reason: the SVNFC frequencies were even greater). Motorcycles also had a high frequency (160), but there were no significant differences in their proportions of SVFCs and SVNFCs, so they were not considered to be significantly over- or under-represented. It is recommended that countermeasure programs that are currently in effect be continued and augmented to emphasize the special issues with the vehicle types

noted above have in Single Vehicle crashes. Pedestrian programs should include warnings against Impaired Walking (walking along the roadway after the use of alcohol or other drugs), and the many other errors addressed in most pedestrian safety programs. Pedestrian fatalities are statistically significantly over-represented in the SVFCs, indicating that more emphasis might be warranted for divided and four-lane roadways. Additional pedestrian fatality study is warranted; see Section 7.5 below.

- Number of Pedestrians (7.5, C058) – Single Vehicle Fatal pedestrian crashes occur at a proportion of over three (3.151) times greater than their Single Vehicle Non-Fatal proportion. A total, including multiple pedestrians, of 491 pedestrians were involved in fatal crashes. Single pedestrian fatalities numbered 459. This is consistent with what has been found in most pedestrian studies. Both ID (Impaired Driving) and Impaired Walking, contribute to this, 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 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. 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) – SVFCs were under-represented in their causal drivers having legitimate licenses by a significant Odds Ratio of 0.817* (with a proportion of about 22.40% lower than the corresponding SVNFC proportion). Revoked, Suspended, and Expired were all similarly over-represented for SVFCs, Revoked significantly so. This would lead us to believe that many of those who caused these fatal crashes are often not operating within the law. It is recommended that special attention be given to all drivers in single-vehicle crashes, and that punitive actions be taken where warranted.
- Driver Employment Status (7.7, C120) – This analysis indicated that the employment rate for the SVFCs was about 62.70%, while that for SVNFCs was 76.77%. Lower-than-average employment rates are not surprising because of the underlying drug/alcohol root cause of many fatal crashes (see Sections 8.3-8.4). The correlation between not having a job and being involved in a fatal crash should be watched carefully going forward in that it could affect the type and location of countermeasures. It is also recommended that research be performed to determine if there are some incentives that could be implemented in conjunction with unemployment payments.

- **1.8 Driver Behavior (8.0)**
  - Primary Contributing Circumstances – PCC (8.1 and 8.2, C015) Driver behaviors that are correlated with Single Vehicle Fatal crashes might provide alternatives

for countermeasure development. Those behaviors that were over-represented in SVFCs are given below with their SVFC and SVNFC percentages:

SVFCs PCC Overrepresented	SVFCs %	SVNFCs %
Over Speed Limit 370	18.89%**	9.34%
Improper Crossing (pedestrian) 164	8.37%**	1.80%
Aggressive Operation 207	10.57%**	5.03%
DUI (aka ID) 298	15.21%	10.49%
Not Visible (most often pedestrian) 47	2.40%**	0.042%
Failed to Yield the Right-of-Way 39	1.99%**	0.36%
Lying/Sitting in Roadway (Pedestrian) 20	1.02*%**	0.09%
Pedestrian Under the Influence 20	1.02%**	0.27%
Improper Lane Change/Use 50	2.55%*	1.80%
Ran off Road 242	12.35%	11.98%
Other Failed to Yield 11	0.56%	0.34%
Other Improper Action 20	1.02%	1.50%
Unseen object/Person/Vehicle 90	4.59%	5.27%
Over Correcting/Over Steering 67	3.42%	4.35%
Driving too Fast for Conditions 128	6.53%	12.68%*
Fatigued/Asleep 67	3.42%	9.43%*

Recommendation: That these behaviors be given special attention for enforcement, especially those that are in violation of state laws.

- CU Officer's Opinion Impaired Driving – CU Officer's Opinion Impaired Driving – Alcohol (8.3-8.4, C122-C123). We saw ample 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 (C122 and C123) indicate the degree that ID was involved in fatal crashes. For alcohol, the proportion of ID fatal crashes was 1.783 times as many for SVFCs as for SVNFCs. For drugs this multiplier was close to this at 2.006. It is quite clear that ID dramatically increases the probability of the crash resulting in a fatality. Recommended countermeasures to reduce both ID types are:
  - Perform additional ID enforcement at locations determined by Single Vehicle hotspot analysis as well as general ID hotspot analysis.
  - Mandate breath-alcohol ignition interlock devices for all convicted of 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.

2.0 Filter and IMPACT Set-ups

Generally, the analyses performed in this study used IMPACT (See Section 2.1) to compare Single Vehicle Fatal Crashes (SVFCs) against Single Vehicle Non-Fatal Crashes (SVNFCs) over a 5-year time period (FY2018-2022). The objective was to determine all significant differences between attributes within these two subsets of data in order to get an improved understanding as to the fatality crash causes (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 Single Vehicles.

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 4-8). This introduction will consist of: (2.1) Introduction to IMPACT, (2.2) Definitions of Filters Used, (2.3) Example IMPACT: Day of the Week, 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 crash, and especially fatal crash, 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. *Max Gain* is a term that CARE users have assigned to indicate 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 the Single Vehicle (SVFCs) than would be expected from that given in the SVNFCs. 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.

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

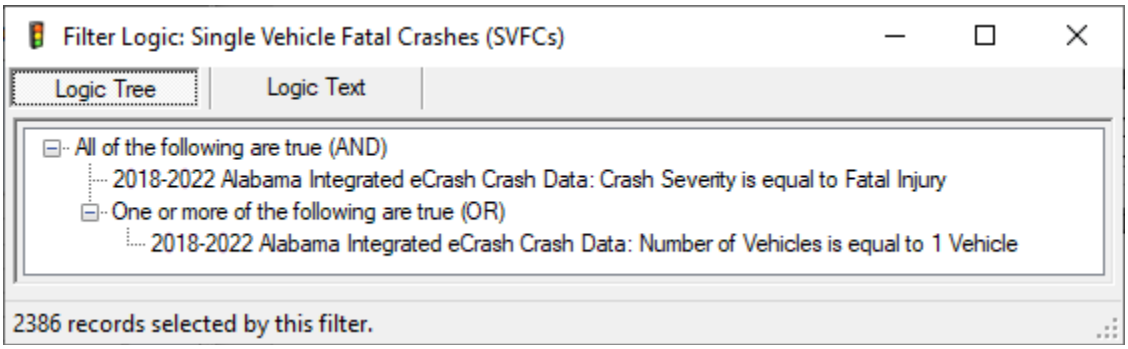
http://www.caps.ua.edu/software/care/

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

2.2 Filter Definitions for the SVFC IMPACT Analyses

The IMPACT analyses will compare Single Vehicle Fatal Crashes (SVFCs) vs Single Vehicle Non-Fatal Crashes (SVNFCs). The standard filter for all fatal crashes based on C025 Crash Severity was applied, and separate filters for the SVFCs and SVNFCs were obtained, as exemplified in the displays below. The formal definitions for these two filters are given below:

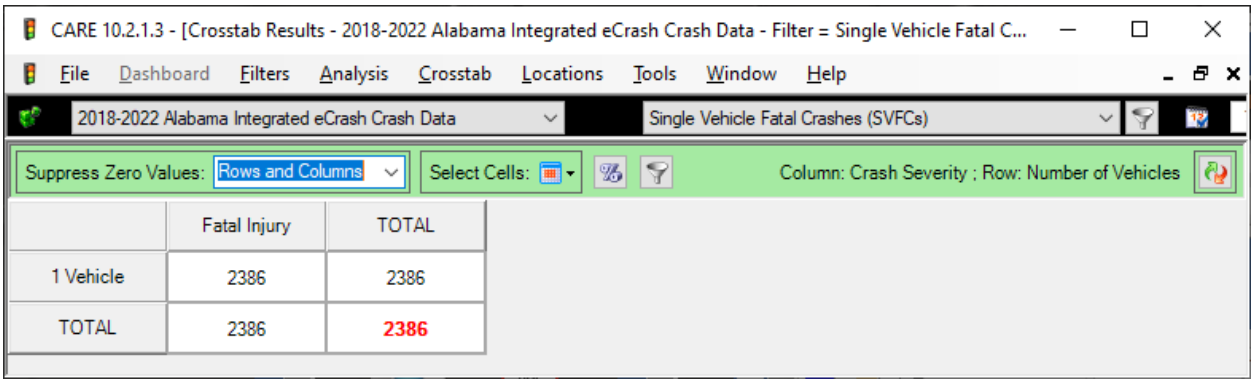
Formal Definition of Single Vehicle Fatal Crashes (SVFCs)



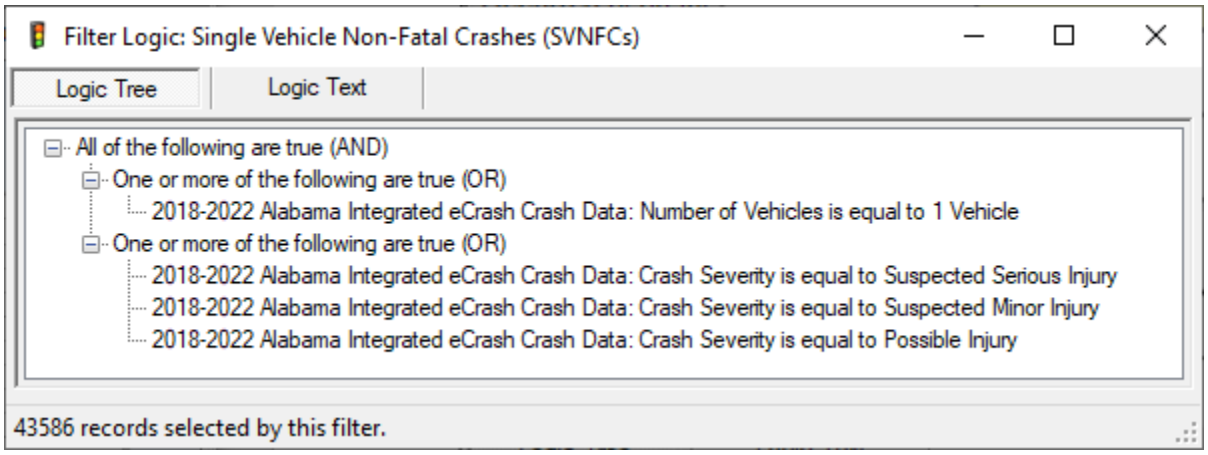
In plain English, the above indicates that all of the *test* crashes to be compared by IMPACT have the following characteristics:

1. They must all be fatal crashes;
2. They must all be Single Vehicle crashes.

2,386 Crashes Qualified as SVFCs for FY2018-2022



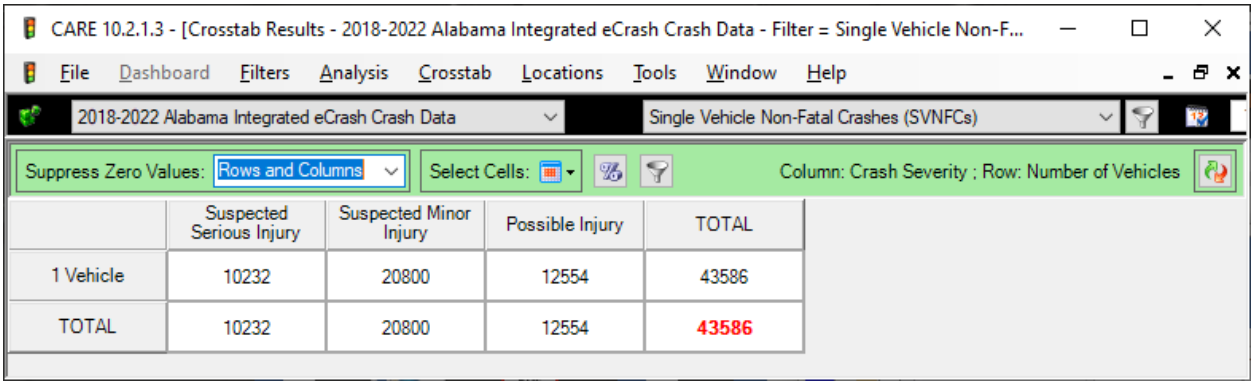
Formal Definition of Single Vehicle Non-Fatal Crashes (SVNFCs)



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* crashes;
2. They must all be Single Vehicle Crashes.
3. Note that Property Damage Only crashes are not in this subset. Rationale: better contrasts in the IMPACT comparisons will be obtained by disallowing them.

43,586 Crashes Qualified as SVNFCs in FY2018-2022.



	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	TOTAL
1 Vehicle	10232	20800	12554	43586
TOTAL	10232	20800	12554	43586

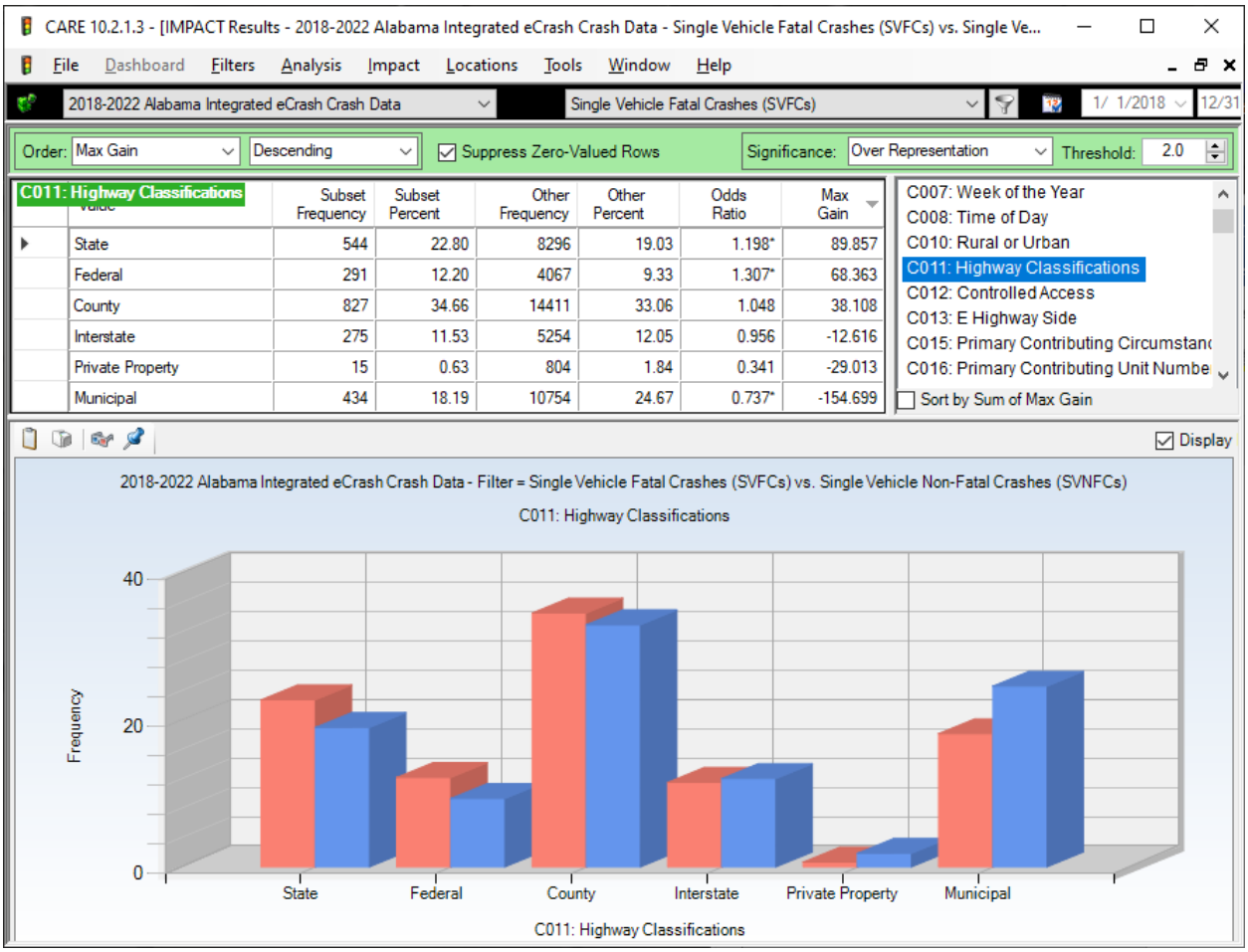
The IMPACT analyses in Section 4-8 below will compare the 2,386 SVFCs with the corresponding attributes of the 43,586 SVNFCs in order to pinpoint the attributes that are most likely to be causing the fatal crashes of Single Vehicles

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

- To determine what causes fatal crashes, the fatal crashes have to be compared against non-fatal crashes.
- The test subset was all single-vehicle fatal crashes.
- The control subset was all single-vehicle non-fatal crashes.

Note the filter of this IMPACT is SVFCs and the comparative "Other" subset is SVNFCs (also called the *control* subset). These comparisons are different from most IMPACT analyses CAPS has done in the past, because here both the Subset crashes and the "Other" crashes consist only of Single Vehicle crashes. Thus, they are quite comparable to each other.

2.3 Highway Classification (4.6, C011); Comparison of SVFCs and SVNFCs



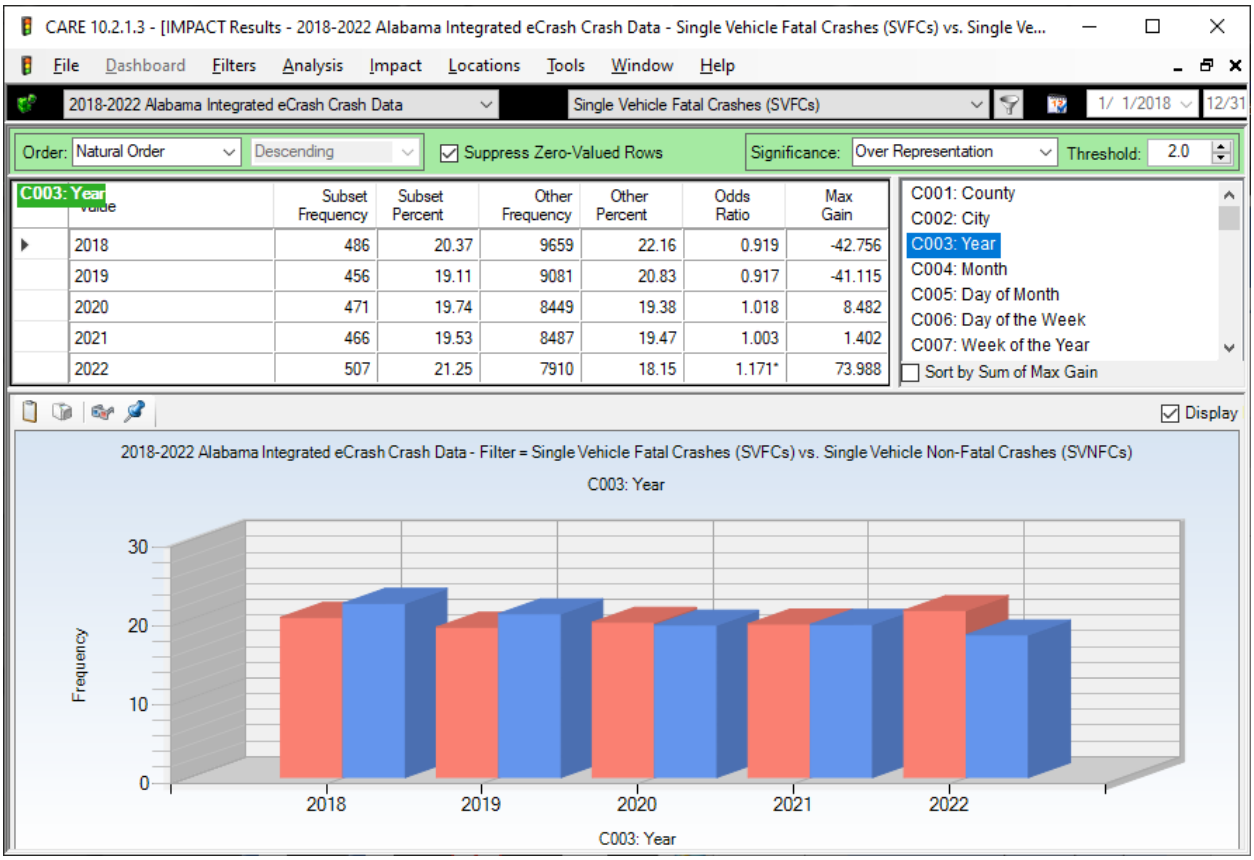
Reminder: SVFCs=Single Vehicle Fatalities=**Red bars**; SVNFCs=Single Vehicle Non-Fatal=**Blue bars**.

In this IMPACT display, as well of those in Sections 4 through 8, the Subset (given by the red bars) is the Single Vehicle Fatal Crashes (SVFCs). The "Other" crashes are those that were Single Vehicle Non-Fatal Crashes (SVNFCs). This IMPACT (and those below) will use both of the filters defined above to compare the SVFCs directly with the SVNFCs. The above shows that State and Federal highway classifications are significantly over-represented in SVFCs. Municipal is significantly under-represented. The SVFC filter will be used to define the "Subset," while SVNFC filter will define the "Other," which is mainly used as a control.

This IMPACT result will be given additional discussion in Section 4.6.

3.0 Fatal to Non-Fatal Crash Comparison by Year

SVFCs vs SVNFCs by Year



Quick reminder: SVFCs= Single Vehicle Fatal=**Red bars**; SVNFCs=Single Vehicle Non-Fatal=**Blue bars**.

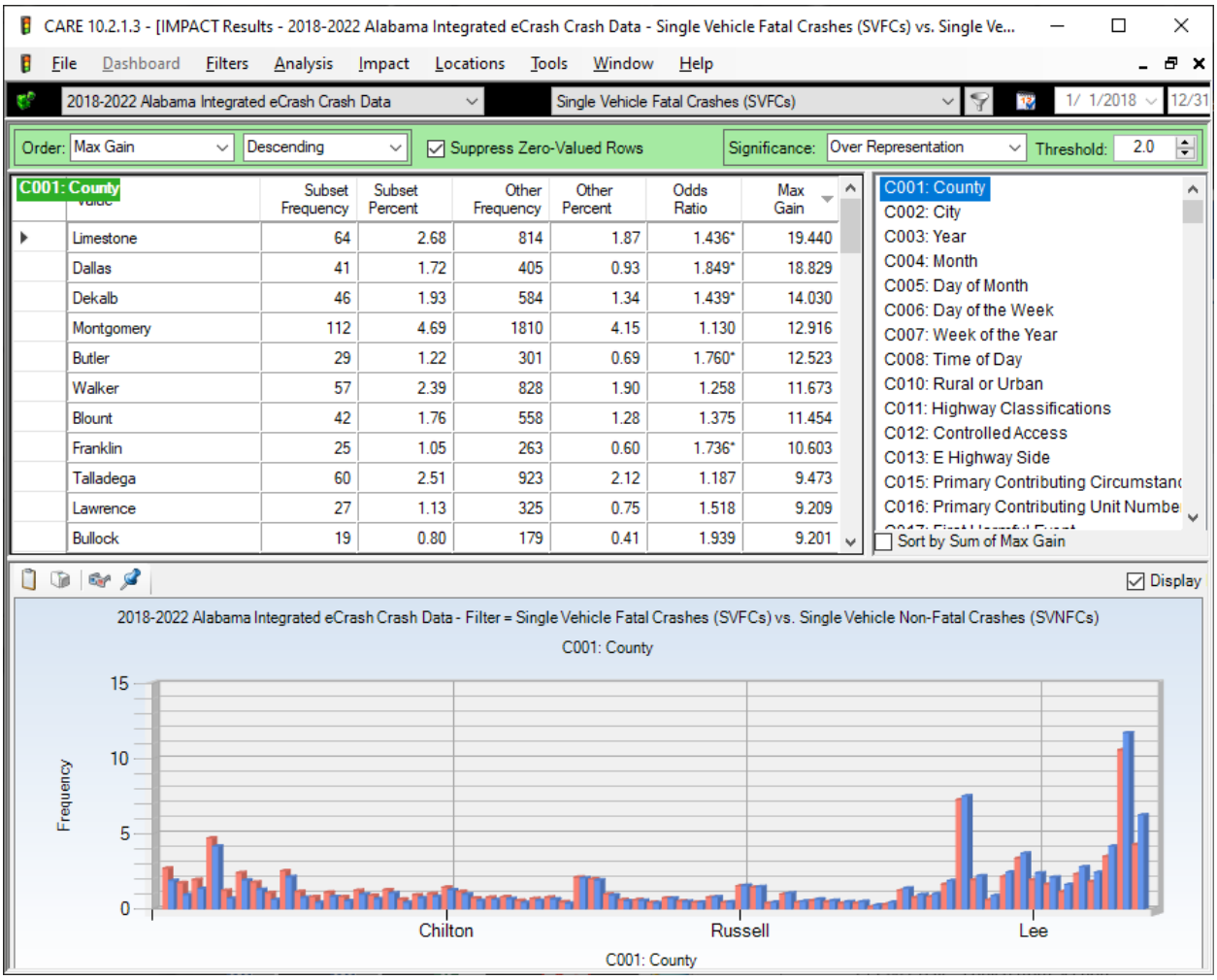
This is an example that further demonstrate the IMPACT displays. The only year that has a statistically significant differences between the fatal and non-fatal crashes is 2022. None of the other results for years (2018-2021) show statistically significant differences.

Statistically significant results for a given attribute are indicated by an asterisk (*) that will appear on the Odds Ratio for the attribute value under consideration.

See Section 5.1 for additional comments on changes by year.

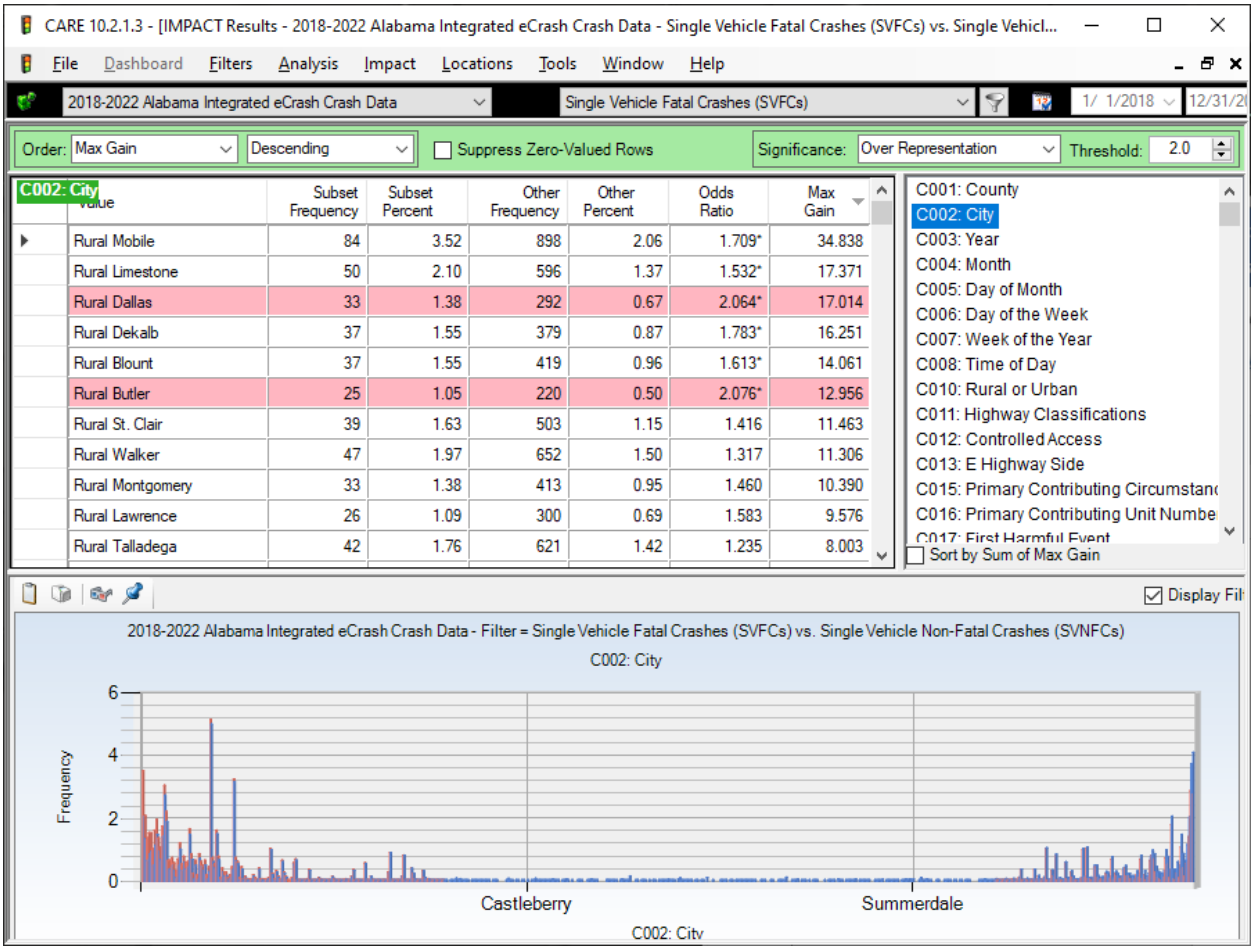
4.0 Geographic and Harmful Event Factors

4.1 C001 County SVFCs vs SVNFCs (top 11 counties) ordered by Max Gain



Each line of table above gives both SVFC and SVNFC crashes. So, Limestone, at the top. had 64 Single Vehicle Fatal Crashes (SVFCs) and 814 Single Vehicle Non-Fatal Crashes (SVNFCs). Their proportions (2.68% and 1.87%) are used to obtain the Odds Ratio of 1.436, which has an asterisk showing that the differences between these proportions is statistically significant. These proportions are calculated from the attribute (Limestone) frequency divided by the total number of crashes in each column. The Max Gain (19.440) is the number of Single Vehicle Fatal Crashes (SVFCs) that would be reduced if the 2.68% was reduced to 1.87%. The above display has been arranged in highest Max Gain order to indicate the counties that have the highest potential for gain in reducing their SVFC proportions to their SVNFC proportions. The display above contains all of the counties with Max Gains greater than 9.000.

4.2 C002 Cities (top 11) with Highest Max Gains (Rural Areas = Virtual Cities)



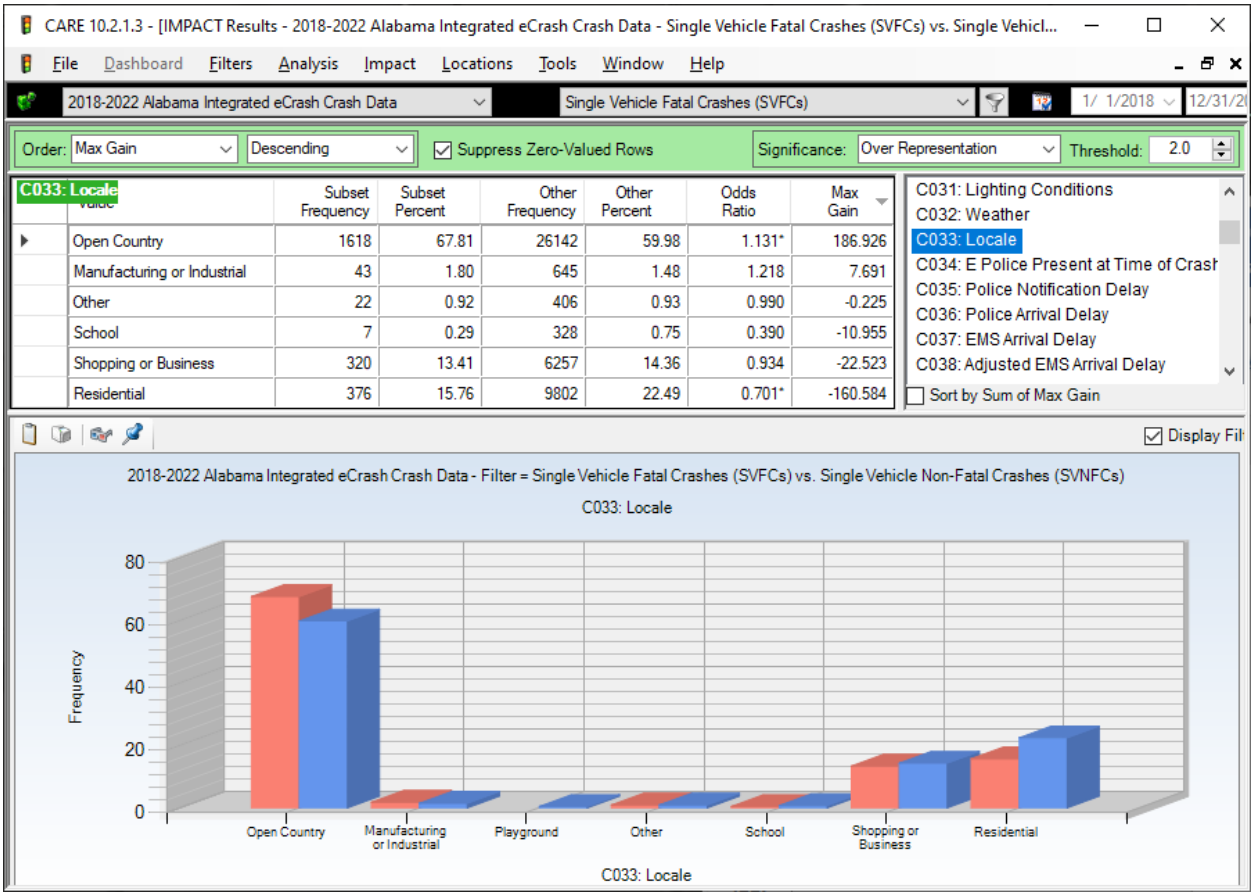
For comparison purposes, the rural areas of counties are considered to be “virtual cities,” and crashes that occur there are listed as “Rural [County Name]” so that these crashes can be effectively accounted for and compared.

The high rural areas are generally adjacent to (or partially contain) significant urban areas that have a high traffic density. This display is in Max Gain ordering to put those (possibly virtual) cities that have the highest potential for Single Vehicle Fatal Crash (SVFC) reduction at the top. The display is for all Max Gains > 7. 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 five highest (virtual) cities are: Rural Mobile 84, Rural Limestone 50, Rural Dallas 33, Rural Dekalb 37, Rural Blount 37, Rural Butler 25, Rural St Clair 39, Rural Walker 47, Rural Montgomery 33, Rural Lawrence 26 and Rural Talladega 42.

4.3 C010 Rural or Urban

The Single Vehicle Fatal Crashes (SVFCs) had 62.41% of their fatal crashes in rural areas, while this percentage was also high at 52.52% for Rural SVNFCs. The SVNFCs were also highly urban, with 47.48% of their crashes in the urban areas. Both results illustrate how lethal rural crashes generally are, as compared to 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 (see Section 4.4 below).

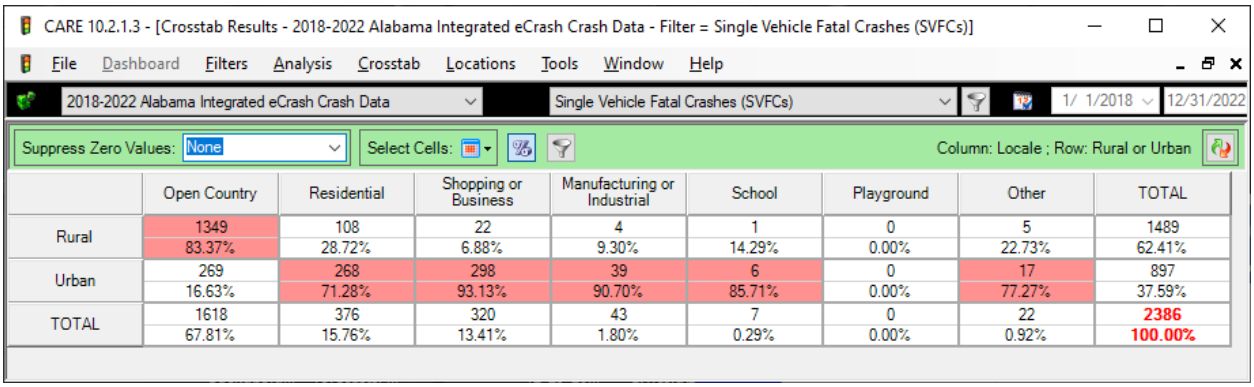
4.4 C033 Locale



Open Country showed significant differences between SVFCs and SVNFCs. The SVFC proportion for Open Country was 67.81%, and its Odds Ratio was 1.131. Residential and Shopping or Business were significantly under-represented, although both had high frequencies (320 for Shopping or Business and 376 for Residential). But the proportions for these were considerably lower than those of their corresponding SVNFCs. 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 that increase the traffic flow, and the greater speeds on the rural roads that increase the number of fatalities.

4.5 C033 Locale by C010 Rural-Urban for SVFCs

It is obvious in the above outputs that SVFCs 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 SVFCs*, gives one such analysis.

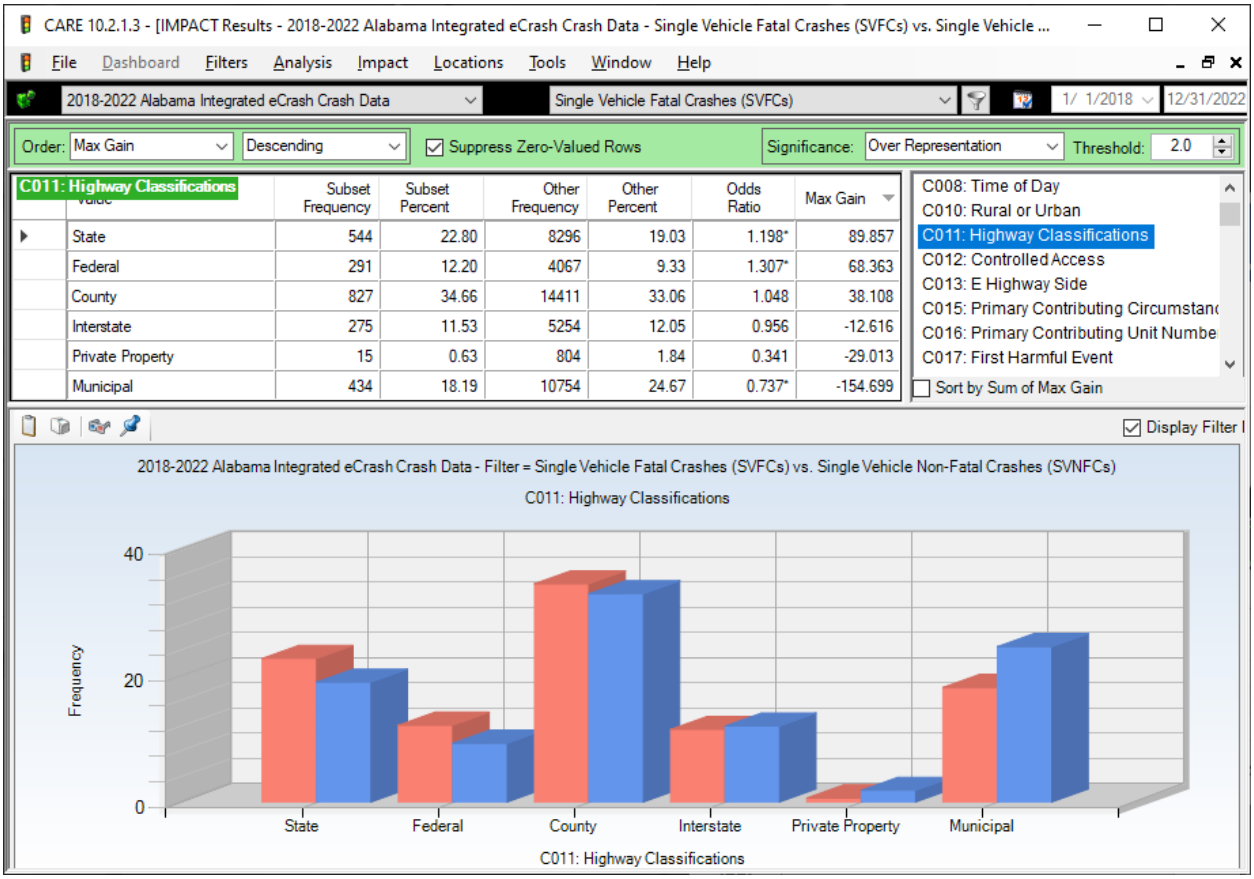


	Open Country	Residential	Shopping or Business	Manufacturing or Industrial	School	Playground	Other	TOTAL
Rural	1349 83.37%	108 28.72%	22 6.88%	4 9.30%	1 14.29%	0 0.00%	5 22.73%	1489 62.41%
Urban	269 16.63%	268 71.28%	298 93.13%	39 90.70%	6 85.71%	0 0.00%	17 77.27%	897 37.59%
TOTAL	1618 67.81%	376 15.76%	320 13.41%	43 1.80%	7 0.29%	0 0.00%	22 0.92%	2386 100.00%

The red-backed cells in the cross-tabulation above indicate over-representation by more than 10%. Those that are over-represented, but by less than 10% would have a yellow background. If under-represented, there will be a white background. For example, while 37.59% of all SVFCs were Urban, 71.28% (268) occurred at the Residential Locale. Since this is greater than a 10% difference, it has a red background.

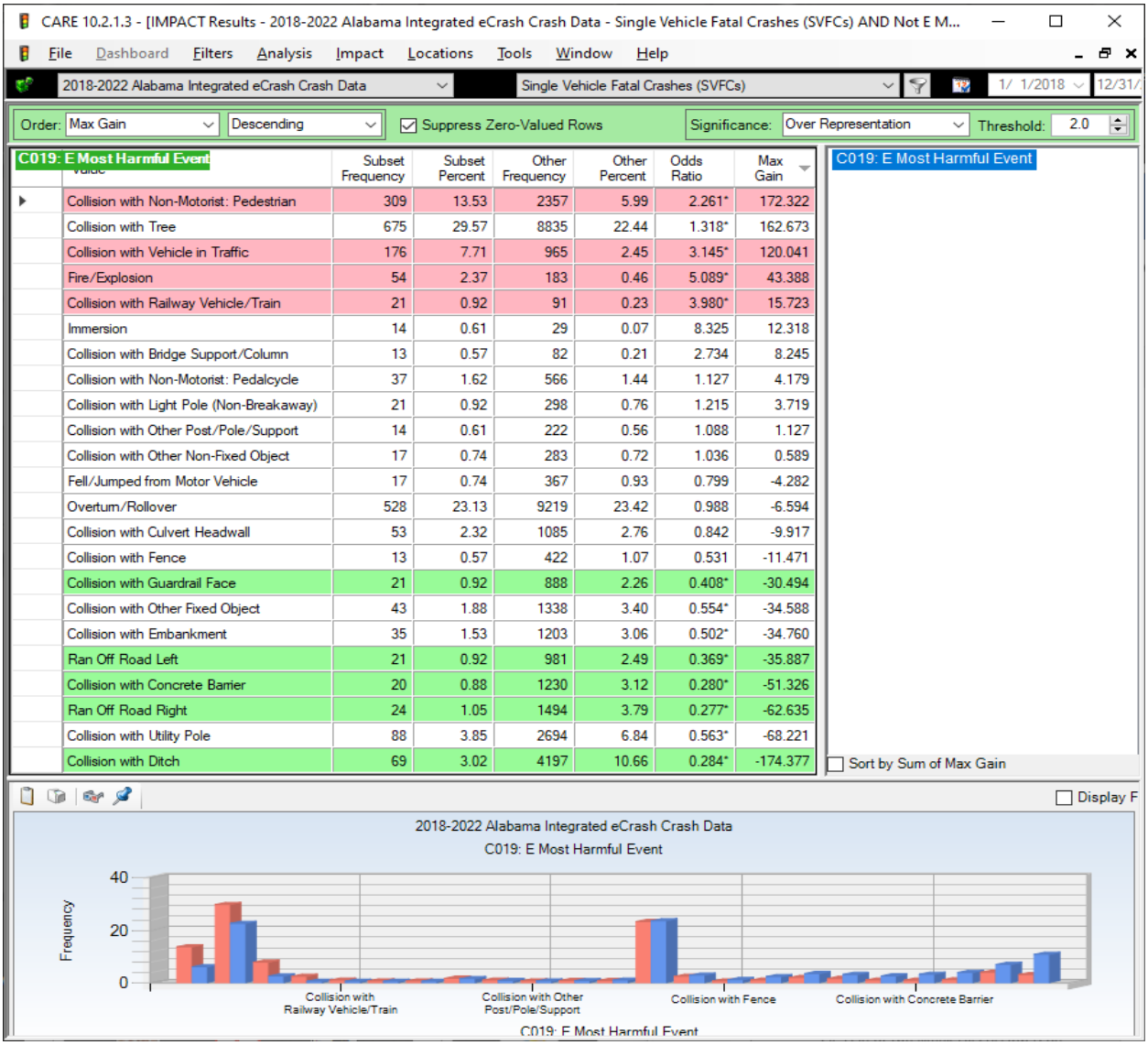
This shows that the Rural/Urban attribute may not be as definitive as is Locale in categorizing crash locations by general environmental factors.

4.6 C011 Highway Classifications



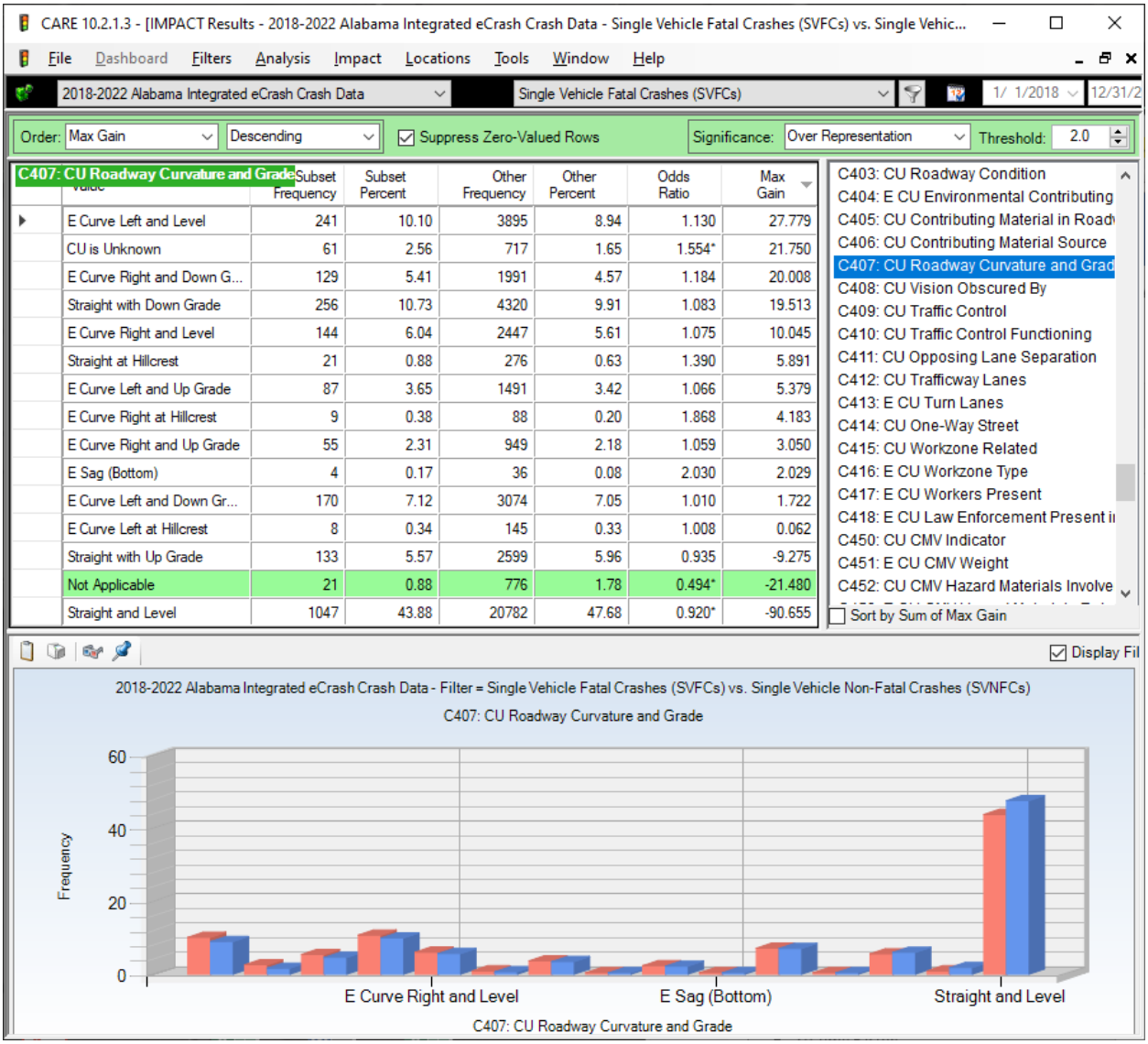
This display was introduced in Section 2.3, but little was said of it countermeasure ramifications. Clearly State (544 frequency) routes have the largest number of Single Vehicle Fatal Crashes (SVFCs). The second and third are Federal (291) and County (827), both of which are also over-represented. Interstates (with fewer single vehicle crashes) had only 275, with a lower Odds Ratio of 0.956. While significantly under-represented (0.737*) from its proportion point of view, Municipal had a large frequency (434).

4.7 C019 Most Harmful Event (>10 in MaxGain order)



The display above is intended to show safety engineers the most predominant obstacles that are over-represented in Fatal Single Vehicle Crashes. The most over-represented SVFC is Collision with Non-Motorist Pedestrian 309, Collision with Tree 675, Collision with Vehicle in Traffic 176, and Fire/Explosion 54. The statistical algorithm does not consider items with frequencies less than 20, so there could be other significant differences. At the bottom of the table it can be seen that for SVNFC over-representations, Collisions with Utility Pole 88 and Collisions with Ditch 69. For more details on Pedestrian crashes, please see Section 7.5.

4.8 C407 CU Roadway Curvature and Grade

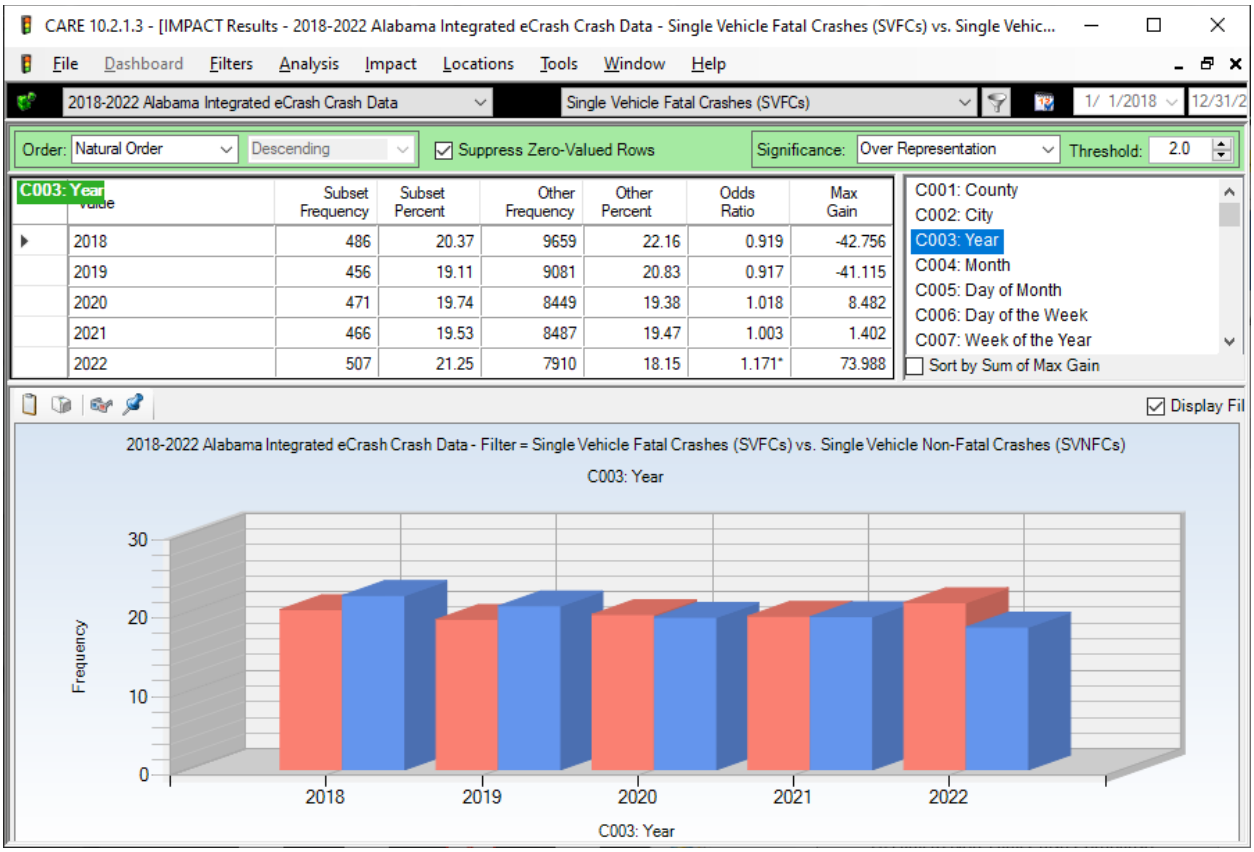


SVFCs are over-represented in the vast majority of curve types. OVER-REPRESENTED SVFCs with the highest frequencies: Curve Left and Level 241, Curve Right and Down Grade 129, Straight with Down Grade 256, and Curve Right and Level 144.

5.0 Time Factors

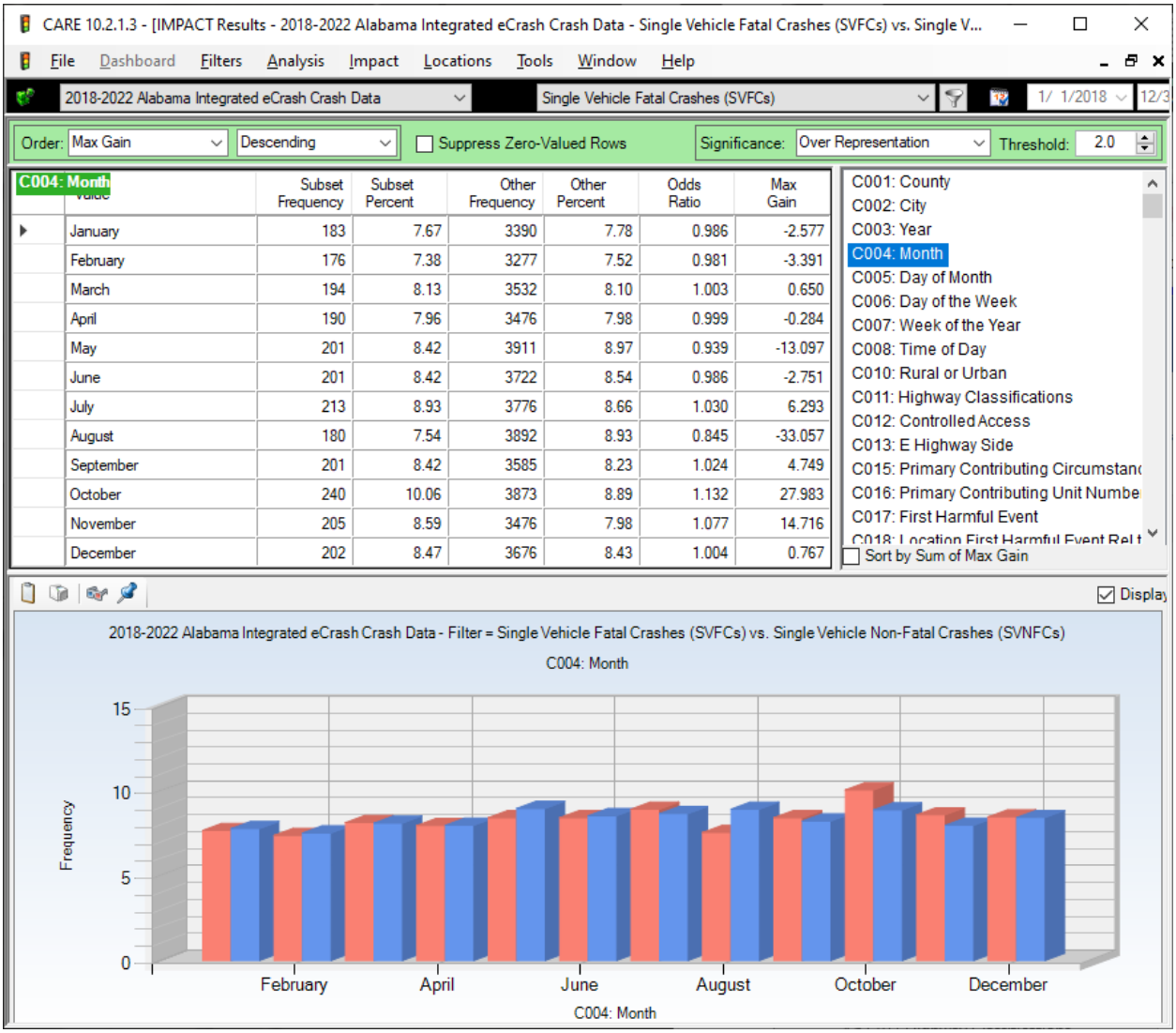
5.1 C003 Year – copied from Section 3.0 for ease of reference

Single Vehicle Fatal Crashes (SVFCs) vs Single Vehicle Non-Fatal Crashes (SVNFCs)



Variations from year to year were not significant in any years except 2022. SVFCs were under-represented in 2018 and 2019, but they became over-represented in 2020-2022. The reason for these increased SVFC proportions is not definitive, but this consistent increase should be watched to determine a cause in future years.

5.2 C004 Month



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. SVFC months generally fell in line with their SVNFC counterparts. The largest over-representation was in October, which had an Odds Ratio of 1.132, which was relatively large, but not large enough to qualify as statistically significant. The collective over-representations of September, October, November and December collectively could qualify.

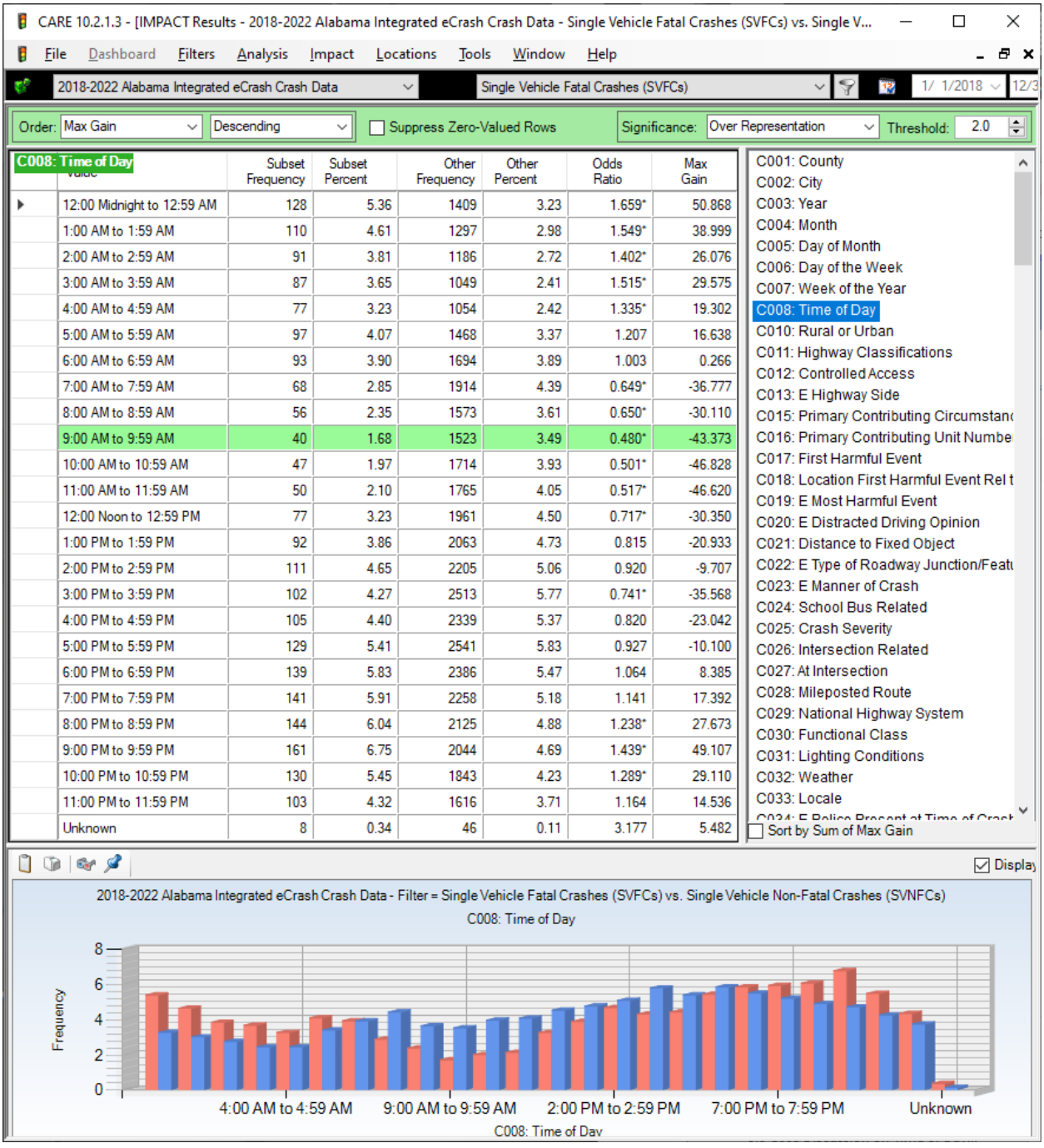
5.3 C006 Day of the Week Comparison SVFCs and SVNFCs

The above presents Days of the Week with significant over-representations displayed. Sunday was the only day with a significant SVFC. Friday and Saturday were also over-represented, but not to the point of it being statistically significant. These are the days of the week that are over-represented in ID (DUI alcohol and drugs). All of the other days of the week were under-represented in SVFCs (thus over-represented in SVNCs).

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



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

Refer to the Day of the Week by Time of Day cross-tabulation *for all fatal crashes* given immediately below in Section 5.7. The over-representation of night-time hours and weekend days is further confirmation of the correlation of this attribute with that of Impaired Driving (ID, DUI alcohol and/or non-alcohol drugs). It is no surprise to find Fatal Crashes over-represented during the late night/early morning hours, since their other correlations with aspects of Impaired Driving (ID) and pedestrian collisions are clear. The following narrative was developed with regard to a special study that was done for ID. We include it here because of its relevance to the comparison of SVFCs to SVNFCs.

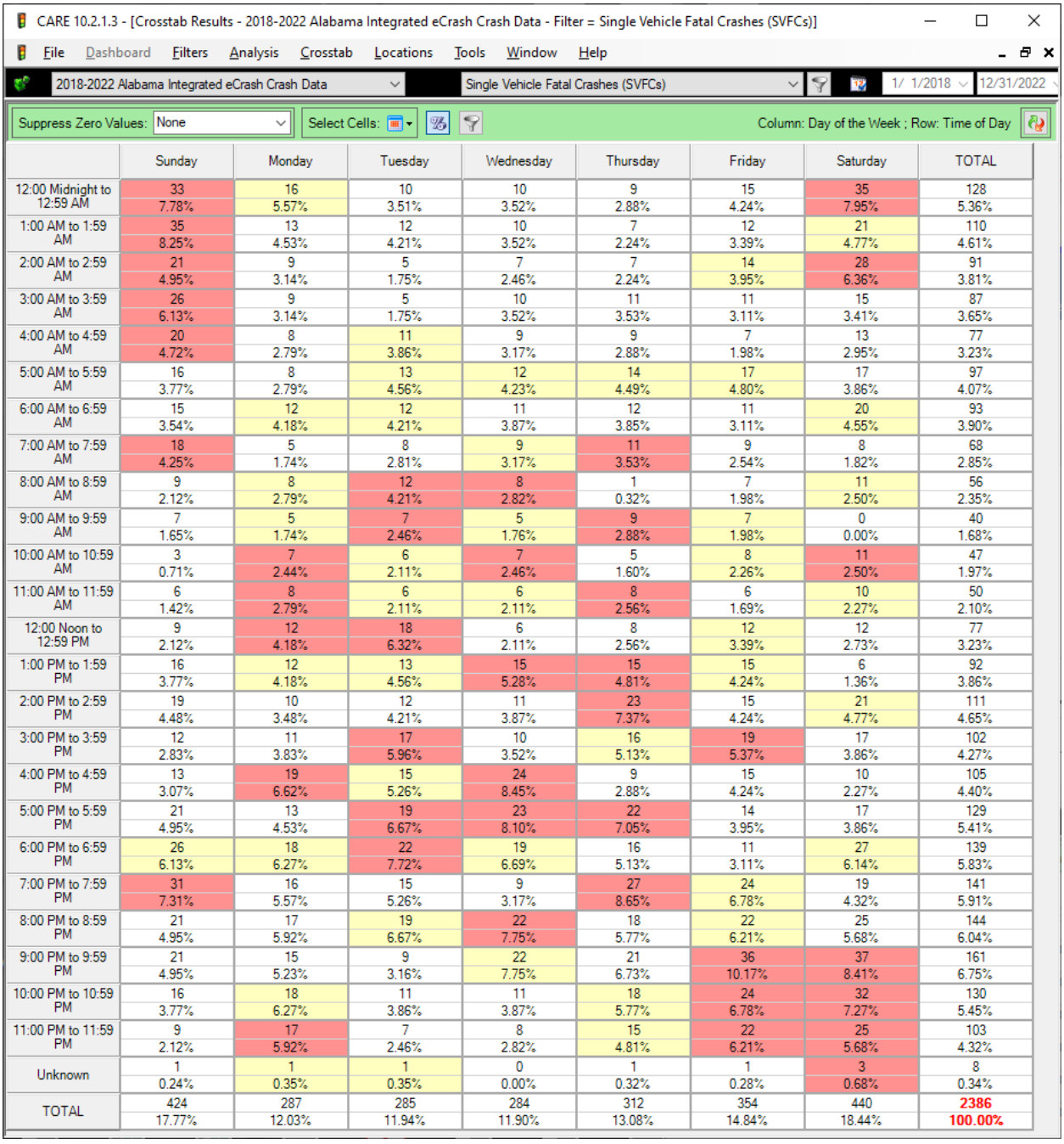
Typical traffic patterns of high traffic results on more crashes in the morning and afternoon rush hours. However, IDs, and especially the IDs that occur at night, are just getting started in the afternoon rush hours, and they continue to grow through midnight and the early morning hours, often not tapering off until about 7:00 AM the next day. It is clear that if selective enforcement is going to have an effect on Fatal Crashes, it would have to be conducted at the times when these crashes are most occurring. Optimal times that start with Friday enforcement would continue immediately following any rush hour details, and would continue through at least 8:00 AM the following Saturday or Sunday.

The *Time of Day by Day of the Week* cross-tabulation (given in the next section *for all fatal crashes* (not subdivided by SVFCs and SVNFCs) shows the optimal times for Single Vehicle selective enforcement on all roadways. Generally, the highest proportion of times in any day are given in red for that day. Notice that this works well for Friday Nights, Saturday mornings, Saturday nights, and Sunday mornings.

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) are red.

For example, the 2 AM to 2:59 AM row has a total percentage value of 3.8`% for these fatal crashes. The red cells to the left have percentages of 4.95% (Sunday) and 6.36% (Saturday). The yellow cell has a percentage of 3.95%, which is more than 3.81% but less than 10% more than the average. All the rest of the cells have white background indicating that their percentages are less than 3.81%.

5.7 C008 Time of Day x C005 Day of the Week for SVFCs



CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Single Vehicle Fatal Crashes (SVFCs)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

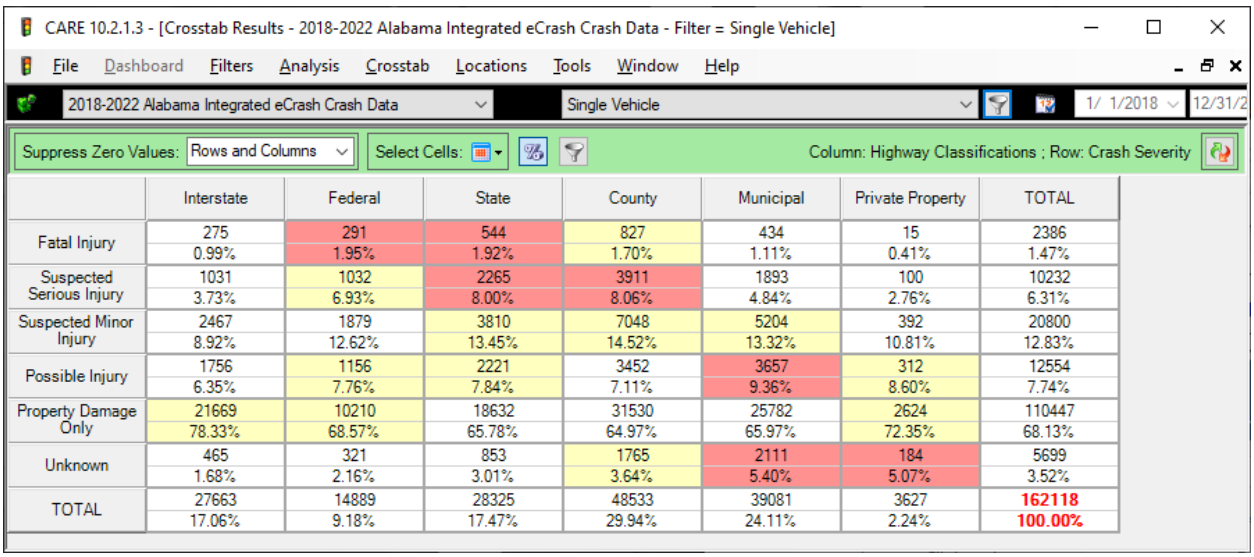
2018-2022 Alabama Integrated eCrash Crash Data | Single Vehicle Fatal Crashes (SVFCs) | 1/ 1/2018 | 12/31/2022

Suppress Zero Values: None | Select Cells: | Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	33 7.78%	16 5.57%	10 3.51%	10 3.52%	9 2.88%	15 4.24%	35 7.95%	128 5.36%
1:00 AM to 1:59 AM	35 8.25%	13 4.53%	12 4.21%	10 3.52%	7 2.24%	12 3.39%	21 4.77%	110 4.61%
2:00 AM to 2:59 AM	21 4.95%	9 3.14%	5 1.75%	7 2.46%	7 2.24%	14 3.95%	28 6.36%	91 3.81%
3:00 AM to 3:59 AM	26 6.13%	9 3.14%	5 1.75%	10 3.52%	11 3.53%	11 3.11%	15 3.41%	87 3.65%
4:00 AM to 4:59 AM	20 4.72%	8 2.79%	11 3.86%	9 3.17%	9 2.88%	7 1.98%	13 2.95%	77 3.23%
5:00 AM to 5:59 AM	16 3.77%	8 2.79%	13 4.56%	12 4.23%	14 4.49%	17 4.80%	17 3.86%	97 4.07%
6:00 AM to 6:59 AM	15 3.54%	12 4.18%	12 4.21%	11 3.87%	12 3.85%	11 3.11%	20 4.55%	93 3.90%
7:00 AM to 7:59 AM	18 4.25%	5 1.74%	8 2.81%	9 3.17%	11 3.53%	9 2.54%	8 1.82%	68 2.85%
8:00 AM to 8:59 AM	9 2.12%	8 2.79%	12 4.21%	8 2.82%	1 0.32%	7 1.98%	11 2.50%	56 2.35%
9:00 AM to 9:59 AM	7 1.65%	5 1.74%	7 2.46%	5 1.76%	9 2.88%	7 1.98%	0 0.00%	40 1.68%
10:00 AM to 10:59 AM	3 0.71%	7 2.44%	6 2.11%	7 2.46%	5 1.60%	8 2.26%	11 2.50%	47 1.97%
11:00 AM to 11:59 AM	6 1.42%	8 2.79%	6 2.11%	6 2.11%	8 2.56%	6 1.69%	10 2.27%	50 2.10%
12:00 Noon to 12:59 PM	9 2.12%	12 4.18%	18 6.32%	6 2.11%	8 2.56%	12 3.39%	12 2.73%	77 3.23%
1:00 PM to 1:59 PM	16 3.77%	12 4.18%	13 4.56%	15 5.28%	15 4.81%	15 4.24%	6 1.36%	92 3.86%
2:00 PM to 2:59 PM	19 4.48%	10 3.48%	12 4.21%	11 3.87%	23 7.37%	15 4.24%	21 4.77%	111 4.65%
3:00 PM to 3:59 PM	12 2.83%	11 3.83%	17 5.96%	10 3.52%	16 5.13%	19 5.37%	17 3.86%	102 4.27%
4:00 PM to 4:59 PM	13 3.07%	19 6.62%	15 5.26%	24 8.45%	9 2.88%	15 4.24%	10 2.27%	105 4.40%
5:00 PM to 5:59 PM	21 4.95%	13 4.53%	19 6.67%	23 8.10%	22 7.05%	14 3.95%	17 3.86%	129 5.41%
6:00 PM to 6:59 PM	26 6.13%	18 6.27%	22 7.72%	19 6.69%	16 5.13%	11 3.11%	27 6.14%	139 5.83%
7:00 PM to 7:59 PM	31 7.31%	16 5.57%	15 5.26%	9 3.17%	27 8.65%	24 6.78%	19 4.32%	141 5.91%
8:00 PM to 8:59 PM	21 4.95%	17 5.92%	19 6.67%	22 7.75%	18 5.77%	22 6.21%	25 5.68%	144 6.04%
9:00 PM to 9:59 PM	21 4.95%	15 5.23%	9 3.16%	22 7.75%	21 6.73%	36 10.17%	37 8.41%	161 6.75%
10:00 PM to 10:59 PM	16 3.77%	18 6.27%	11 3.86%	11 3.87%	18 5.77%	24 6.78%	32 7.27%	130 5.45%
11:00 PM to 11:59 PM	9 2.12%	17 5.92%	7 2.46%	8 2.82%	15 4.81%	22 6.21%	25 5.68%	103 4.32%
Unknown	1 0.24%	1 0.35%	1 0.35%	0 0.00%	1 0.32%	1 0.28%	3 0.68%	8 0.34%
TOTAL	424 17.77%	287 12.03%	285 11.94%	284 11.90%	312 13.08%	354 14.84%	440 18.44%	2386 100.00%

6.0 Factors Affecting Severity

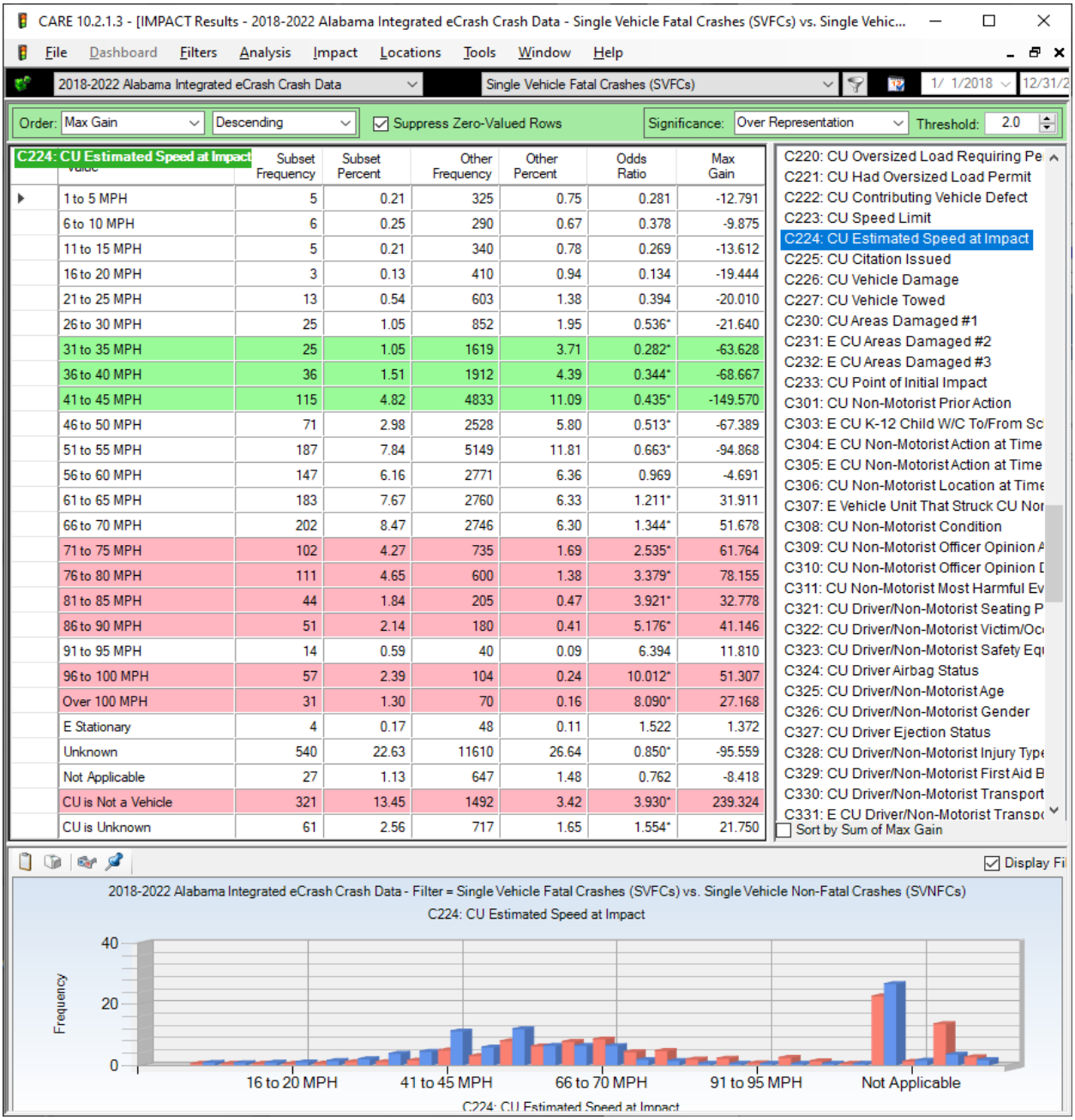
6.1 C011 Highway Classification by C025 Severity (Single Vehicle crashes)



	Interstate	Federal	State	County	Municipal	Private Property	TOTAL
Fatal Injury	275 0.99%	291 1.95%	544 1.92%	827 1.70%	434 1.11%	15 0.41%	2386 1.47%
Suspected Serious Injury	1031 3.73%	1032 6.93%	2265 8.00%	3911 8.06%	1893 4.84%	100 2.76%	10232 6.31%
Suspected Minor Injury	2467 8.92%	1879 12.62%	3810 13.45%	7048 14.52%	5204 13.32%	392 10.81%	20800 12.83%
Possible Injury	1756 6.35%	1156 7.76%	2221 7.84%	3452 7.11%	3657 9.36%	312 8.60%	12554 7.74%
Property Damage Only	21669 78.33%	10210 68.57%	18632 65.78%	31530 64.97%	25782 65.97%	2624 72.35%	110447 68.13%
Unknown	465 1.68%	321 2.16%	853 3.01%	1765 3.64%	2111 5.40%	184 5.07%	5699 3.52%
TOTAL	27663 17.06%	14889 9.18%	28325 17.47%	48533 29.94%	39081 24.11%	3627 2.24%	162118 100.00%

Notice that the basis for this cross-tabulation is all 162,118 Single Vehicle crashes, for all severities, not just fatal crashes. Fatal Single Vehicle Crashes only would restrict this output to just the top row. This does verify the results presented for fatal Single Vehicle crashes in Section 4.6, but it also shows comparable results for the lesser severities for all of the Highway Classifications.

6.2 SVFCs vs SVNFCs for C224 Speed at Impact



Generally, the travel speeds at roads that have the most Single Vehicle Crashes have speed limits of 45 MPH or lower, and it is these speeds that are over-represented for the SVNFCs, as are speeds up to 60 MPH. Speeds of 61 and above are over-represented in fatal crashes (SVFCs), and the Odds Ratios generally increase systematically with these increases in speed.

6.3 Cross-tab: C025 Severity by C224 Speed at Impact (Single Vehicle crashes)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Single Vehicle]

File | Dashboard | Filters | Analysis | Crosstab | Locations | Tools | Window | Help

2018-2022 Alabama Integrated eCrash Crash Data | Single Vehicle | 1/ 1/2018 | 12/31/2

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	5 0.21%	61 0.60%	165 0.79%	99 0.79%	1370 1.24%	50 0.88%	1750 1.08%
6 to 10 MPH	6 0.25%	44 0.43%	129 0.62%	117 0.93%	1316 1.19%	33 0.58%	1645 1.01%
11 to 15 MPH	5 0.21%	58 0.57%	175 0.84%	107 0.85%	1325 1.20%	33 0.58%	1703 1.05%
16 to 20 MPH	3 0.13%	51 0.50%	195 0.94%	164 1.31%	1604 1.45%	36 0.63%	2053 1.27%
21 to 25 MPH	13 0.54%	108 1.06%	308 1.48%	187 1.49%	2483 2.25%	78 1.37%	3177 1.96%
26 to 30 MPH	25 1.05%	128 1.25%	450 2.16%	274 2.18%	3035 2.75%	74 1.30%	3986 2.46%
31 to 35 MPH	25 1.05%	278 2.72%	822 3.95%	519 4.13%	5263 4.77%	178 3.12%	7085 4.37%
36 to 40 MPH	36 1.51%	362 3.54%	970 4.66%	580 4.62%	5643 5.11%	138 2.42%	7729 4.77%
41 to 45 MPH	115 4.82%	1091 10.66%	2479 11.92%	1263 10.06%	12617 11.42%	236 4.14%	17801 10.98%
46 to 50 MPH	71 2.98%	577 5.64%	1243 5.98%	708 5.64%	6065 5.49%	135 2.37%	8799 5.43%
51 to 55 MPH	187 7.84%	1388 13.57%	2508 12.06%	1253 9.98%	11504 10.42%	189 3.32%	17029 10.50%
56 to 60 MPH	147 6.16%	815 7.97%	1329 6.39%	627 4.99%	5256 4.76%	114 2.00%	8288 5.11%
61 to 65 MPH	183 7.67%	841 8.22%	1288 6.19%	631 5.03%	6685 6.05%	106 1.86%	9734 6.00%
66 to 70 MPH	202 8.47%	840 8.21%	1217 5.85%	689 5.49%	8657 7.84%	80 1.40%	11685 7.21%
71 to 75 MPH	102 4.27%	265 2.59%	327 1.57%	143 1.14%	1680 1.52%	26 0.46%	2543 1.57%
76 to 80 MPH	111 4.65%	238 2.33%	242 1.16%	120 0.96%	848 0.77%	24 0.42%	1583 0.98%
81 to 85 MPH	44 1.84%	100 0.98%	73 0.35%	32 0.25%	214 0.19%	3 0.05%	466 0.29%
86 to 90 MPH	51 2.14%	88 0.86%	63 0.30%	29 0.23%	152 0.14%	5 0.09%	388 0.24%
91 to 95 MPH	14 0.59%	20 0.20%	14 0.07%	6 0.05%	25 0.02%	4 0.07%	83 0.05%
96 to 100 MPH	57 2.39%	60 0.59%	29 0.14%	15 0.12%	77 0.07%	7 0.12%	245 0.15%
Over 100 MPH	31 1.30%	26 0.25%	24 0.12%	20 0.16%	63 0.06%	3 0.05%	167 0.10%
E Stationary	4 0.17%	7 0.07%	23 0.11%	18 0.14%	335 0.30%	17 0.30%	404 0.25%
Unknown	540 22.63%	2029 19.83%	5407 26.00%	4174 33.25%	29299 26.53%	3430 60.19%	44879 27.68%
Not Applicable	27 1.13%	103 1.01%	320 1.54%	224 1.78%	2217 2.01%	289 5.07%	3180 1.96%
CU is Not a Vehicle	321 13.45%	526 5.14%	662 3.18%	304 2.42%	173 0.16%	60 1.05%	2046 1.26%
CU is Unknown	61 2.56%	128 1.25%	338 1.63%	251 2.00%	2541 2.30%	351 6.16%	3670 2.26%
TOTAL	2386 1.47%	10232 6.31%	20800 12.83%	12554 7.74%	110447 68.13%	5699 3.52%	162118 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 crashes. Notice the red in the Fatality and Serious Injury 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.

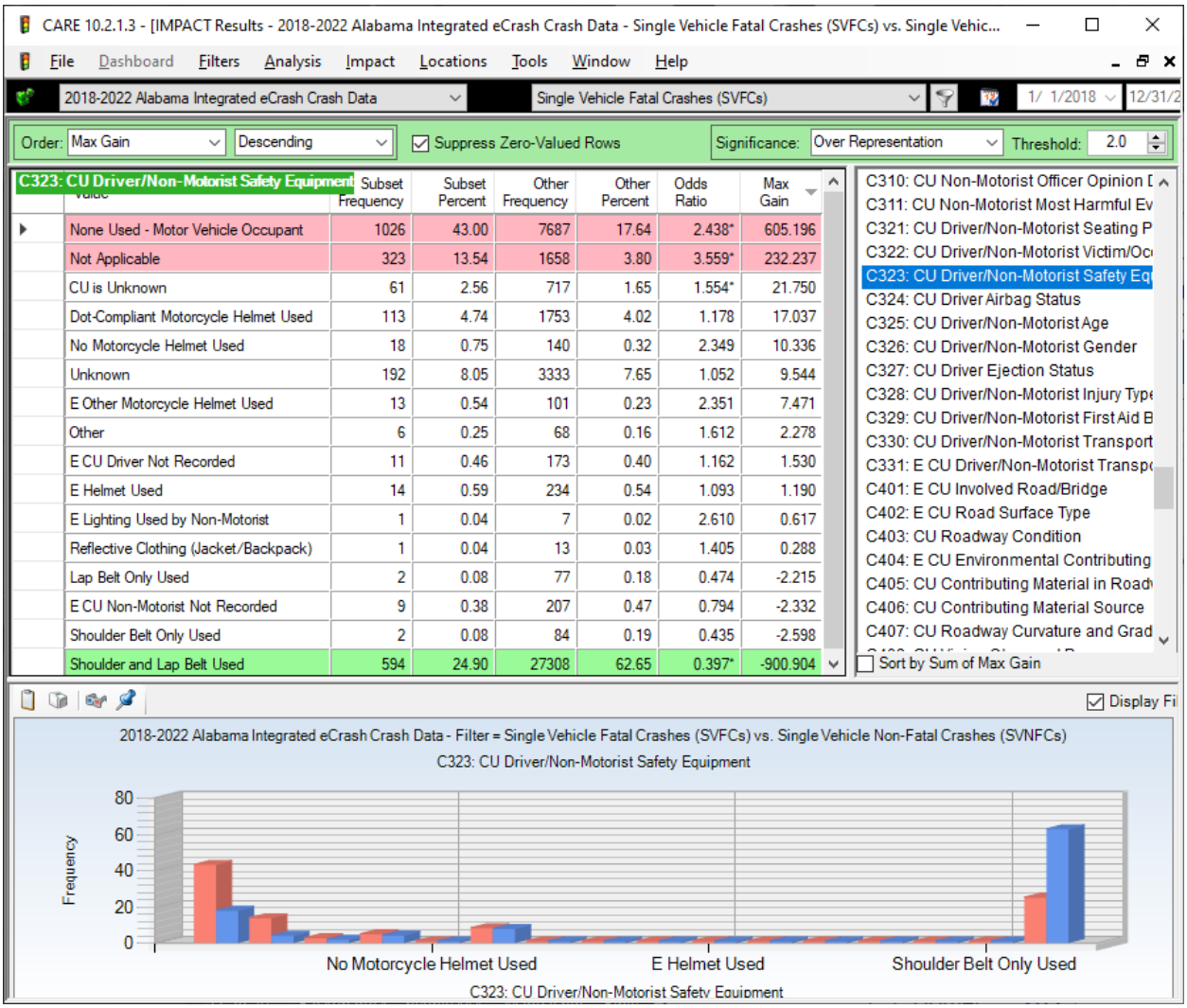
Speed at Impact	Fatality Odds (1 in …)	Increase Probability above 31-35
31 to 35 MPH	283.4	1
36 to 40 MPH	214.7	1.3
41 to 45 MPH	154.8	1.8
46 to 50 MPH	123.9	2.3
51 to 55 MPH	91.1	3.1
56 to 60 MPH	56.4	5.0
61 to 65 MPH	53.2	5.3
66 to 70 MPH	57.8	4.9
71 to 75 MPH	24.9	11.4
76 to 80 MPH	14.3	19.9
81 to 85 MPH	10.6	26.8
86 to 90 MPH	7.6	37.3
91 to 95 MPH	5.9	47.8
96 to 100 MPH	4.3	65.9
Over 100 MPH	5.4	*

The last column of the above table gives the fatality probability multiplier based on the lowest probability (31-35 MPH), to which was assigned a relative value of 1.0 (not a probability). The probabilities in the form of "**1 in X"** are given in the middle column. For example, the probability of a crash at 46-50 MPH being fatal is one in 123.9. This is 2.3 times that probability if the impact speed were in the 31 to 35 range, as given in the third column. Speeds 100 and over had too few occurrences to be reliable estimates, and it is assigned an asterisk (*).

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 cut 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 SVFC and SVNFC drivers to be properly restrained, which will be covered in the next separate attribute below (6.5; Restraint Use by Causal Drivers in Fatal Collisions). This is also correlated with 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 Single SVFCs vs SVNFCs

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



The proportion of failure to use proper restraints is 43.00% for Single Vehicle Fatal Crashes. The Odds Ratio is 2.438, showing that their failure to use restraint is well over twice that of the Non-Fatal Single Vehicle crashes. Shoulder and Lap Belt Used is over-represented by SVNFCs in about 62,65% (Odds Ratio 1/0.397 = 2.52 times the expected use in comparison to Fatal Single Vehicle Crash seatbelt usage). Clearly, not being restrained contributes heavily to the SVFC fatalities.

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

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Injury Crashes (including Fatalities)]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Injury Crashes (including Fatalities) | 1/ 1/2018

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Crash Severity ; Row: CU Driver/Non-Motorist Safety Equipment

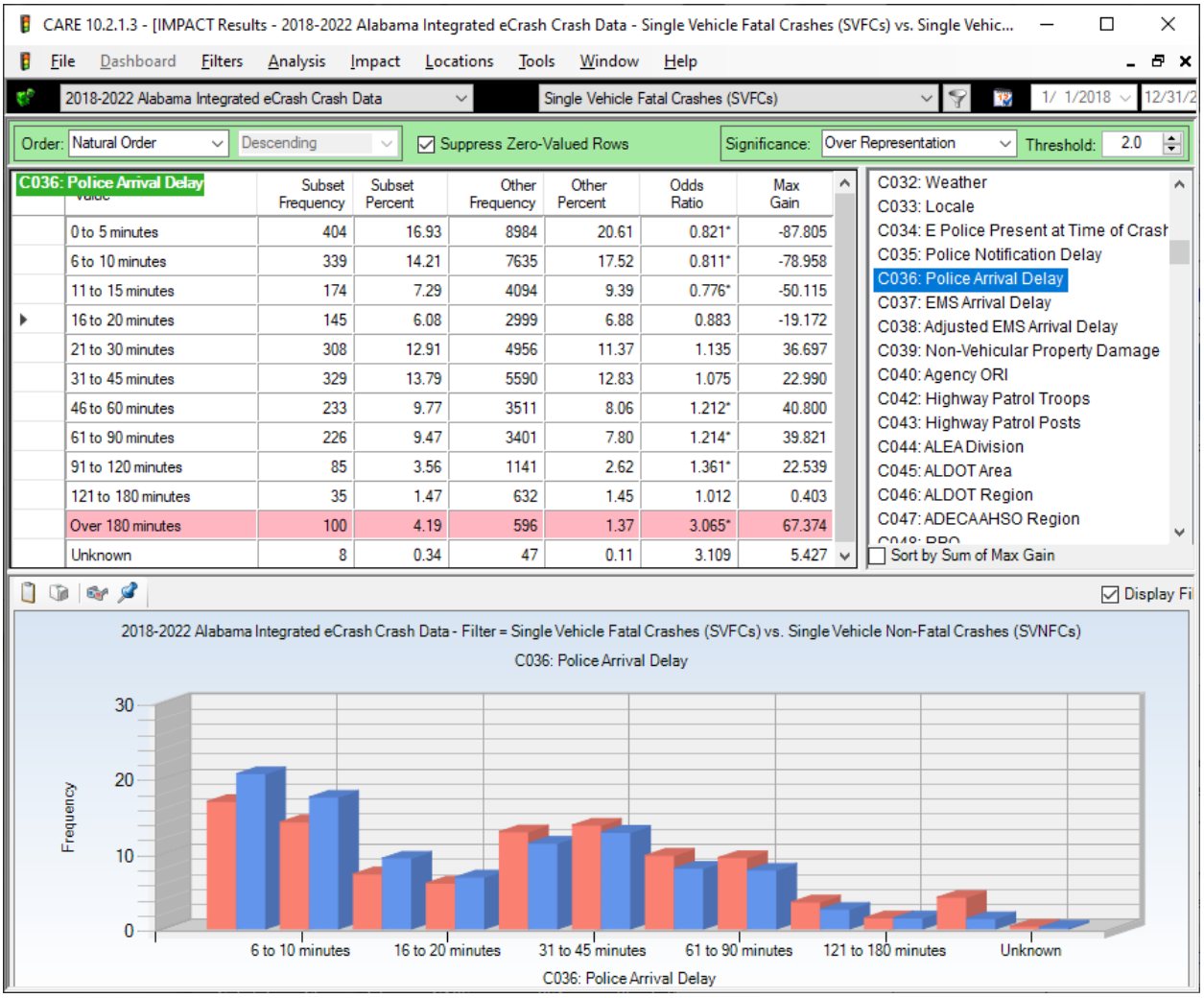
	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	TOTAL
None Used - Motor Vehicle Oc	1596 36.51%	4412 21.75%	5240 8.69%	2510 3.91%	13758 9.23%
Shoulder and Lap Belt Used	1581 36.16%	11626 57.32%	44825 74.34%	51783 80.69%	109815 73.64%
Lap Belt Only Used	7 0.16%	42 0.21%	123 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.
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 when not using proper restraints.

6.7 C052 Number of Vehicles Involved (SVFCs vs SVNFCs)

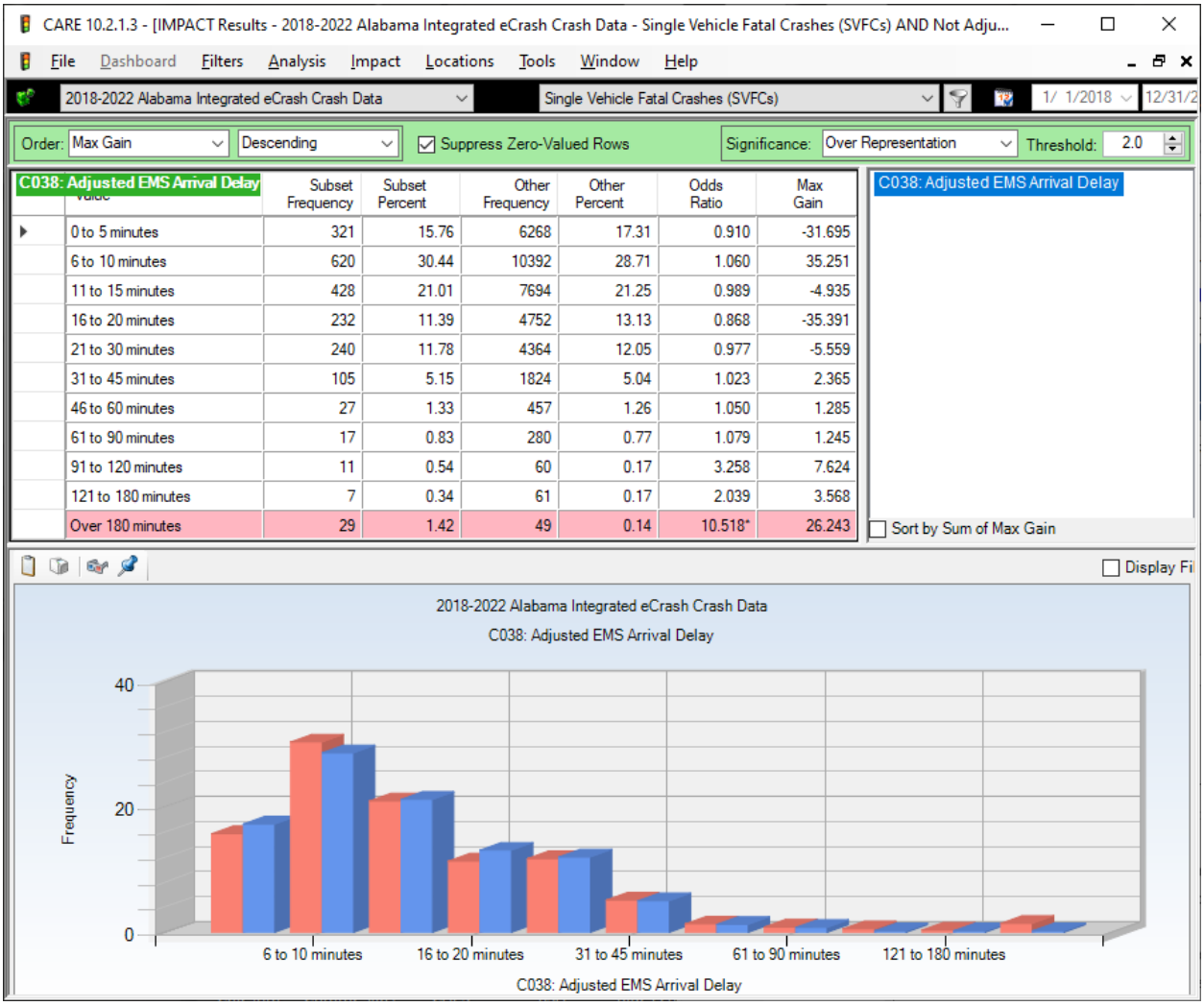
All crashes under consideration in this study were single vehicle crashes.

6.8 C036 Police Arrival Delay (SVFCs vs SVNFCs)



SVFC police arrival delays reflect the issues in finding out about the crash and getting to the scene, especially at night. All but one of the delay times of 20 minutes or less were over-represented for SVNFCs with high Odds Ratios. SVFCs are over-represented in all delay times above 20 minutes, of which three were statistically significant. The analysis below shows how this correlates with EMS arrival times.

6.9 C038 Adjusted EMS Arrival Delay

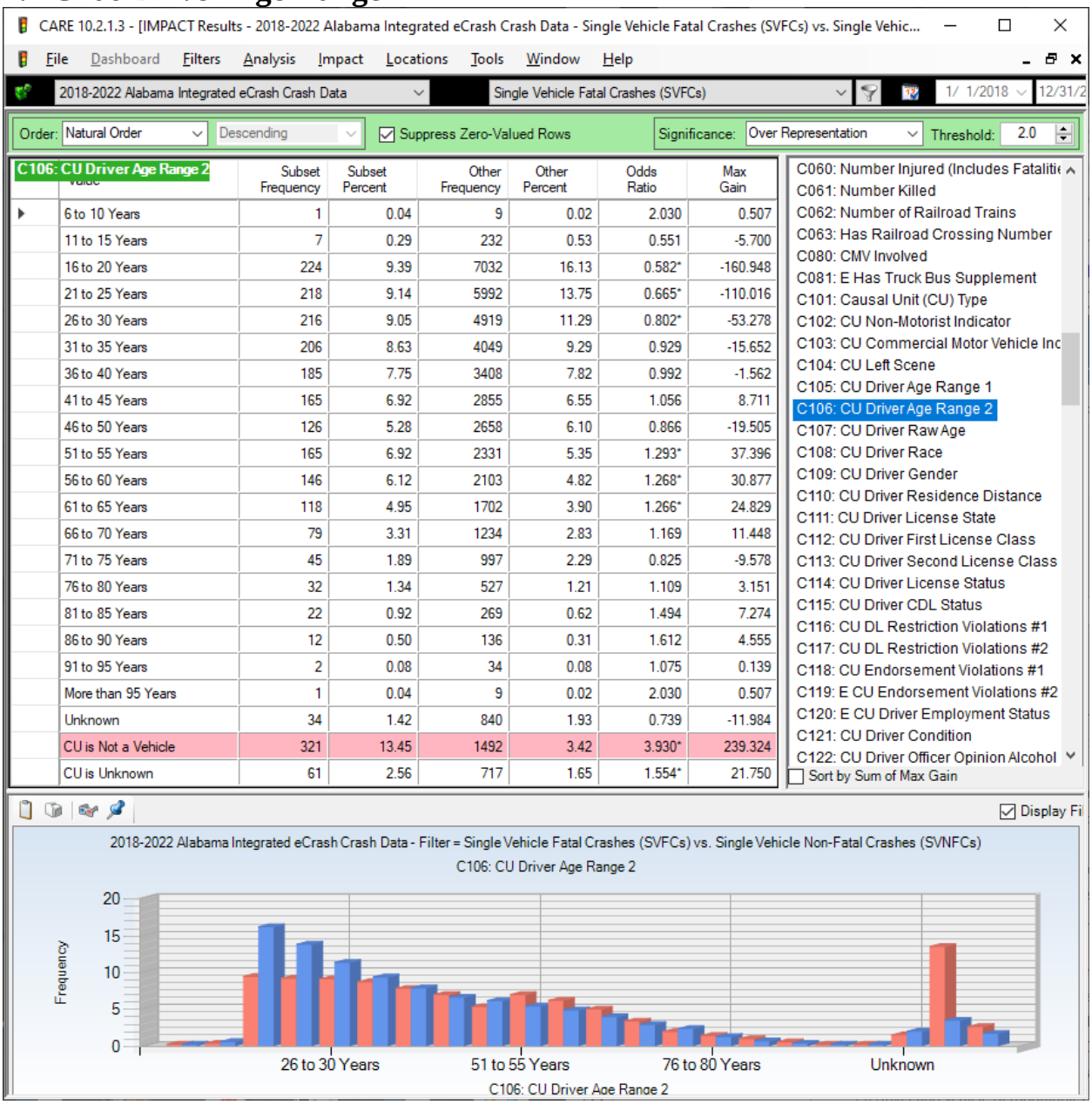


C038: Adjusted EMS Arrival Delay	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
0 to 5 minutes	321	15.76	6268	17.31	0.910	-31.695
6 to 10 minutes	620	30.44	10392	28.71	1.060	35.251
11 to 15 minutes	428	21.01	7694	21.25	0.989	-4.935
16 to 20 minutes	232	11.39	4752	13.13	0.868	-35.391
21 to 30 minutes	240	11.78	4364	12.05	0.977	-5.559
31 to 45 minutes	105	5.15	1824	5.04	1.023	2.365
46 to 60 minutes	27	1.33	457	1.26	1.050	1.285
61 to 90 minutes	17	0.83	280	0.77	1.079	1.245
91 to 120 minutes	11	0.54	60	0.17	3.258	7.624
121 to 180 minutes	7	0.34	61	0.17	2.039	3.568
Over 180 minutes	29	1.42	49	0.14	10.518*	26.243

There were no significant differences found in the ambulance delay times between the fatal and non-fatal single-vehicle crashes. However, the fact that over 45% had responses less than 10 minutes, and another 40% were between 11 and 30 minutes is quite commendable.

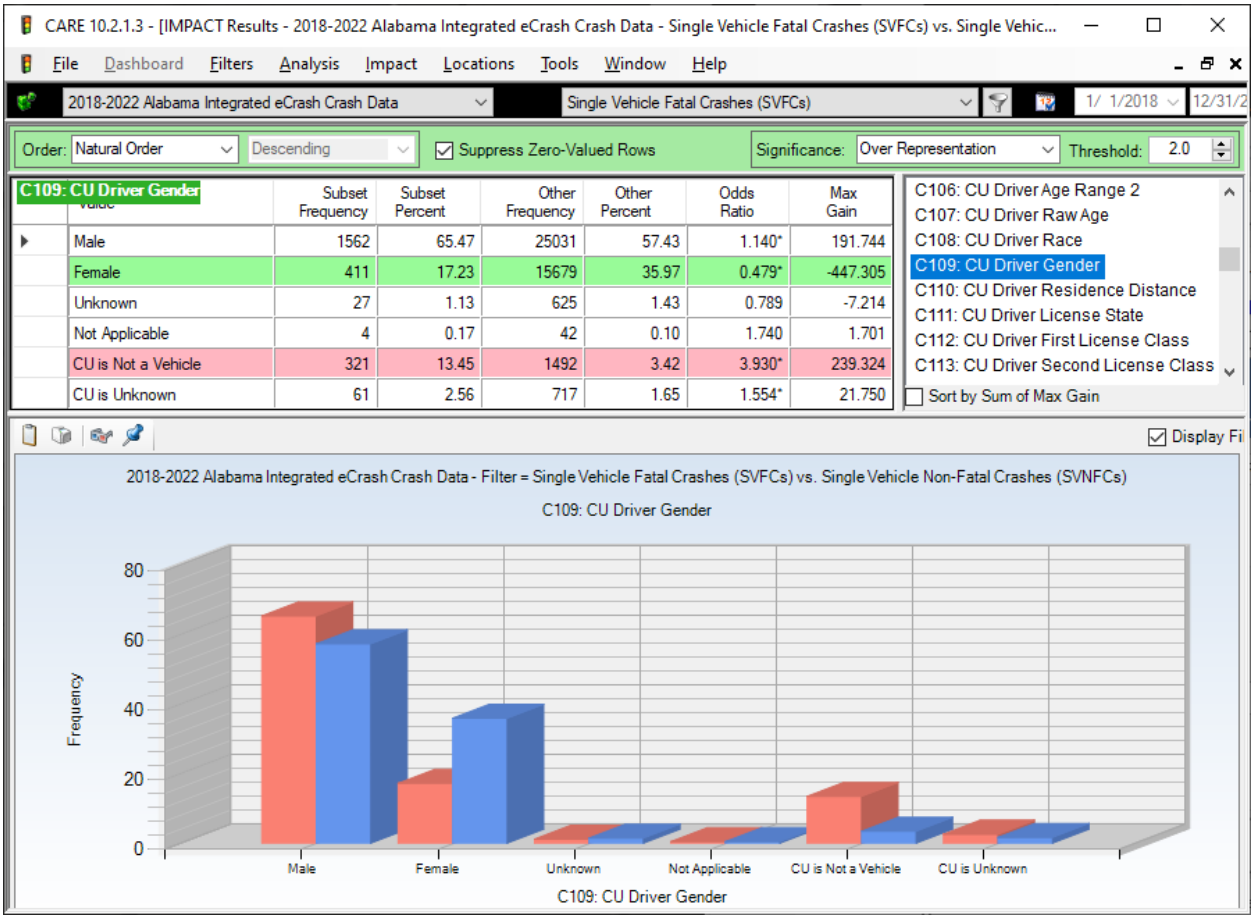
7.0 Driver and Vehicle Demographics

7.1 C106 Driver Age Range 2



The table display above presents SVFCs compared to SVNFCs given in 5-year age increments. The significant under-representations in the 16-40 age groups probably occur because of the large numbers of SCNFCs in these age intervals. Above 40 years of age, the SVFCs are over-represented, showing that these ages have more than their share of fatal crashes.

7.2 C109 Driver Gender SVFCs vs SVNFCs



The male and female red and blue bar proportions each individually sum very close to 100%. So the breakdown in SVFCs causal drivers is 65.47% male and 17.23% female. For "Other," SVNFCs, the percentage is 57.43% male and 35.97% female. These differences in proportions certainly indicate that males are a greater cause of Single Vehicle Fatal Crashes (SVFCs) than crashes in general, although their proportion of causing crashes in general is 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.

The highly significant over-representation in "CU is Not a Vehicle" is largely due to pedestrians being coded in this category. Obviously, pedestrians are not always the causal unit. For more definitive specifications, see Sections 7.4 and 7.5.

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 SVFCs)

CARE 10.2.1.3 - [Crosstab Results - 2018-2022 Alabama Integrated eCrash Crash Data - Filter = Single Vehicle Fatal Crashes (S...

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2018-2022 Alabama Integrated eCrash Crash Data | Single Vehicle Fatal Crashes (SVFCs) | 1/ 1/201

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

	Male	Female	Unknown	Not Applicable	CU is Not a Vehicle	CU is Unknown	TOTAL
6 to 10 MPH	5	1	0	0	0	0	6
11 to 15 MPH	2	3	0	0	0	0	5
16 to 20 MPH	2	1	0	0	0	0	3
21 to 25 MPH	12	1	0	0	0	0	13
26 to 30 MPH	20	5	0	0	0	0	25
31 to 35 MPH	22	3	0	0	0	0	25
36 to 40 MPH	26	10	0	0	0	0	36
41 to 45 MPH	87	27	1	0	0	0	115
46 to 50 MPH	59	12	0	0	0	0	71
51 to 55 MPH	141	45	1	0	0	0	187
56 to 60 MPH	109	37	1	0	0	0	147
61 to 65 MPH	148	34	1	0	0	0	183
66 to 70 MPH	160	42	0	0	0	0	202
71 to 75 MPH	75	27	0	0	0	0	102
76 to 80 MPH	94	17	0	0	0	0	111
81 to 85 MPH	36	8	0	0	0	0	44
86 to 90 MPH	42	9	0	0	0	0	51
91 to 95 MPH	14	0	0	0	0	0	14
96 to 100 MPH	49	8	0	0	0	0	57
Over 100 MPH	26	5	0	0	0	0	31

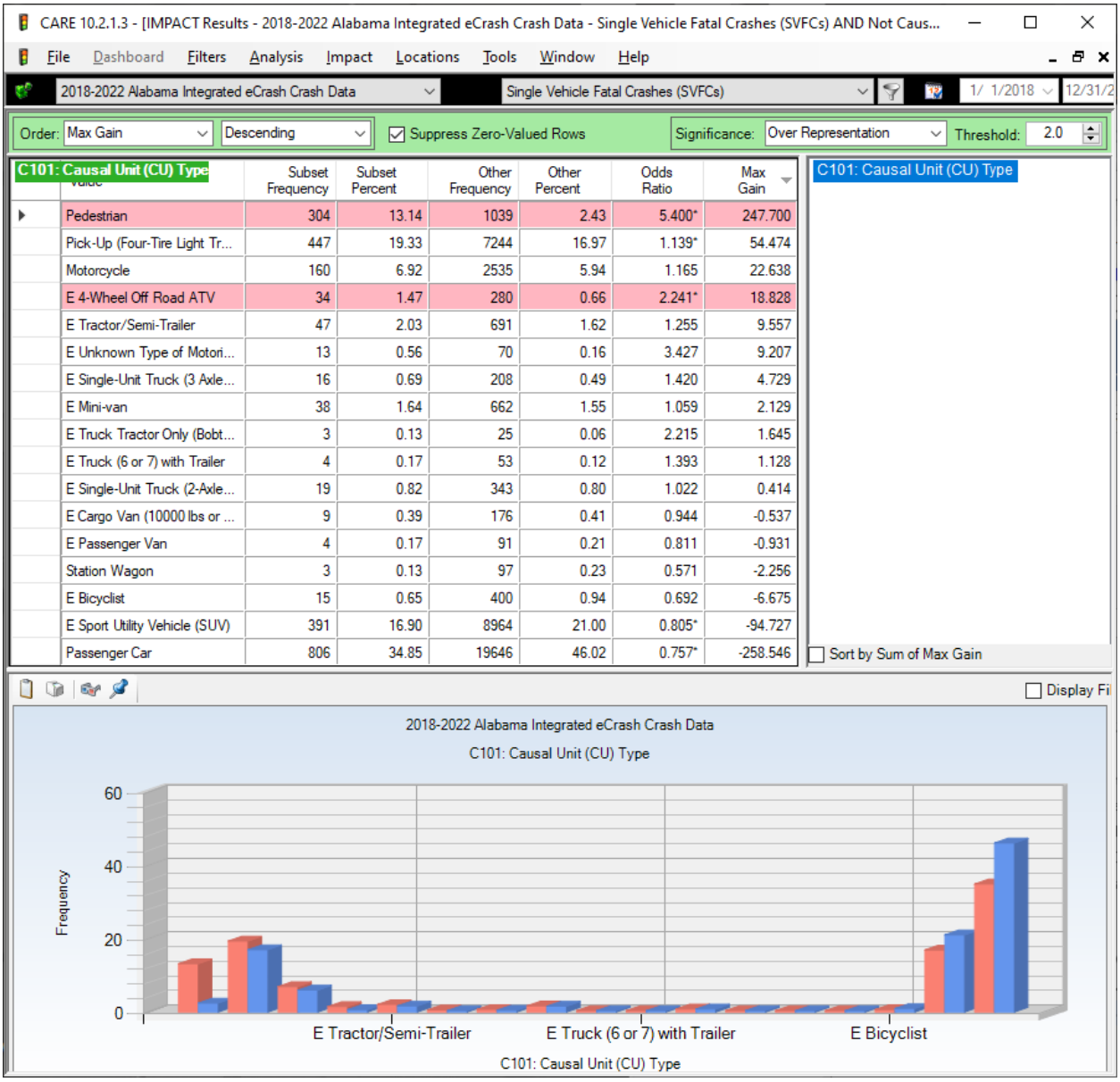
Number and Percent males and females involved in fatal crashes over 75 MPH:

261 Male = 261/1134 = 23.01%

47 Female = 47/295 = 15.93%.

The proportion of male fatal crashes over 75 MPH is 44.46% higher than that of the females.

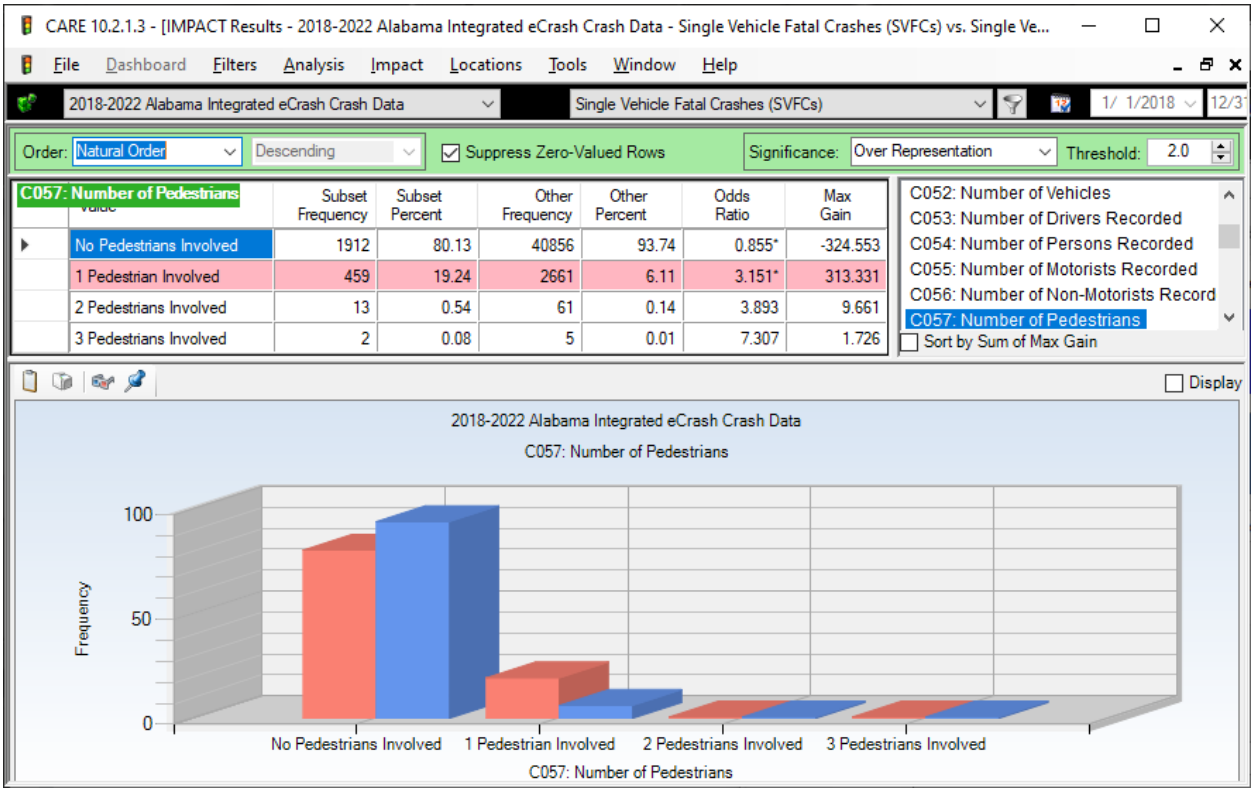
7.4 C101 Causal Vehicle Type (> 2 or more crashes) SVFCs vs SVNFCs



Pedestrians 304 and Pick Ups 447 were significantly over-represented SVFCs. The proportion of Sport Utility Vehicles (16.90%, 391) and Passenger Cars (34.85%, 806) resulted in their placement at the bottom of the list, indicating that they were (in this case significantly) under-represented in SVFCs. Motorcycle had a high frequency (160), but there were no significant differences in their proportions of SVFCs and SVNFCs.

See Section 7.5 for more information on Pedestrians.

7.5 C057 Number of Pedestrians

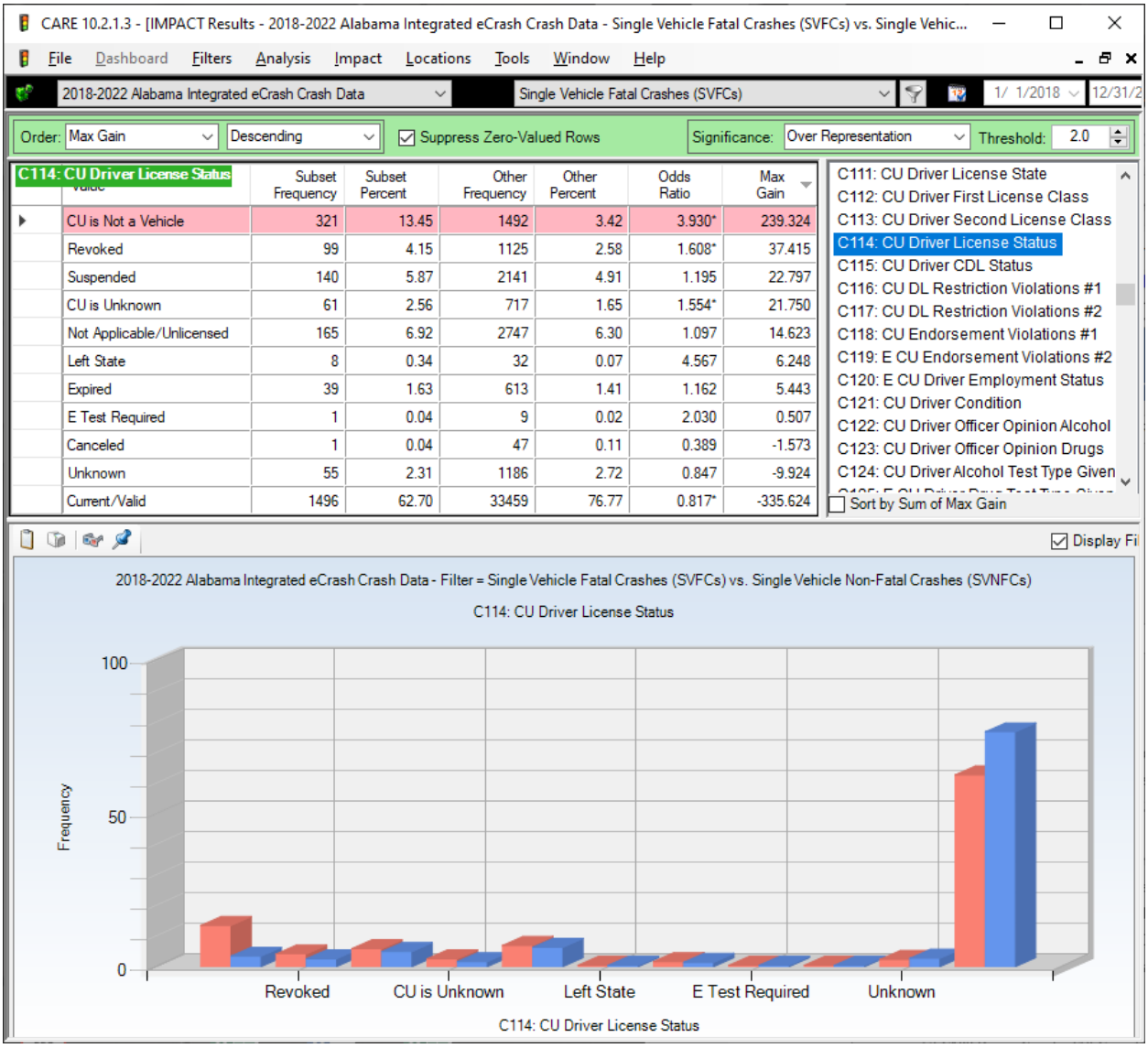


There were a total of 491 fatal crashes involving Pedestrians in Single Vehicle crashes. Most (459) of them were single pedestrian incidents.

Both ID and Impaired Walking, contribute to this, as well as pedestrians not taking the maximum provisions for being seen, especially at night.

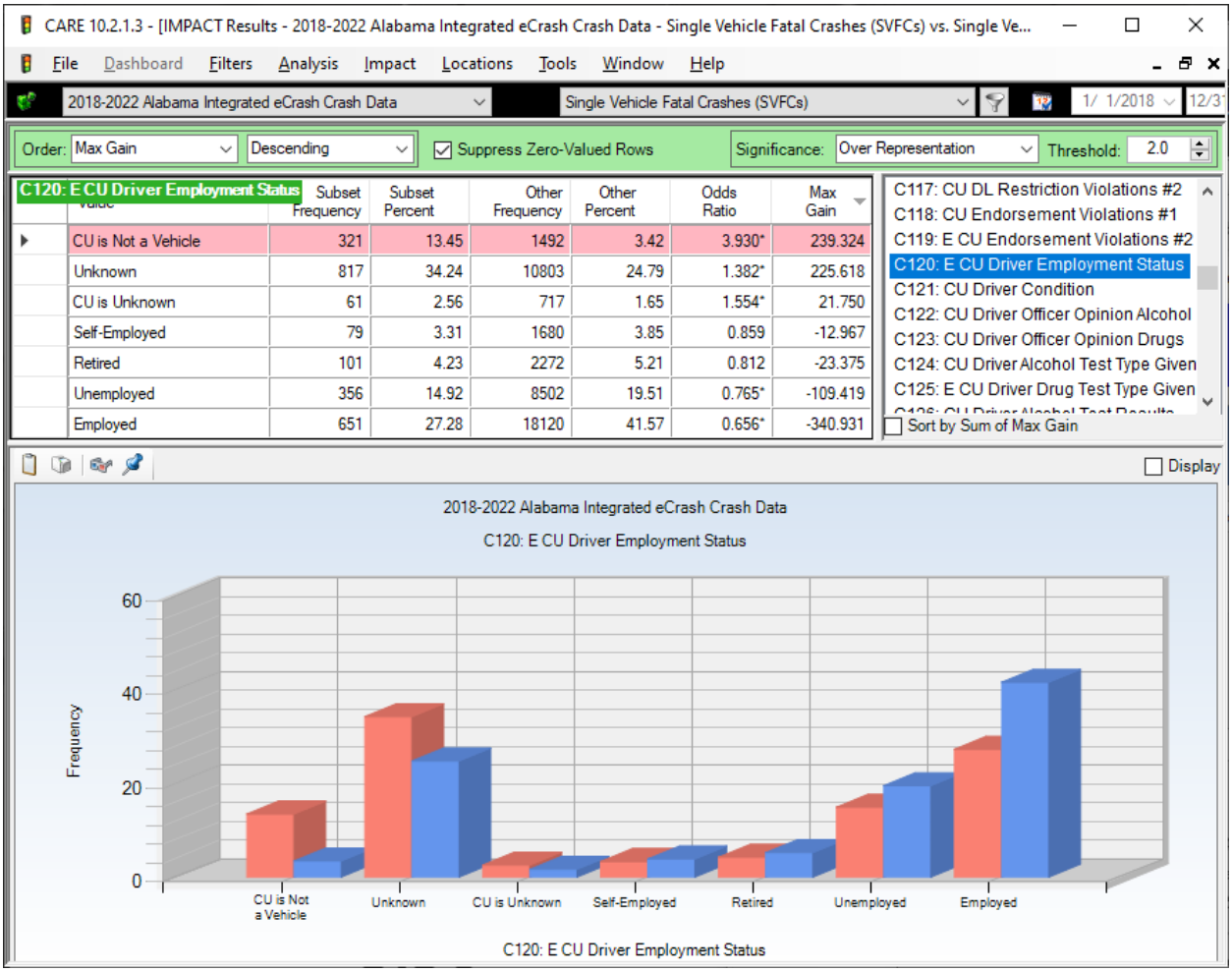
For a nore detailed study of pedestrian crashes, please see:
http://www.safehomealabama.gov/wp-content/uploads/2023/05/Ped-SS-Using-2018-22-Data-v04.pdf

7.6 C114 Driver License Status



SVFCs were under-represented in their causal drivers having legitimate licenses by a significant Odds Ratio of 0.817* (with a proportion of about 22.44% lower than the corresponding SVNFC proportion). Revoked, Suspended, and Expired were all over-represented as well, Revoked significantly so. This would lead us to believe that many of those who caused fatal crashes are often not operating within the law.

7.7 C120 Driver Employment Status



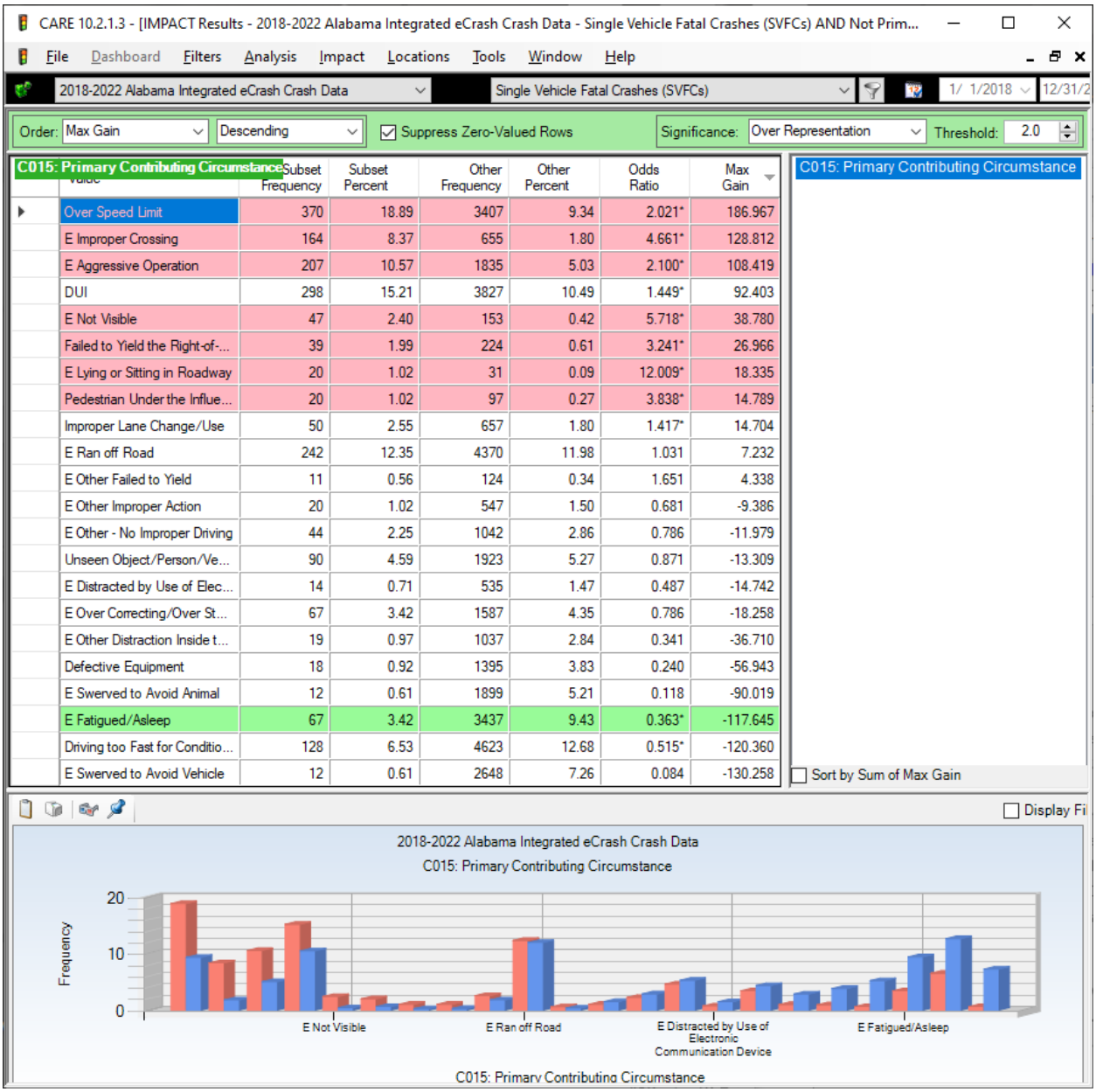
The following gives the proportion comparisons for SVFCs and SVNFCs, with over-representation indicated by (*):

Status	SVFCs	SVNFCs	ODDS RATIO
Retired	4.23%	5.21%	0.812
Unemployed	14.92%	19.51%	0.765*
Self-Employed	3.31%	3.85%	0.859
Employed	27.28%	41.57%	0.656*

While the records indicated that the unemployment rate was lower for SVFCs than for SVNFCs, it also indicated that the employment rate was higher for SVNFCs than for SVNCs, which would seem to be a contradiction.

8.0 Driver Behavior

8.1 C015 Primary Contributing Circumstances (Items < 10 Crashes Removed)



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 SVFCs and SVNFCs. All SVFC over-representations in their expected proportion are as follows, with percentages:

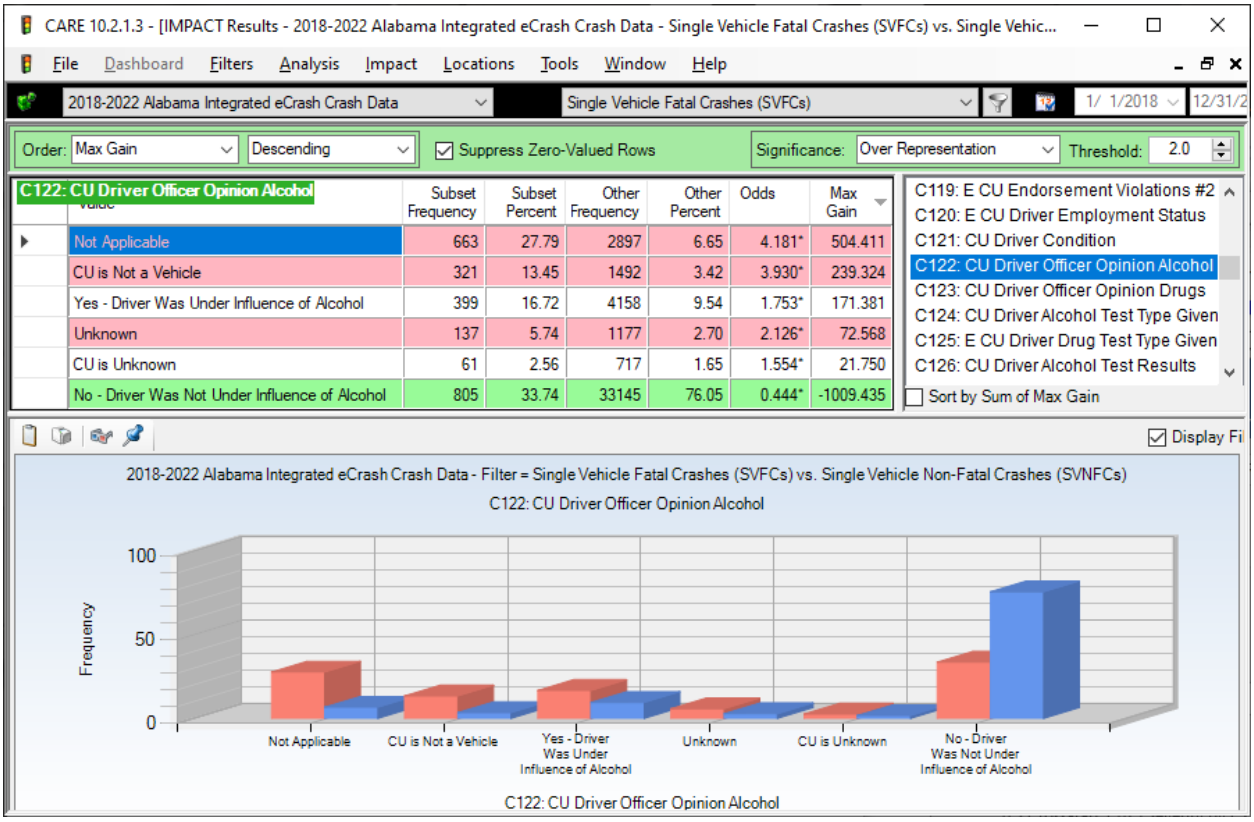
	SVFCs PCC Overrepresented/Frequency	**SVFC%**	**SVNFC%**
o	Over Speed Limit 370	18.89%**	9.34%
o	Improper Crossing (pedestrian) 164	8.37%**	1.80%
o	Aggressive Operation 207	10.57%**	5.03%
o	DUI (aka ID) 298	15.21%	10.49%
o	Not Visible (most often pedestrian) 47	2.40%**	0.042%
o	Failed to Yield the Right-of-Way 39	1.99%**	0.36%
o	Lying/Sitting in Roadway (Pedestrian) 20	1.02*%**	0.09%
o	Pedestrian Under the Influence 20	1.02%**	0.27%
o	Improper Lane Change/Use 50	2.55%*	1.80%
o	Ran off Road 242	12.35%	11.98%
o	Other Failed to Yield 11	0.56%	0.34%
o	Other Improper Action 20	1.02%	1.50%
o	Unseen object/Person/Vehicle 90	4.59%	5.27%
o	Over Correcting/Over Steering 67	3.42%	4.35%
o	Driving too Fast for Conditions 128	6.53%	12.68%*
o	Fatigued/Asleep 67	3.42%	9.43%*

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 speed, improper pedestrian actions and DUI (both alcohol and non-alcohol drugs). Some items with a high frequency have percentages that are close to the SVNFC percentage and are thus further down on the list and not marked as significant (*) or highly significant (**) by more than a 10% difference.

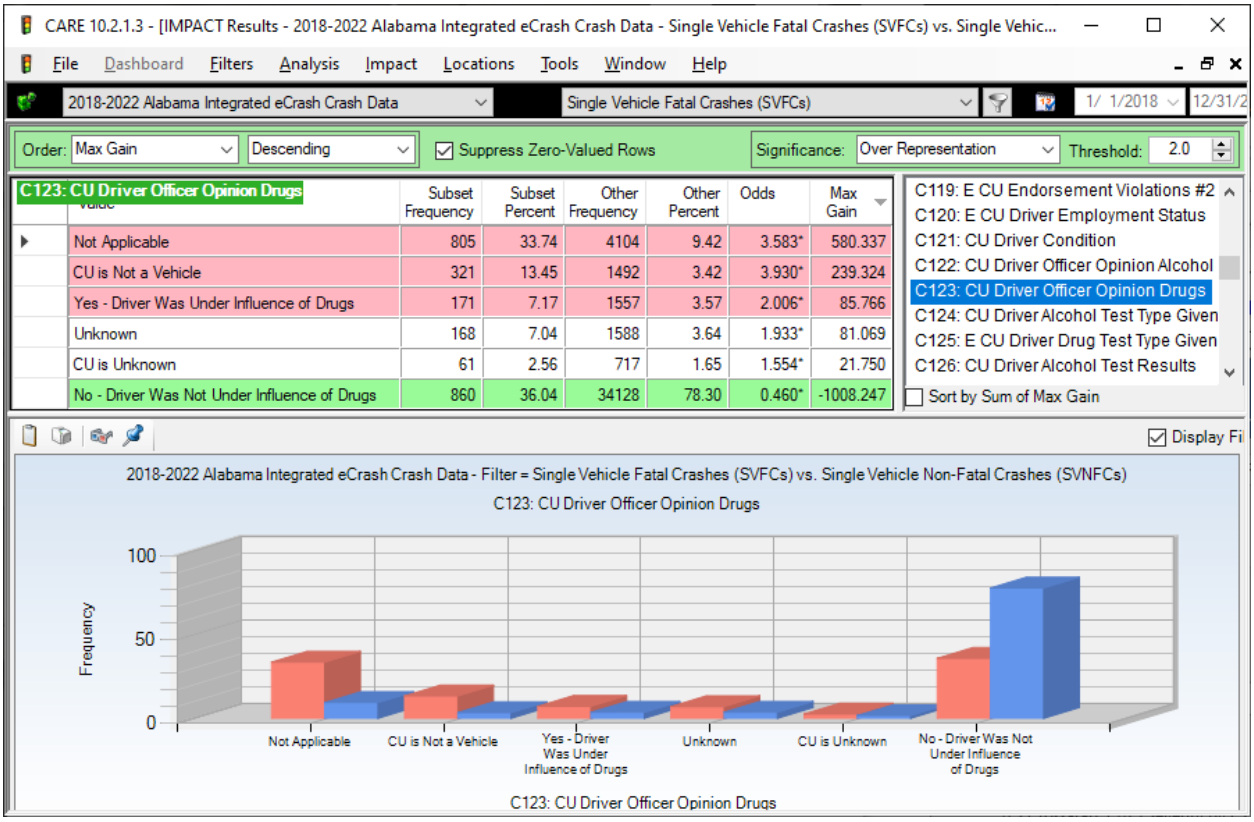
Not that there are several entries for pedestrians – See Section 7.5 for more information on pedestrians.

8.3 C122 CU Driver Officer's Opinion Alcohol



Impaired Driving/Alcohol was indicated as one cause of the crash for 16.72% of the SVFCs, and 9.54% of the SVNFCs. This gives an Odds Ratio of 1.753. 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, both day and night. From the positive perspective, 76.05% of the SVNFCS were not ID alcohol, but only 33.74% of the SVFCs were sober in this regard.

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



The reported drug use proportions in SVFCs was less than half (7.17/16.72 = 42,88%) of that for alcohol. In both cases (SVFCs and SVNFCs), 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 of single vehicle fatal crashes. Note the Impaired Pedestrians that are noted in Sections 8.1-8.2.

From the positive perspective, 78.30% of the SVNFCS were not Under the Influence of Non-Alcohol Drugs, but only 36.04% of the SVFCs 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 is Impaired.