Special Study

Restraint Issues Problem Identification

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For general information on restraints from NHTSA and other sources, please see "Restraints" in:
http://www.safehomealabama.gov/safety-topics/

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Restraint Issues Problem Identification

Recommendations

Typical recommendations to increase restraint use can be found throughout the SafeHomeAlabam.gov web pages that are devoted to restraint issues. These are:

- Child restraints: http://web01-staging.caps.ua.edu/safehome/tag/child-safety-seats/
- Safety belts: http://web01-staging.caps.ua.edu/safehome/tag/safety-belts/
- Click It or Ticket: http://web01-staging.caps.ua.edu/safehome/tag/click-it-or-ticket/

The motivational content given on these web pages will generally not be repeated here. Instead, we will focus on practical guidance that can make the findings of this study useful to those who are involved with countermeasure development. No priority should be inferred from the ordering; recommendations will be ordered as in the report.

Geographical Factors. Counties, cities and virtual cities (rural areas within counties) that are over-represented should be given additional resources for PI&E and selective enforcement programs. Rural areas adjacent to major metropolitan areas are particularly in need of additional resources. Sheriffs' officers should get involved on the county roadways in giving out warnings if nothing else. Shopping or Business locales are the most significantly under-represented and can be avoided in favor of the rural areas.

Time Factors. Time of Day and Day of the Week together are some of the best proxies for impaired driving (ID). Other studies done by CAPS that centered on the causes for the increase in fatalities in 2016 made the high correlation between ID and failing to use restraints quite clear. Thus, the ID days and hours should be the targets, perhaps with seatbelt use being supplemental to the ID enforcement.

Crash Causal Factors. Restraint non-use was also correlated to other risk taking behaviors, such as speeding, aggressive operation, running off the road and fatigue/sleep. It is recommended that these behaviors be sought out similar to ID, as indicators of restraint non-use. It is recognized that since these factors tend to cause the crashes, they might be of greater law enforcement interest than the failure to use restraints. However, to reduce fatalities, we strongly recommend that restraint enforcement be performed in conjunction with that of any other behaviors.

Severity Factors. There should be some way to impress risk-takers that the odds are against them, but perhaps everything has already been said. The numbers are in the details, and probably the most impressive is that the chances of getting killed if not wearing a seatbelt is 30 times that than if restrained. The problem is that risk-takers think they are immune to getting in a crash in any event. Perhaps playing on the fact that about half of the crashes are not the fault of the unbelted victim drivers would help. There is ample evidence here to make a case, and this case has been made effectively to the vast majority of drivers. But these have not been effective in influencing those who are prone to taking risks. We strongly recommend that psychological research be performed for this purpose.

Driver Demographics. As would be expected, younger male drivers are over-represented mainly because of their affinity toward risk taking. Countermeasures that do not concentrate on trying to change the risk-taking nature of this demographic are not going to be effective. Countermeasures addressing other demographics have been extremely effective, and for the most part, they have already reaped their benefits. Since they are proven, they should be continued as countermeasures to risk-taking are developed. It is interesting that the "young age" problem is not isolated to the "under 25" males whose brains generally have not yet developed to the point where they fully understand and appreciate risk. The over-representation was found to be extended up to age 39, although it diminished somewhat with age.

Ejection and Back Seat Restraints. To the extent possible, the statistics presented in the summary and the IMPACT analyses should be exploited to increase restraint use. We feel the most effective ones are as follow:

- Non-restrained persons are over 300 times more likely to be totally ejected than those who are properly restrained.
- Being ejected results in a probability of death about 50 times that of those not ejected, so the odds of survival are to those who stay within the protection of the vehicle.
- If all back-seat occupants were properly restrained it would result in an estimated saving of 62 lives per year. Being in the back seat is no protection. To the contrary, those unrestrained in the back seat can become projectiles that can cause injury or death to other passengers.

Executive Summary

The following summarizes the findings of the analysis, corresponding to the respective sections of this report (given in parentheses):

- **Geographical Factors (2)**
  - Counties with the greatest overrepresentation factors for unrestrained driver crashes include Walker, Talladega, Jackson, DeKalb, Monroe and Cullman,
  - The number of crashes involving drivers who use no restraints is greatly overrepresented in rural areas in comparison to the urban areas. The odds ratio for rural areas is about 2.5 times that of what would be expected if rural and urban restraint use were the same.
  - The most overrepresented (worst) areas are the rural county areas in Walker, Talladega, Mobile, Tuscaloosa and Cullman Counties.
  - The most underrepresented (best) cities are Birmingham, Mobile, Montgomery, and Huntsville.
  - Crash incidents with no driver restraints being used are greatly overrepresented on county highways, with 2.75 times the expected number of crashes. County and State were the only roadway classification that were overrepresented. Federal, Interstate and Municipal roads were significantly under-represented.
  - In the analysis of locale, crashes involving no restraints are most commonly overrepresented in Open Country areas, and Shopping or Business locales are the most significantly under-represented.

- **Time Factors (3)**
  - The weekend days are the most overrepresented days of the week for crashes in which drivers did not use restraints. This correlates highly with impaired driving crashes.
  - In the evaluation of time of day, overrepresentations peak during the 7 PM to 6 AM time periods and then taper off, falling back below crashes involving causal drivers who use restraints in the 7 AM to 7 PM time periods. Additional cross-tabulations were performed for crashes involving injury.

- **Analysis of Time of Day by Day of Week (3.3-3.4)**
  - Crosstab analyses of time of day by day of the week of crashes in which restraints were not used enables officers to determine target times and days to enforce restraint laws so that severe crashes may be prevented. Two analyses were performed and compared for all crashes with restraint deficiencies and injury crashes for restraint deficiencies. The late night and early morning over-representations

were largely on the weekend days starting on Friday night and ending on Sunday morning.
    - The cross-tabulation of time of day by day of the week that was restricted to injury crashes showed a very high resemblance to the same analysis for impaired driving (alcohol and other drugs involvement).

- **Crash Causal Factors (4)**
    - The overrepresentation factors indicate that certain risk-taking behaviors are often associated with crashes in which restraints are not used, including DUI, over the speed limit, aggressive operation, running off the road, and fatigue/sleep.
    - Crashes attributed to drivers who used no restraints are greatly overrepresented in vehicles with model years 1960-2004, which could be attributed to the lack of standard safety restraints in some of these older model vehicles, or perhaps the removal of these safety devices over time.
    - The speed at impact for crashes for restraint-deficient crashes is significantly overrepresented in all of the categories above 45 MPH, indicating that these crashes consistently occur at higher speeds than crashes in which restraints were used by the causal driver. This is highly correlated with rural driving and risk taking.

- **Severity Factors (5)**
    - Fatal, incapacitating, and non-incapacitating injuries are all overrepresented in crashes where drivers were not restrained; this analysis quantified the benefits of the restraint use.
    - Fatal injuries in crashes where no restraints are used are highly overrepresented on interstate, federal and state roadways. "Possible Injuries and Property Damage Only were highly overrepresented on municipal highways.
    - Analysis of number injured shows that the proportion of injuries (including fatalities) in unrestrained driver crashes is overrepresented from 1 to 6 injuries per crash. Crashes without restraints are clearly causing much more severe injuries and a greater number of injuries and fatalities per crash.
    - The proportion of fatalities in general as well as the proportion of multiple fatality crashes is dramatically overrepresented in crashes where the causal driver is unrestrained.
    - As expected, ejection of the unrestrained driver is overrepresented, indicating one major cause for many fatalities in which safety equipment is not properly utilized.
    - All types of injuries, including fatalities, are consistently overrepresented in crashes where no restraints were used.

- **Driver Demographics (6)**
    - Analysis of individual driver ages indicates that crashes involving no restraints are overrepresented in drivers in and immediately above the teen driver classification (age range 19-39).
    - Male drivers account for a majority of crashes in which restraints are not used, and they are overrepresented by a factor of 1.296.

- **Ejection and Back Seat Analysis (5.5-5.8; 7)**
    - The non-restrained person is over 300 times more likely to be totally ejected than those who are properly restrained.
    - Being ejected results in a probability of death about 50 times that of those not ejected.
    - If all back-seat occupants were properly restrained it would result in an estimated saving of 62 lives per year.

1 Introduction

This section contains the result of a problem identification study that was conducted based on data from Fiscal Years (FY) FY2014-FY2017. This was the latest data that were available at the time of the study, and it is quite representative of the restraint picture going forward into FY2019.

CARE was used to process and display the information. Generally, the comparisons made were between those crashes in which the causal drivers were not restrained (generally represented by the red bars in the charts) and those that were reported to be restrained (generally represented by the blue bars in the charts). The use of proper restraints by causal drivers is seen to be an excellent proxy for proper restraint use by all passengers in the vehicle, and the results obtained are very consistent with expectations in this regard.

The goal of this problem identification is to assure that the restraint enforcement program considered by the state throughout FY2019 is completely evidence-based, the evidence being derived from past data obtained from crash records. Changes from what appeared in the previous year HSP will only be noted in cases where they are considered to be of significance for decision-making.

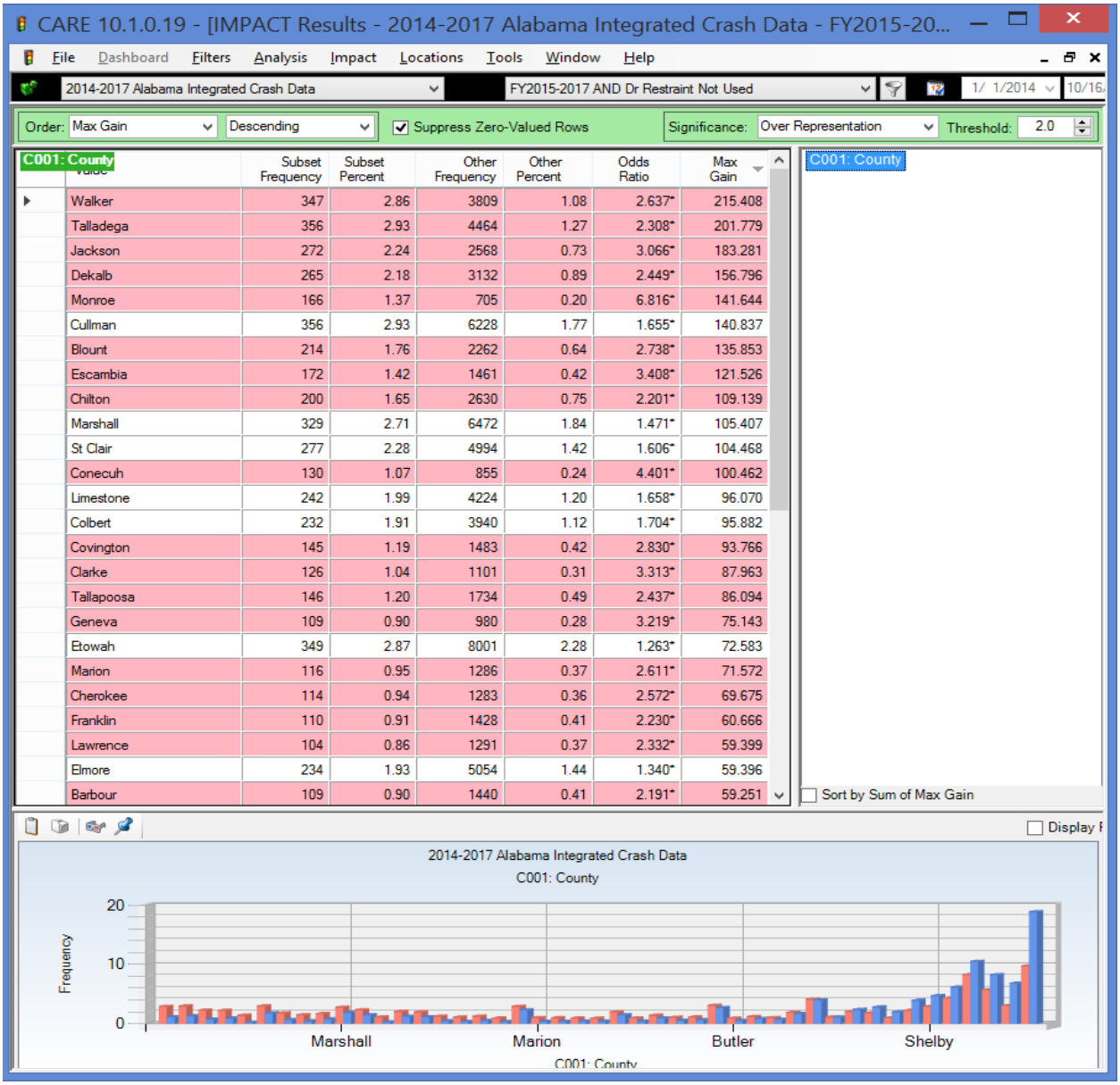
The major subsections within this problem identification are as follows:

- 2 Geographical Factors
- 3 Time Considerations
- 4 Crash Causal Factors
- 5 Severity Factors
- 6 Driver Demographics
- 7 Analysis for Back Seat Occupants
- 8 Summary and Conclusions

2 Geographical Factors

Geographical factors were analyzed in order to determine which areas are overrepresented for crashes involving drivers who did not use restraints. In order to determine these problem areas, geographical factors were analyzed in the following categories: county, city, rural versus urban, highway classification and locale.

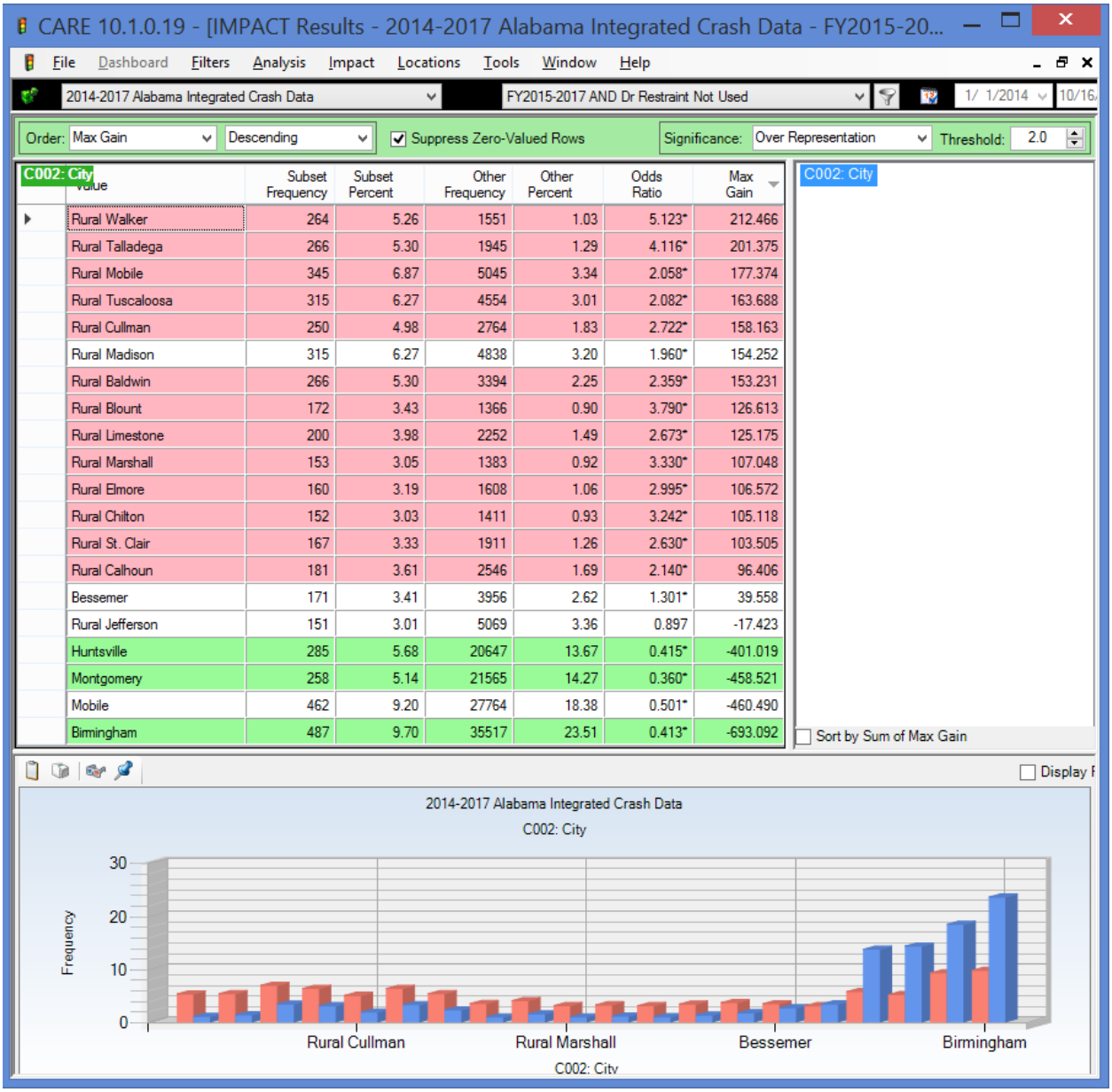
2.1 County



C001: County	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Walker	347	2.86	3809	1.08	2.637*	215.408
Talladega	356	2.93	4464	1.27	2.308*	201.779
Jackson	272	2.24	2568	0.73	3.066*	183.281
Dekalb	265	2.18	3132	0.89	2.449*	156.796
Monroe	166	1.37	705	0.20	6.816*	141.644
Cullman	356	2.93	6228	1.77	1.655*	140.837
Blount	214	1.76	2262	0.64	2.738*	135.853
Escambia	172	1.42	1461	0.42	3.408*	121.526
Chilton	200	1.65	2630	0.75	2.201*	109.139
Marshall	329	2.71	6472	1.84	1.471*	105.407
St Clair	277	2.28	4994	1.42	1.606*	104.468
Conecuh	130	1.07	855	0.24	4.401*	100.462
Limestone	242	1.99	4224	1.20	1.658*	96.070
Colbert	232	1.91	3940	1.12	1.704*	95.882
Covington	145	1.19	1483	0.42	2.830*	93.766
Clarke	126	1.04	1101	0.31	3.313*	87.963
Tallapoosa	146	1.20	1734	0.49	2.437*	86.094
Geneva	109	0.90	980	0.28	3.219*	75.143
Etowah	349	2.87	8001	2.28	1.263*	72.583
Marion	116	0.95	1286	0.37	2.611*	71.572
Cherokee	114	0.94	1283	0.36	2.572*	69.675
Franklin	110	0.91	1428	0.41	2.230*	60.666
Lawrence	104	0.86	1291	0.37	2.332*	59.399
Elmore	234	1.93	5054	1.44	1.340*	59.396
Barbour	109	0.90	1440	0.41	2.191*	59.251

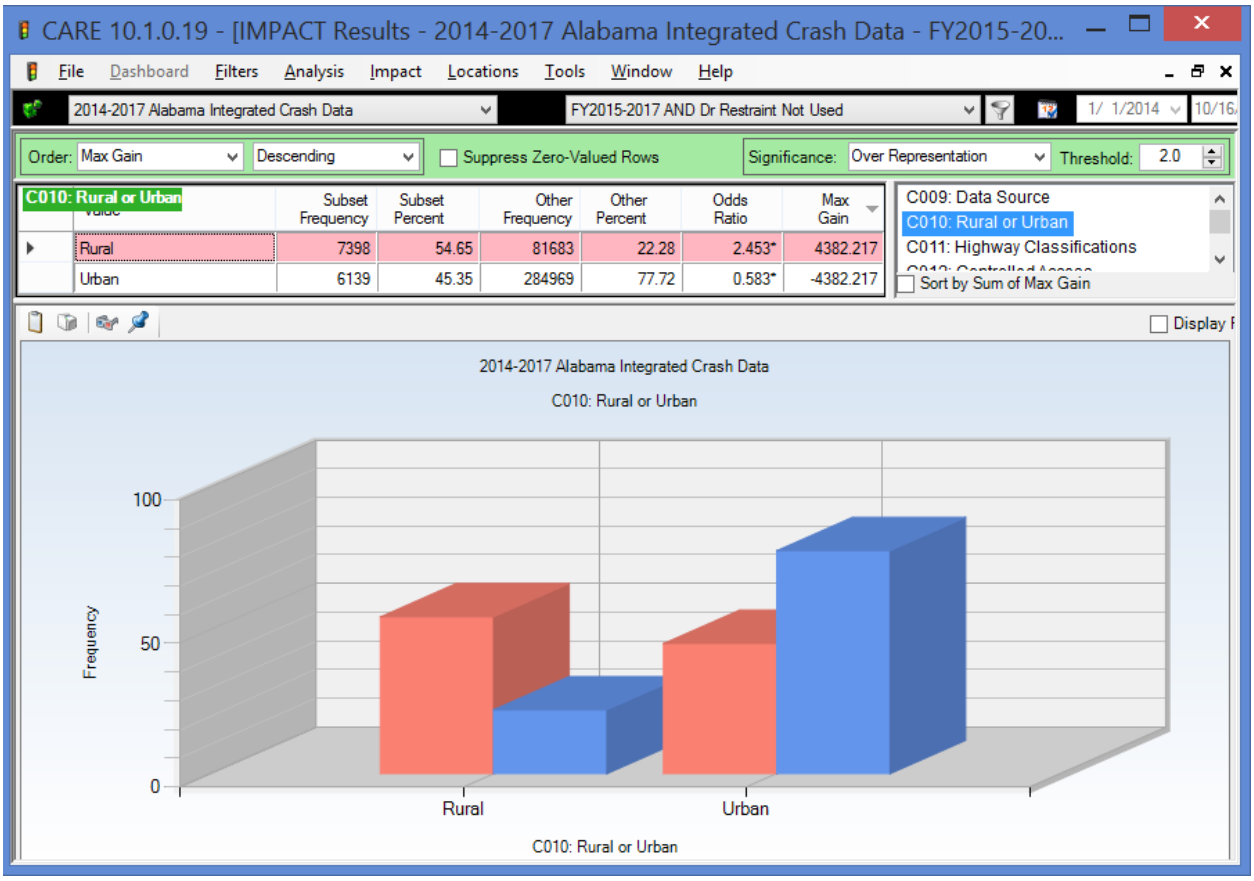
The display above is restricted to those counties that: (1) had at least 100 crashes in which the driver was reported to be unrestrained, and (2) the county had an over-representation (Odds Ration) of at least two times their expectation when compared to the proportion of their crashes statewide. For example, Walker County had a proportion of Drivers not restrained of 2.86% while their statewide proportion of all crashes is only 1.08%, which leads to an Odds Ratio of 2.637 (the asterisk * indicates that this difference is statistically significant at a very high level. The counties are arranged in Max Gain order, meaning those with the greatest potential for improvement are at the top. Max Gain is the number of crashes that could be reduced if the over-representation was reduced to zero. The more populated urbanized counties generally showed the highest occupant restraint use.

2.2 City



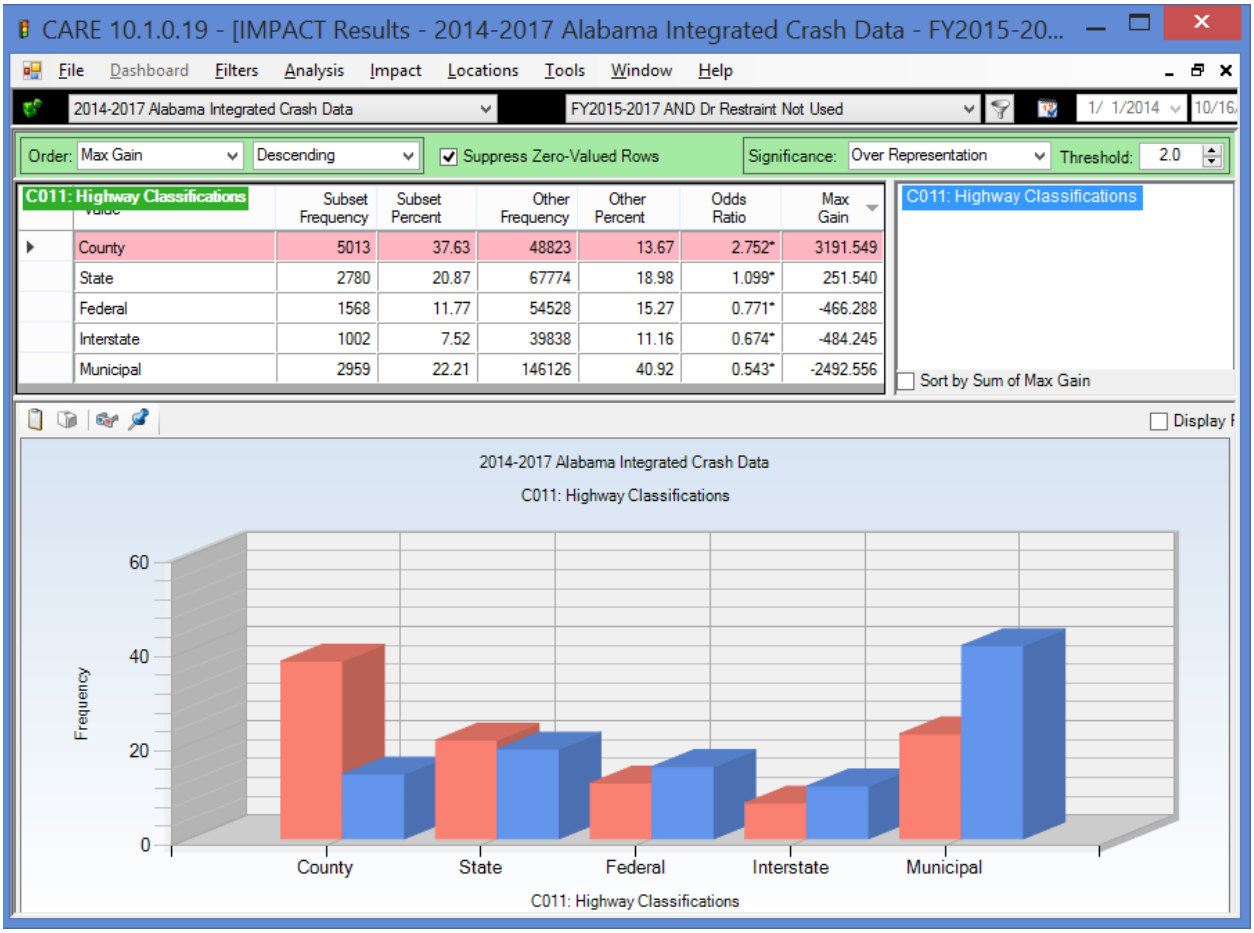
The display above is for all cities that had over 150 or more crashes in which the drivers were not properly restrained. It is in Max Gain order so some of the Odds Ratios will not be over two and thus the line will not appear red. In these crashes the large number of crashes drives up the Max Gain value, which is the potential for non-restrained driver crash reduction. Cities listed at the bottom of the list generally have a high number of non-restrained driver crashes, but their proportion is less than their overall proportion of all crashes. These displays demonstrate the CARE capabilities; if similar runs would be useful with different constraints, please contact CAPS (brown@cs.ua.edu).

2.3 Rural/Urban



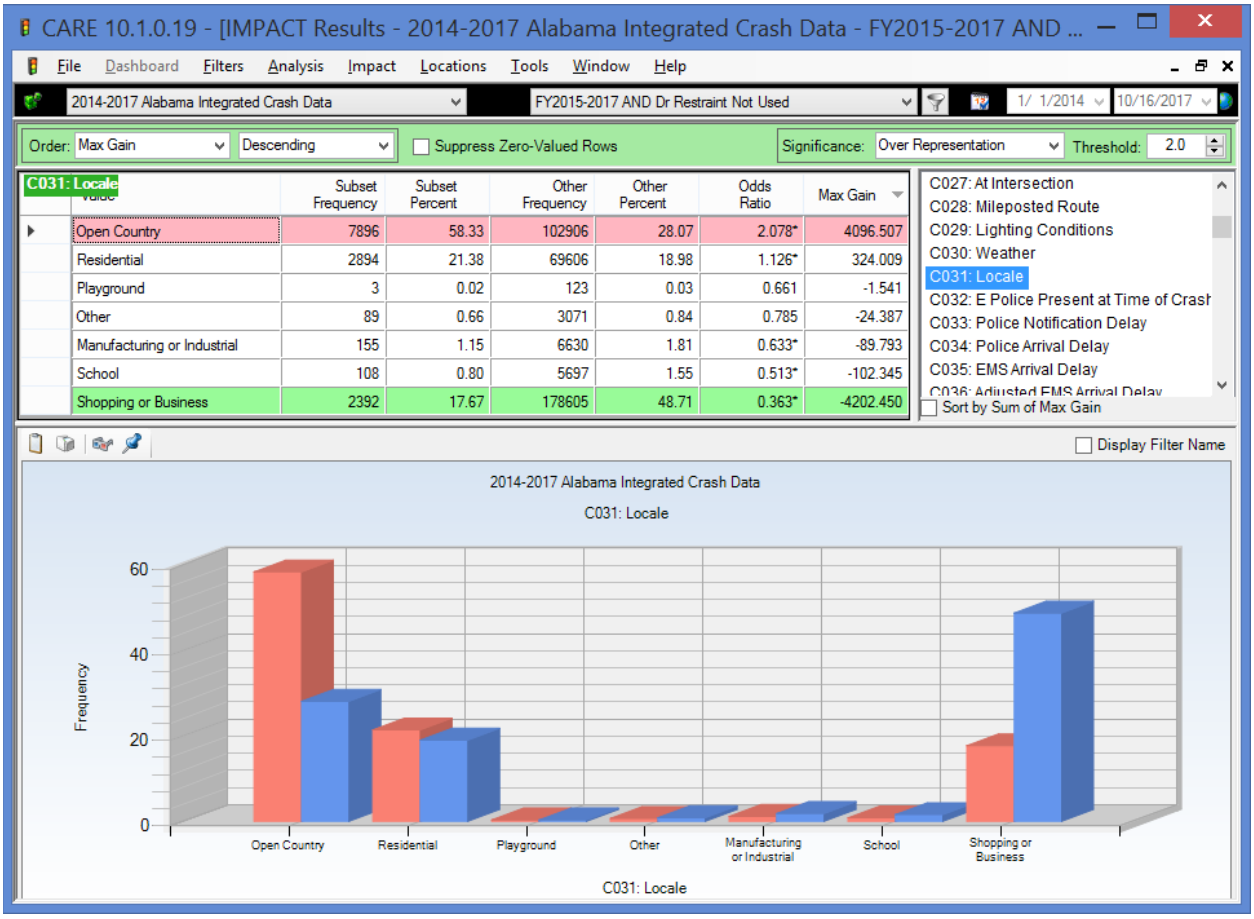
As expected from the city results above, the proportion of crashes involving drivers who use no restraints is greatly overrepresented in rural areas, being well over double what it is in the urban areas. The increased number of crashes in which restraints were used in urban areas might be attributed to greater police presence, newer vehicles, public information and education efforts, and the demographics of urban drivers in general. Speeds are generally much higher in the rural area and thus there is also a very high correlation of fatalities to rural driving. These results are effectively the same as in the former problem identification study (CY2012-CY2016)

2.4 Highway Classification



Crash incidents in which no restraints were used are greatly overrepresented on county highways with over 2.752 times the expected number of crashes. The restraint deficiencies are about what would be expected on state roads, although there is a small but significant over-representation of about 10% of the proportion. The proportion of crashes in which restraints were used is greater on federal, interstate, and municipal highway areas.

2.5 Locale

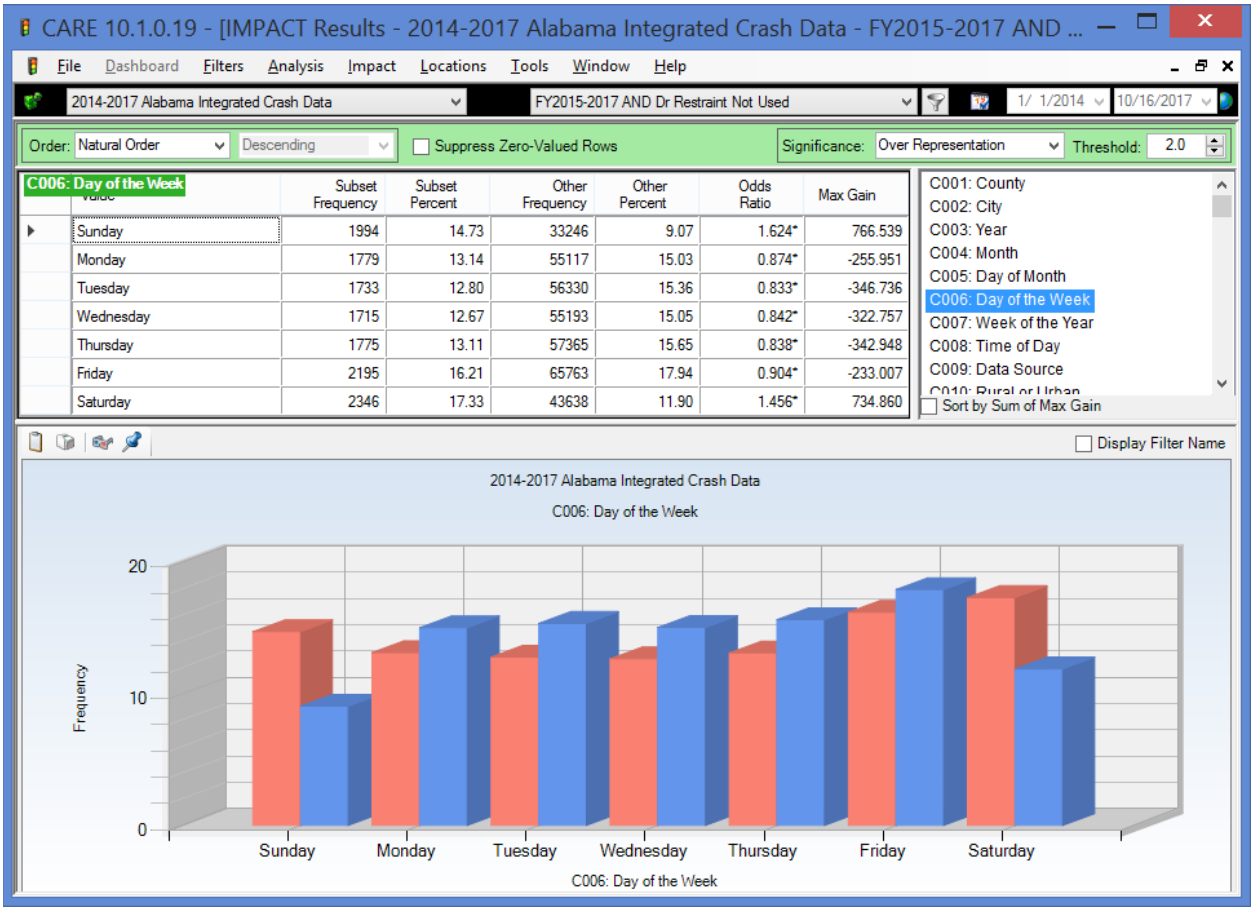


The crash incidents involving no restraints are overrepresented in open country areas. However, school and shopping areas are significantly underrepresented, indicating that crashes in these areas generally involve drivers who were much more apt to use their restraints. This, along with the Highway Classification, gives the general area of the locations at which restraint enforcement will be most effective.

3 Time Considerations

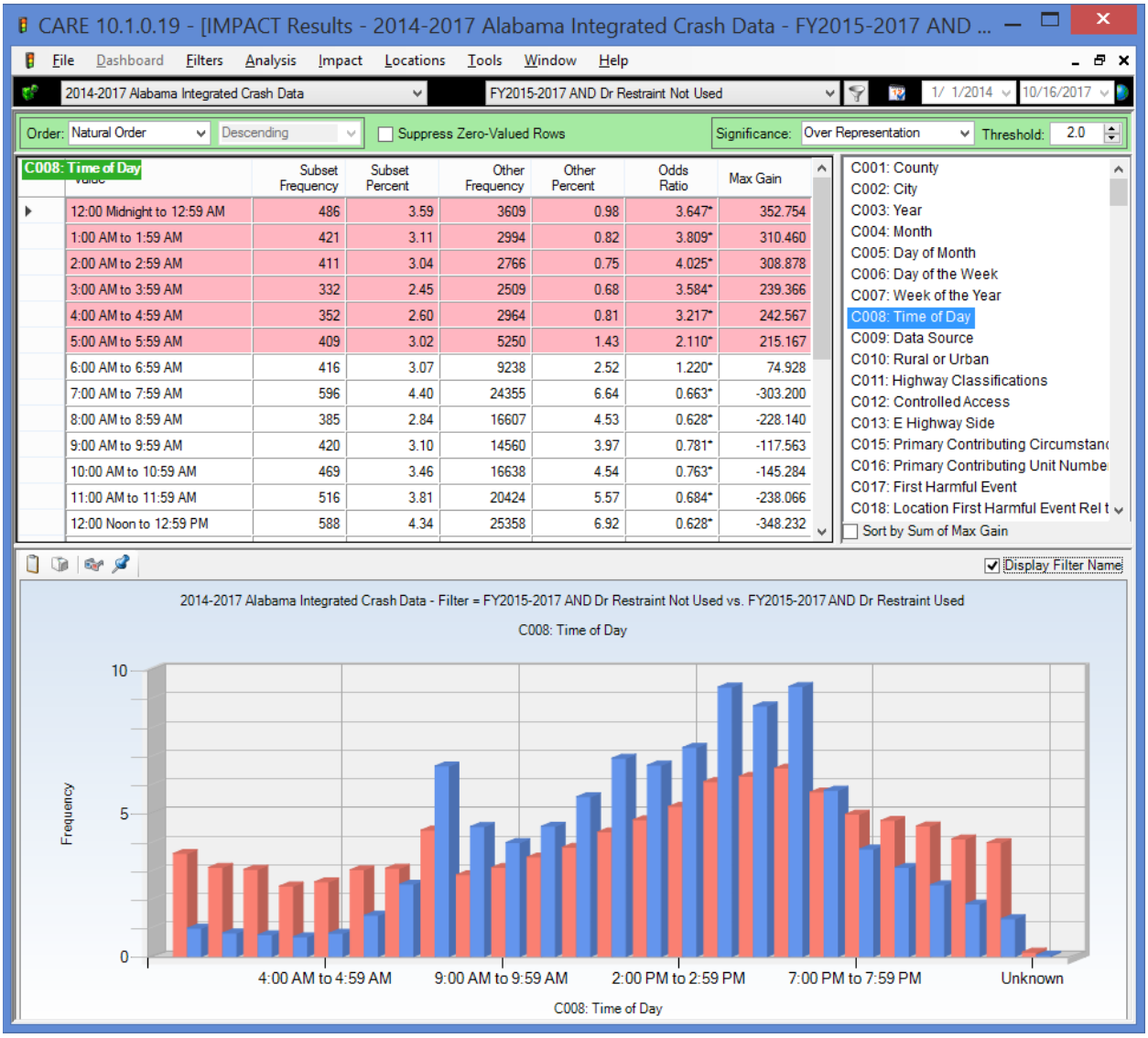
Time factors were analyzed in several different categories to determine overrepresentation for day of the week and time of day. Analysis of these time factors allows for the determination of particular days of week and time of day combinations in which more crashes occur with drivers who are not properly restrained, and thus, those times in which enforcement would have a greater effect.

3.1 Day of the Week



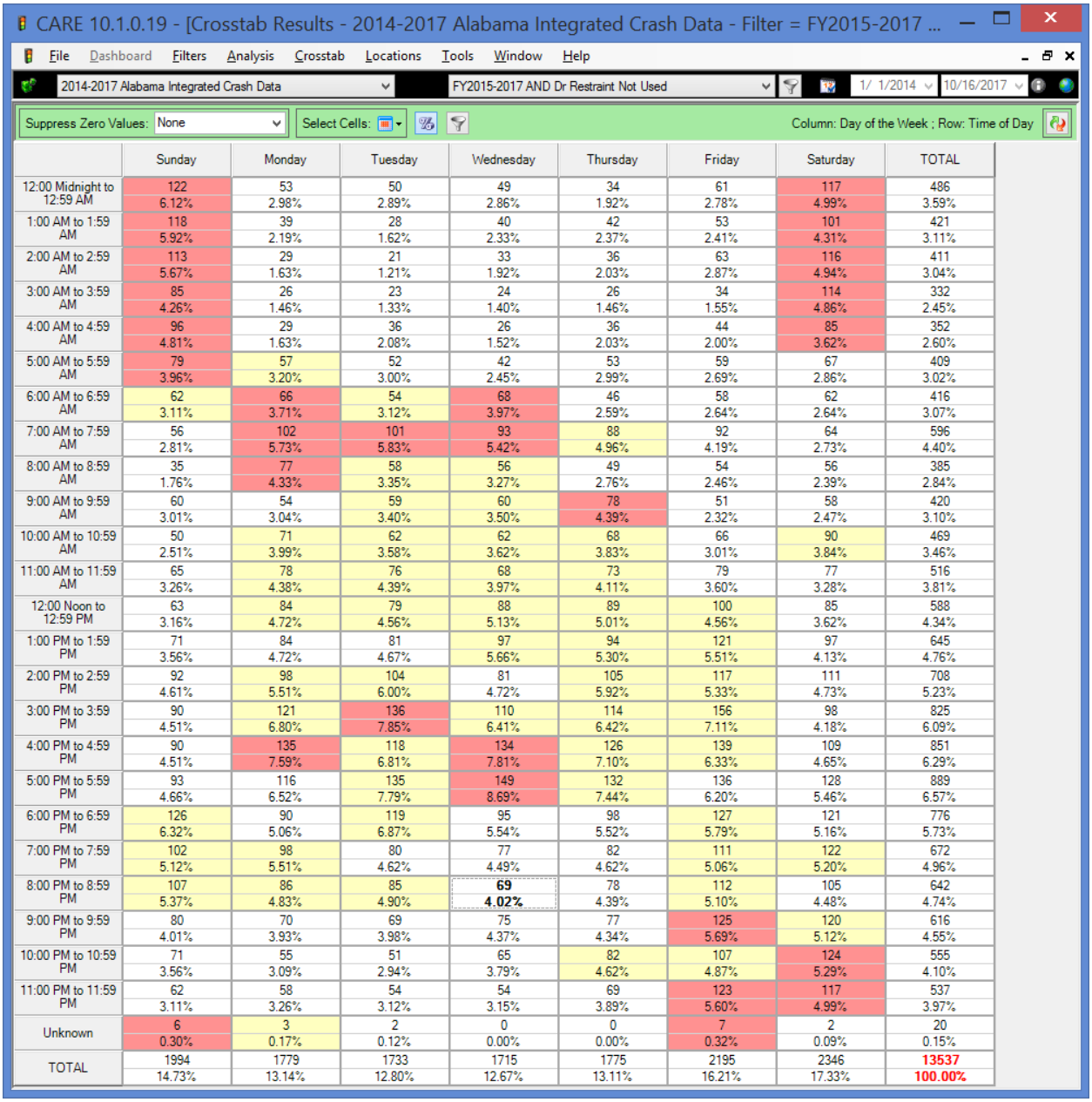
The weekend is overrepresented for crashes involving causal drivers who failed to use restraints, demonstrating a heavy correlation with alcohol-involved crashes. Saturday and Sunday averaged out to about 1.5 times the expected number of crashes involving causal drivers who failed to use restraints.

3.2 Time of Day



The relative probability of crashes involving no restraints is generally greater before and after standard work and rush hours. Overrepresentation peaks during the 12 PM to 5 AM period and then tapers off, falling back below crashes involving causal drivers who use restraints in the 7 AM to 8 AM time period. This chart has a very strong resemblance to its DUI counterpart and the fatality study completed for 2016 showed clearly the lack of restraints correlated heavily with DUI (alcohol or other drugs).

3.3 Time of Day by Day of the Week for all Unstrained Causal Driver Crashes



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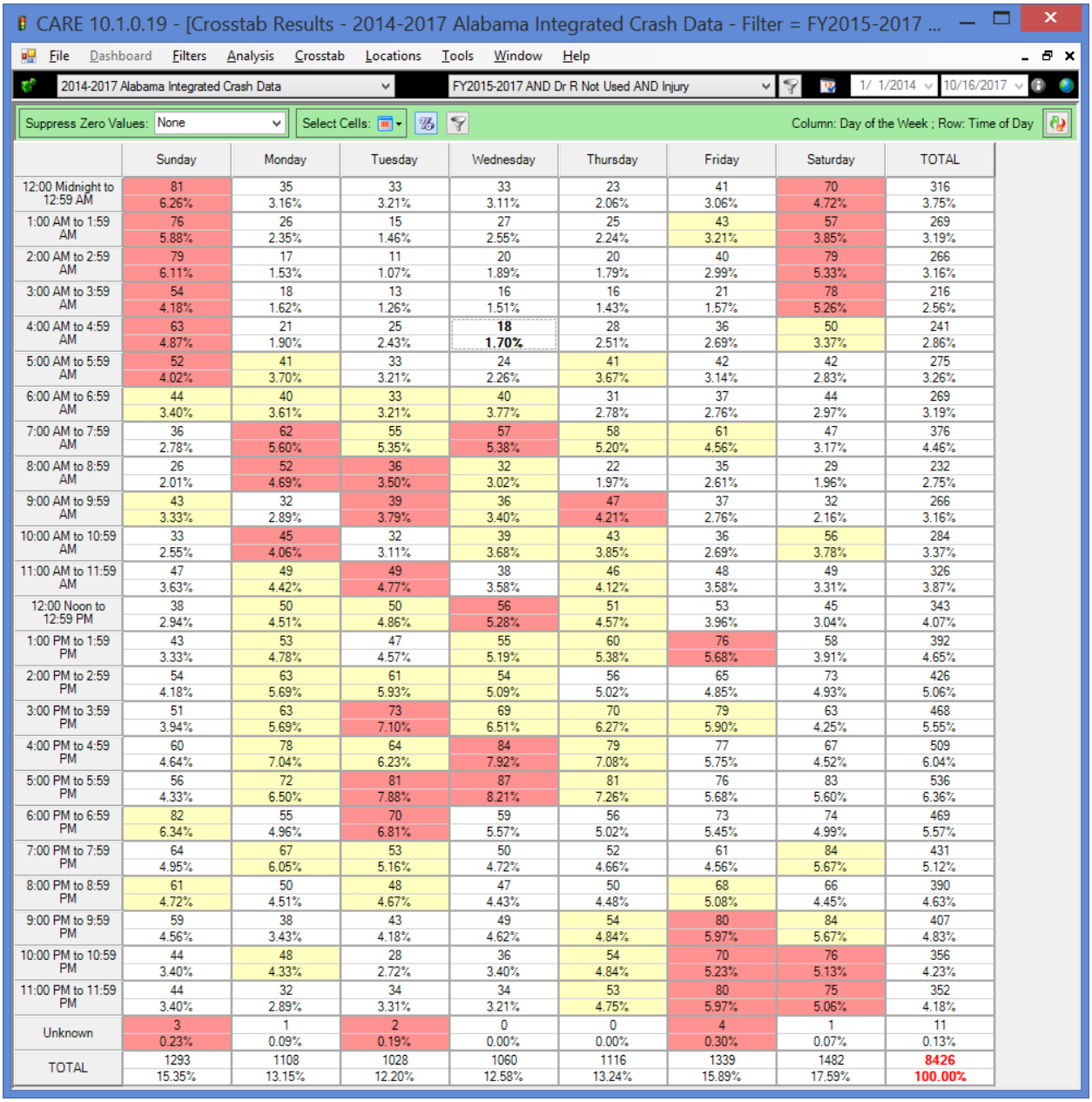
2014-2017 Alabama Integrated Crash Data | FY2015-2017 AND Dr Restraint Not Used | 1/ 1/2014 | 10/16/2017

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	122 6.12%	53 2.98%	50 2.89%	49 2.86%	34 1.92%	61 2.78%	117 4.99%	486 3.59%
1:00 AM to 1:59 AM	118 5.92%	39 2.19%	28 1.62%	40 2.33%	42 2.37%	53 2.41%	101 4.31%	421 3.11%
2:00 AM to 2:59 AM	113 5.67%	29 1.63%	21 1.21%	33 1.92%	36 2.03%	63 2.87%	116 4.94%	411 3.04%
3:00 AM to 3:59 AM	85 4.26%	26 1.46%	23 1.33%	24 1.40%	26 1.46%	34 1.55%	114 4.86%	332 2.45%
4:00 AM to 4:59 AM	96 4.81%	29 1.63%	36 2.08%	26 1.52%	36 2.03%	44 2.00%	85 3.62%	352 2.60%
5:00 AM to 5:59 AM	79 3.96%	57 3.20%	52 3.00%	42 2.45%	53 2.99%	59 2.69%	67 2.86%	409 3.02%
6:00 AM to 6:59 AM	62 3.11%	66 3.71%	54 3.12%	68 3.97%	46 2.59%	58 2.64%	62 2.64%	416 3.07%
7:00 AM to 7:59 AM	56 2.81%	102 5.73%	101 5.83%	93 5.42%	88 4.96%	92 4.19%	64 2.73%	596 4.40%
8:00 AM to 8:59 AM	35 1.76%	77 4.33%	58 3.35%	56 3.27%	49 2.76%	54 2.46%	56 2.39%	385 2.84%
9:00 AM to 9:59 AM	60 3.01%	54 3.04%	59 3.40%	60 3.50%	78 4.39%	51 2.32%	58 2.47%	420 3.10%
10:00 AM to 10:59 AM	50 2.51%	71 3.99%	62 3.58%	62 3.62%	68 3.83%	66 3.01%	90 3.84%	469 3.46%
11:00 AM to 11:59 AM	65 3.26%	78 4.38%	76 4.39%	68 3.97%	73 4.11%	79 3.60%	77 3.28%	516 3.81%
12:00 Noon to 12:59 PM	63 3.16%	84 4.72%	79 4.56%	88 5.13%	89 5.01%	100 4.56%	85 3.62%	588 4.34%
1:00 PM to 1:59 PM	71 3.56%	84 4.72%	81 4.67%	97 5.66%	94 5.30%	121 5.51%	97 4.13%	645 4.76%
2:00 PM to 2:59 PM	92 4.61%	98 5.51%	104 6.00%	81 4.72%	105 5.92%	117 5.33%	111 4.73%	708 5.23%
3:00 PM to 3:59 PM	90 4.51%	121 6.80%	136 7.85%	110 6.41%	114 6.42%	156 7.11%	98 4.18%	825 6.09%
4:00 PM to 4:59 PM	90 4.51%	135 7.59%	118 6.81%	134 7.81%	126 7.10%	139 6.33%	109 4.65%	851 6.29%
5:00 PM to 5:59 PM	93 4.66%	116 6.52%	135 7.79%	149 8.69%	132 7.44%	136 6.20%	128 5.46%	889 6.57%
6:00 PM to 6:59 PM	126 6.32%	90 5.06%	119 6.87%	95 5.54%	98 5.52%	127 5.79%	121 5.16%	776 5.73%
7:00 PM to 7:59 PM	102 5.12%	98 5.51%	80 4.62%	77 4.49%	82 4.62%	111 5.06%	122 5.20%	672 4.96%
8:00 PM to 8:59 PM	107 5.37%	86 4.83%	85 4.90%	**69** **4.02%**	78 4.39%	112 5.10%	105 4.48%	642 4.74%
9:00 PM to 9:59 PM	80 4.01%	70 3.93%	69 3.98%	75 4.37%	77 4.34%	125 5.69%	120 5.12%	616 4.55%
10:00 PM to 10:59 PM	71 3.56%	55 3.09%	51 2.94%	65 3.79%	82 4.62%	107 4.87%	124 5.29%	555 4.10%
11:00 PM to 11:59 PM	62 3.11%	58 3.26%	54 3.12%	54 3.15%	69 3.89%	123 5.60%	117 4.99%	537 3.97%
Unknown	6 0.30%	3 0.17%	2 0.12%	0 0.00%	0 0.00%	7 0.32%	2 0.09%	20 0.15%
TOTAL	1994 14.73%	1779 13.14%	1733 12.80%	1715 12.67%	1775 13.11%	2195 16.21%	2346 17.33%	13537 100.00%

The over-represented times for improperly restrained drivers is almost a perfect correlation with DUI (alcohol or other drugs). The correlation with age and DUI is also extremely high. If seat-belts are going to expand in their life-saving capabilities, some way will have to be found to get the impaired drivers to buckle up. In the past there has been a tendency to give up on these drivers, and this may be the result. However, some behavioral change was seen in 2017 with the reduced ID fatalities due to a reduction in impact speeds. If that change can be made, then there is no reason that persons who are impaired could not be convinced that it was in their interests to buckle up.

3.4 Time of Day by Day of the Week: INJURY Unrestrained Causal Drivers



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2014-2017 Alabama Integrated Crash Data | FY2015-2017 AND Dr R Not Used AND Injury | 1/ 1/2014 | 10/16/2017

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

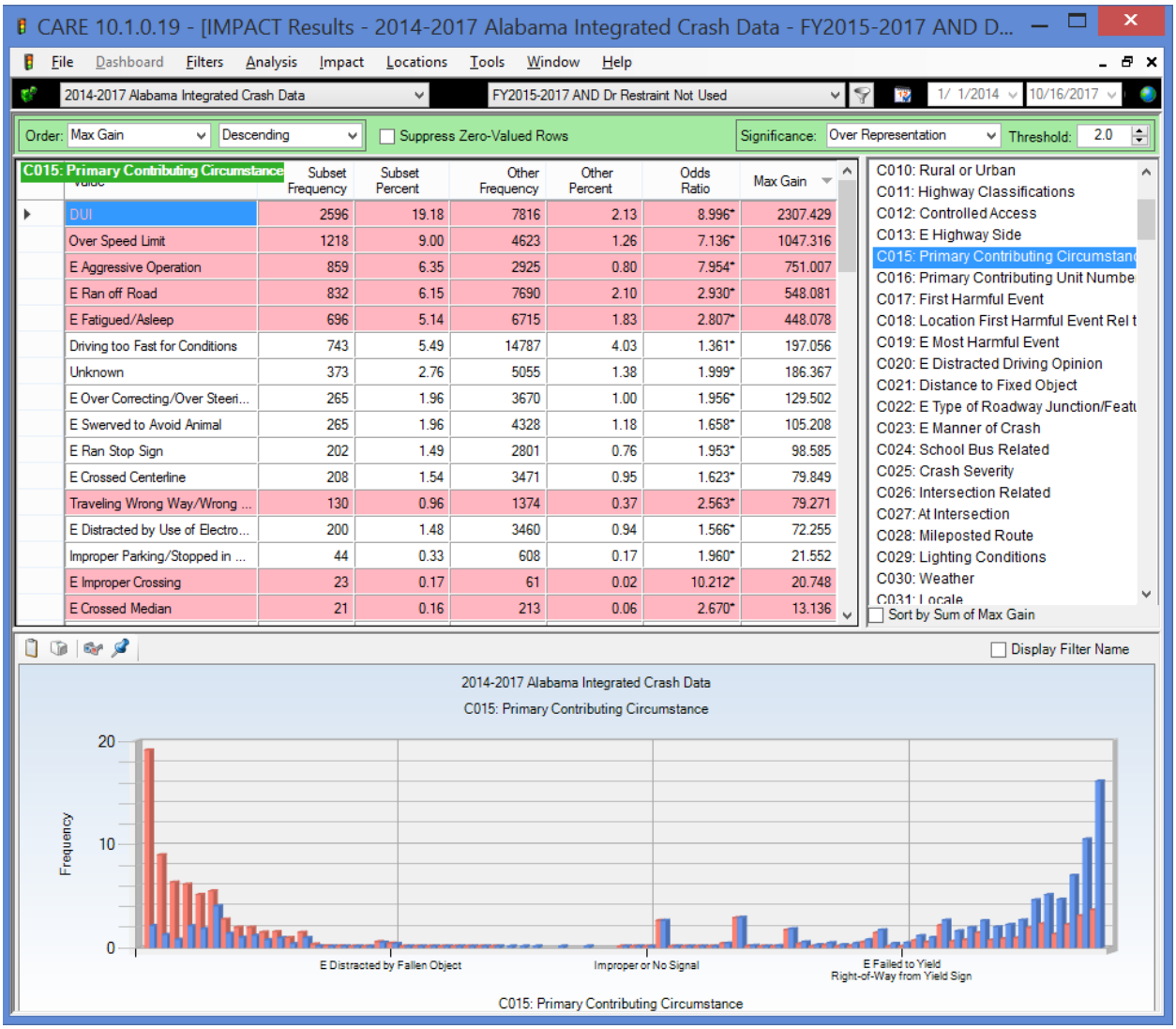
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	81 6.26%	35 3.16%	33 3.21%	33 3.11%	23 2.06%	41 3.06%	70 4.72%	316 3.75%
1:00 AM to 1:59 AM	76 5.88%	26 2.35%	15 1.46%	27 2.55%	25 2.24%	43 3.21%	57 3.85%	269 3.19%
2:00 AM to 2:59 AM	79 6.11%	17 1.53%	11 1.07%	20 1.89%	20 1.79%	40 2.99%	79 5.33%	266 3.16%
3:00 AM to 3:59 AM	54 4.18%	18 1.62%	13 1.26%	16 1.51%	16 1.43%	21 1.57%	78 5.26%	216 2.56%
4:00 AM to 4:59 AM	63 4.87%	21 1.90%	25 2.43%	**18** **1.70%**	28 2.51%	36 2.69%	50 3.37%	241 2.86%
5:00 AM to 5:59 AM	52 4.02%	41 3.70%	33 3.21%	24 2.26%	41 3.67%	42 3.14%	42 2.83%	275 3.26%
6:00 AM to 6:59 AM	44 3.40%	40 3.61%	33 3.21%	40 3.77%	31 2.78%	37 2.76%	44 2.97%	269 3.19%
7:00 AM to 7:59 AM	36 2.78%	62 5.60%	55 5.35%	57 5.38%	58 5.20%	61 4.56%	47 3.17%	376 4.46%
8:00 AM to 8:59 AM	26 2.01%	52 4.69%	36 3.50%	32 3.02%	22 1.97%	35 2.61%	29 1.96%	232 2.75%
9:00 AM to 9:59 AM	43 3.33%	32 2.89%	39 3.79%	36 3.40%	47 4.21%	37 2.76%	32 2.16%	266 3.16%
10:00 AM to 10:59 AM	33 2.55%	45 4.06%	32 3.11%	39 3.68%	43 3.85%	36 2.69%	56 3.78%	284 3.37%
11:00 AM to 11:59 AM	47 3.63%	49 4.42%	49 4.77%	38 3.58%	46 4.12%	48 3.58%	49 3.31%	326 3.87%
12:00 Noon to 12:59 PM	38 2.94%	50 4.51%	50 4.86%	56 5.28%	51 4.57%	53 3.96%	45 3.04%	343 4.07%
1:00 PM to 1:59 PM	43 3.33%	53 4.78%	47 4.57%	55 5.19%	60 5.38%	76 5.68%	58 3.91%	392 4.65%
2:00 PM to 2:59 PM	54 4.18%	63 5.69%	61 5.93%	54 5.09%	56 5.02%	65 4.85%	73 4.93%	426 5.06%
3:00 PM to 3:59 PM	51 3.94%	63 5.69%	73 7.10%	69 6.51%	70 6.27%	79 5.90%	63 4.25%	468 5.55%
4:00 PM to 4:59 PM	60 4.64%	78 7.04%	64 6.23%	84 7.92%	79 7.08%	77 5.75%	67 4.52%	509 6.04%
5:00 PM to 5:59 PM	56 4.33%	72 6.50%	81 7.88%	87 8.21%	81 7.26%	76 5.68%	83 5.60%	536 6.36%
6:00 PM to 6:59 PM	82 6.34%	55 4.96%	70 6.81%	59 5.57%	56 5.02%	73 5.45%	74 4.99%	469 5.57%
7:00 PM to 7:59 PM	64 4.95%	67 6.05%	53 5.16%	50 4.72%	52 4.66%	61 4.56%	84 5.67%	431 5.12%
8:00 PM to 8:59 PM	61 4.72%	50 4.51%	48 4.67%	47 4.43%	50 4.48%	68 5.08%	66 4.45%	390 4.63%
9:00 PM to 9:59 PM	59 4.56%	38 3.43%	43 4.18%	49 4.62%	54 4.84%	80 5.97%	84 5.67%	407 4.83%
10:00 PM to 10:59 PM	44 3.40%	48 4.33%	28 2.72%	36 3.40%	54 4.84%	70 5.23%	76 5.13%	356 4.23%
11:00 PM to 11:59 PM	44 3.40%	32 2.89%	34 3.31%	34 3.21%	53 4.75%	80 5.97%	75 5.06%	352 4.18%
Unknown	3 0.23%	1 0.09%	2 0.19%	0 0.00%	0 0.00%	4 0.30%	1 0.07%	11 0.13%
TOTAL	1293 15.35%	1108 13.15%	1028 12.20%	1060 12.58%	1116 13.24%	1339 15.89%	1482 17.59%	8426 100.00%

Crosstab analysis of time of day by day of the week for crashes involving injury in which restraints were not used helps target specific times in which officers should increase patrols in order to prevent these crashes. The above applies to all injury crashes in which the causal driver was not properly restrained.

4 Crash Causal Factors

Analysis of crash causal factors determines which factors are the most likely contributors to crashes involving drivers who did not use restraints. The primary contributing circumstances of the crashes were analyzed, and overrepresentation values indicate certain risk-taking behaviors associated with this type of crash. Vehicle model year and speed at impact were also evaluated to characterize factors that are consistently associated with crashes in which drivers are not properly restrained.

4.1 Primary Contributing Circumstance



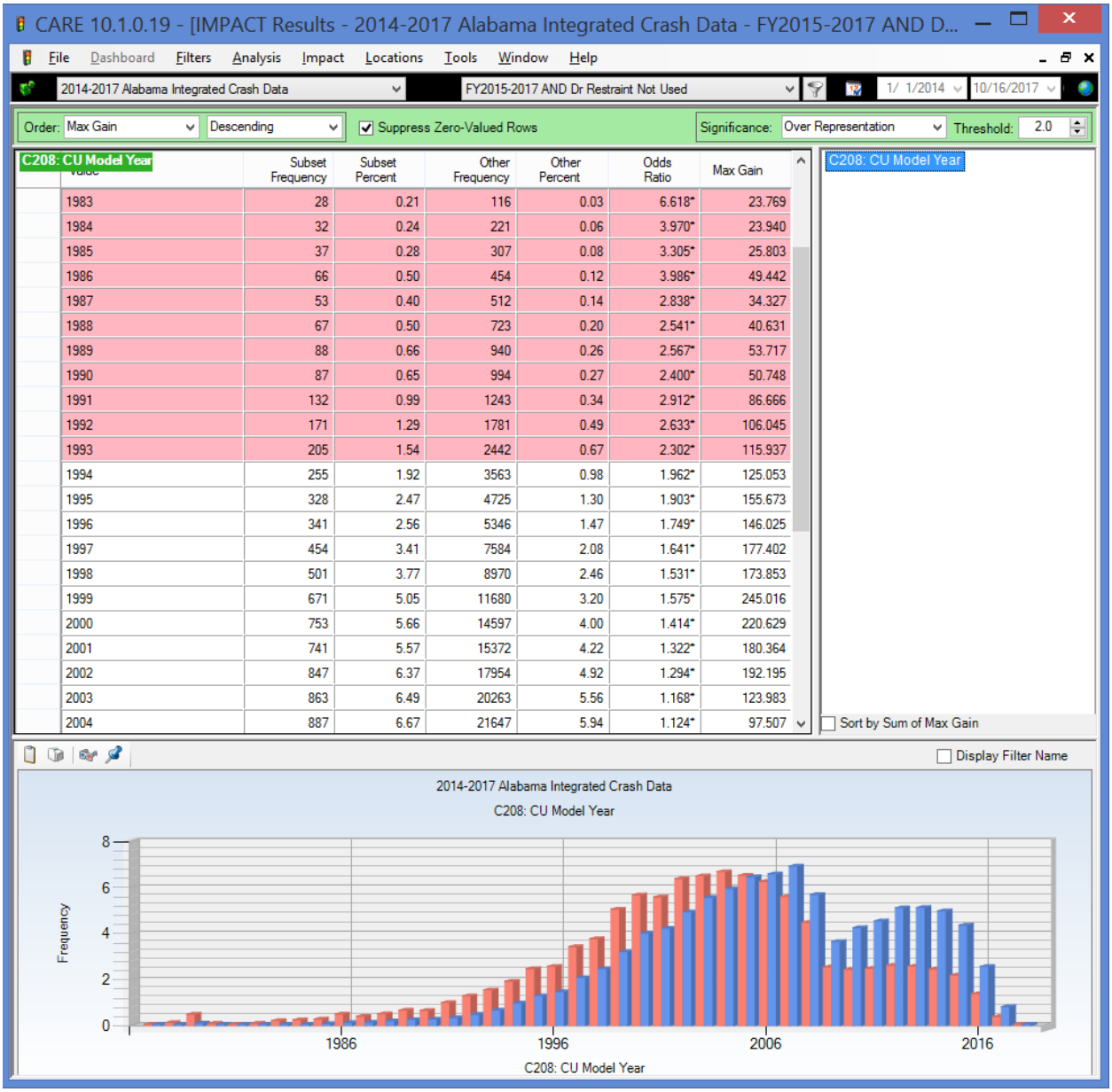
The table listing in the display above includes all of the PCC categories that have a statistically significant over-representations. Over-representation factors indicate that certain risk-taking behaviors are highly correlated with crashes in which causal drivers do not use restraints. In order of maximum potential expected gain (Max Gain), these include: DUI, over the speed limit

(ranked even higher when combined with "Driving too Fast for Conditions"), aggressive operation, ran off the road and fatigued/asleep. DUI for non-restrained drivers was determined to be about nine times (8.996) the proportion that it was for restrained drivers, further reinforcing the findings with regard to impaired driving given above. A recent ID/DUI problem identification for the Impaired Driving Plan revealed that one of the primary reason for fatality in ID crashes is a failure to buckle up. That same study showed that in FY2017 the impact speeds of ID crashes has decreased to a point that a 17% reduction in ID fatalities was observed in FY2017 from the previous year, giving the indication that the behavior of ID drivers is possible.

Other overrepresented contributing circumstances include several things that are correlated with impairment and/or speed: aggressive operation, ran off road, over correcting, swerving, traveling the wrong way for some examples. Aggressive operation is nearly eight times its proportion in comparisons with crashes in which the causal driver is restrained, and over the speed limit is over seven times expectation. Distracted driving is also an issue with the proportion of unrestrained drivers distracted by the use of an electronic device being about 57% higher than that of those properly restrained.

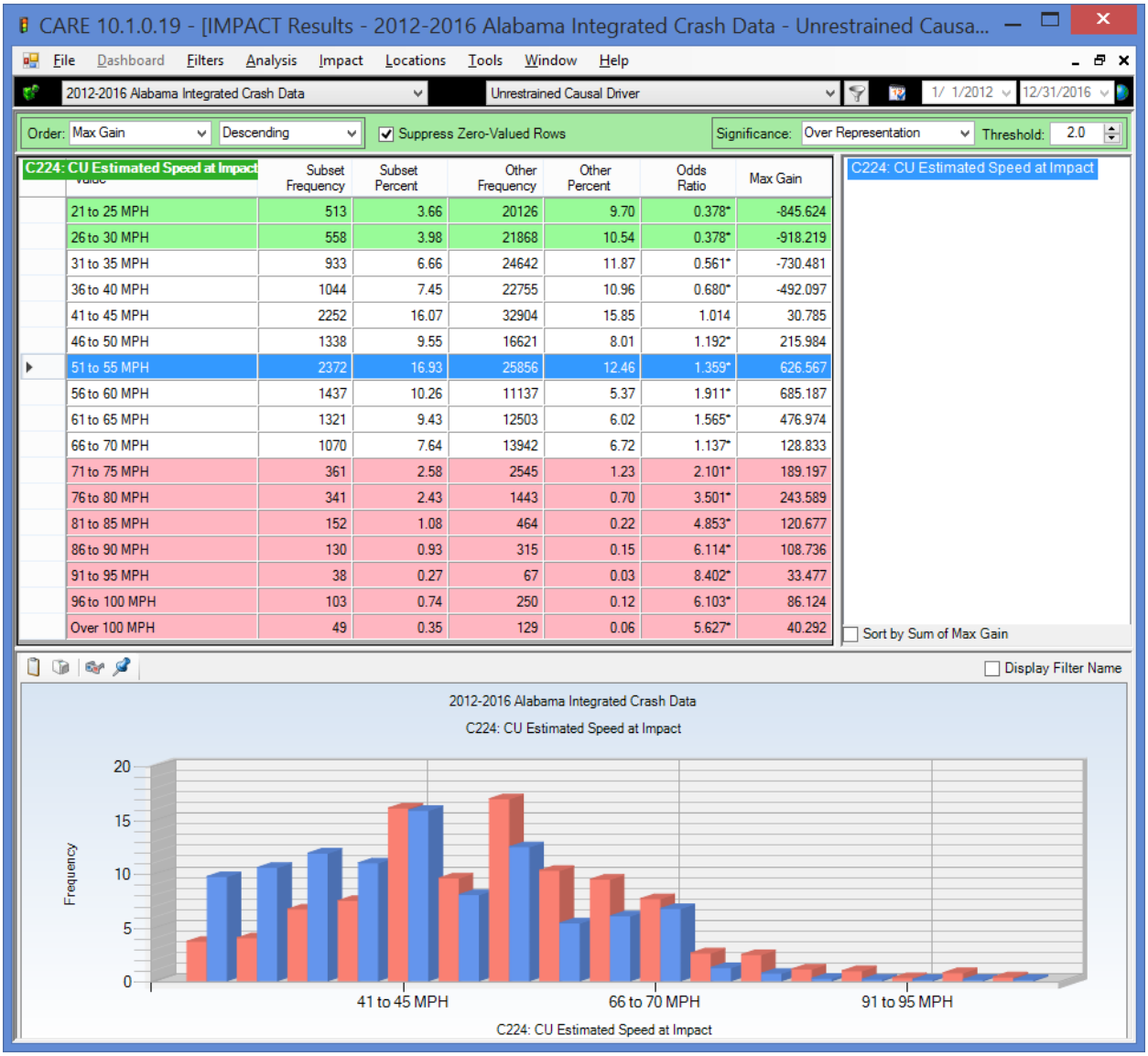
It is obvious that the presence of seat belts will not have a large impact on the causation of these crashes, although the increased ability to maintain control in adverse situations should not be minimized as a benefit of restraints. However, the correlation here would be the result of risk acceptance in general, and the inability or unwillingness of those who are impaired to consider the life-saving benefits of restraint use. Additionally, analysis of other contributing circumstances presented similar risk-taking behaviors associated with crashes in which causal drivers did not use restraints. It is imperative that countermeasures be developed to convince risk takers that it is almost certain that at some point in time they will be involved in a crash.

4.2 Vehicle Age – Model Year



The listing in the display above contains all of the model years that had a statistically significant over-representation. Crashes attributed to drivers who used no restraints are greatly overrepresented in vehicles with model years 1983-2004. This might be attributed to the lack of current safety restraints (or their removal) in the older model vehicles. Vehicles with model years 2007 and later indicates a statistically significant higher proportion involving causal drivers using restraints as compared to those who were not restrained. One factor that would increase the rural problem could well be the economic disadvantages of those in the rural areas, and thus their use of older vehicles.

4.3 Speed at Impact

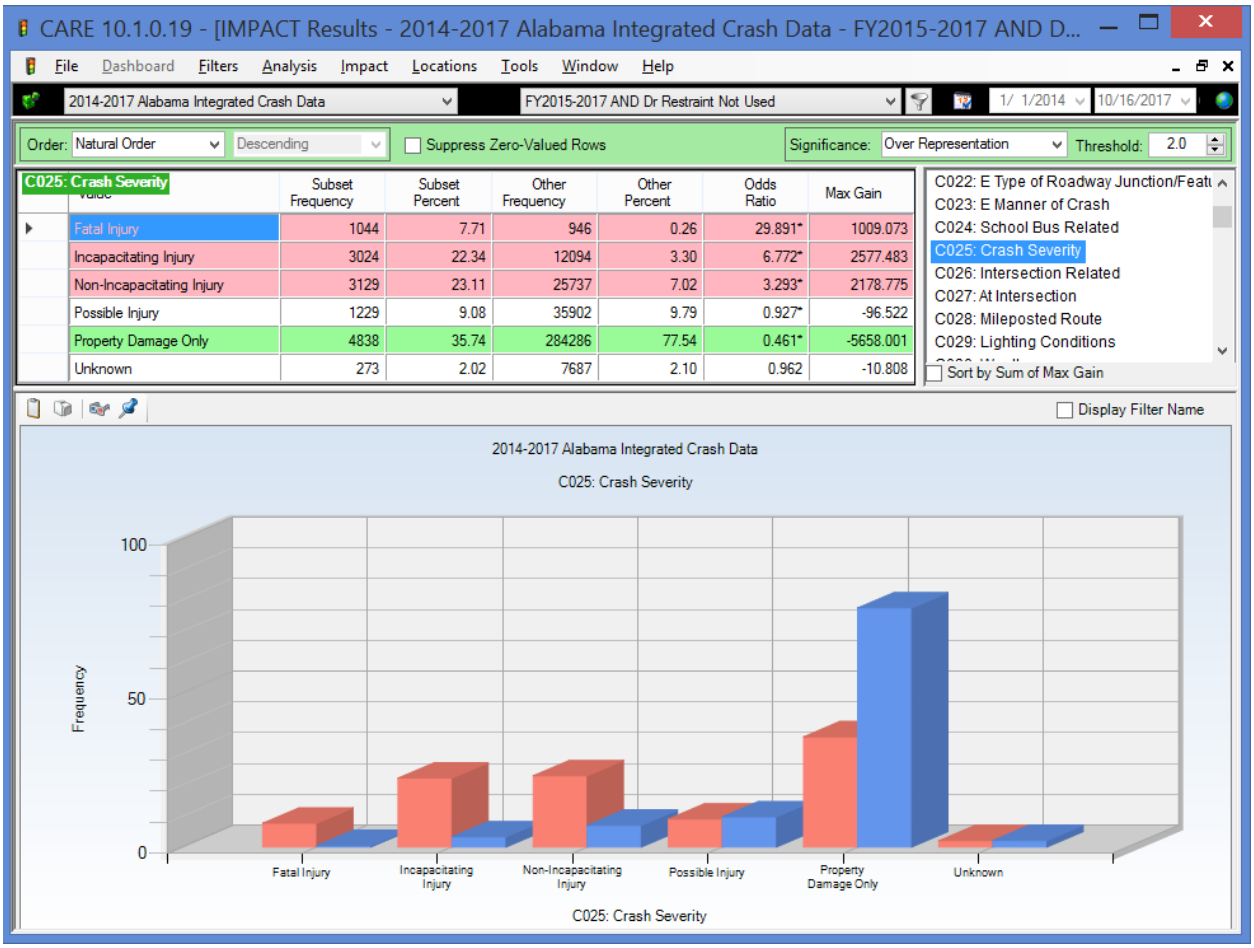


The display above gives all of the speeds that can be recorded on the crash report form. Speed at impact for crashes in which drivers failed to use restraints is most highly overrepresented in the range of 76-80 MPH and over. This is the second year that there has been an increase in these higher speeds, perhaps reflecting that additional horsepower in the later model year vehicles. Crashes in which restraints are not used consistently occur at higher speeds than crashes in which restraints were used by the causal driver. This confirms the rural-urban finding, in that speeds are generally higher in the rural areas, and since speed is an excellent proxy for risk-taking, shows the correlation between improper restraints and other risk-taking behaviors. It also exacerbates the problem, resulting in greater severity caused by the high-speed, unrestrained driver and passenger situations. Other severity factors are considered immediately below.

5 Severity Factors

The sections above generally relate to both crash severity and causation. This section considers crash severity per se. Generally restraints do not prevent crashes, although on some occasions they might help to keep the driver firmly behind the wheel and in a position to avoid or mitigate a crash. But in general occupant restraints serve to reduce the severity of crashes when they occur. Severity factors were analyzed in several different categories to determine to what extent the use of restraints affects the safety of drivers and passengers. These factors analyzed include crash severity, crash severity in urban versus rural areas, number injured, number killed, driver ejection status, and driver injury type.

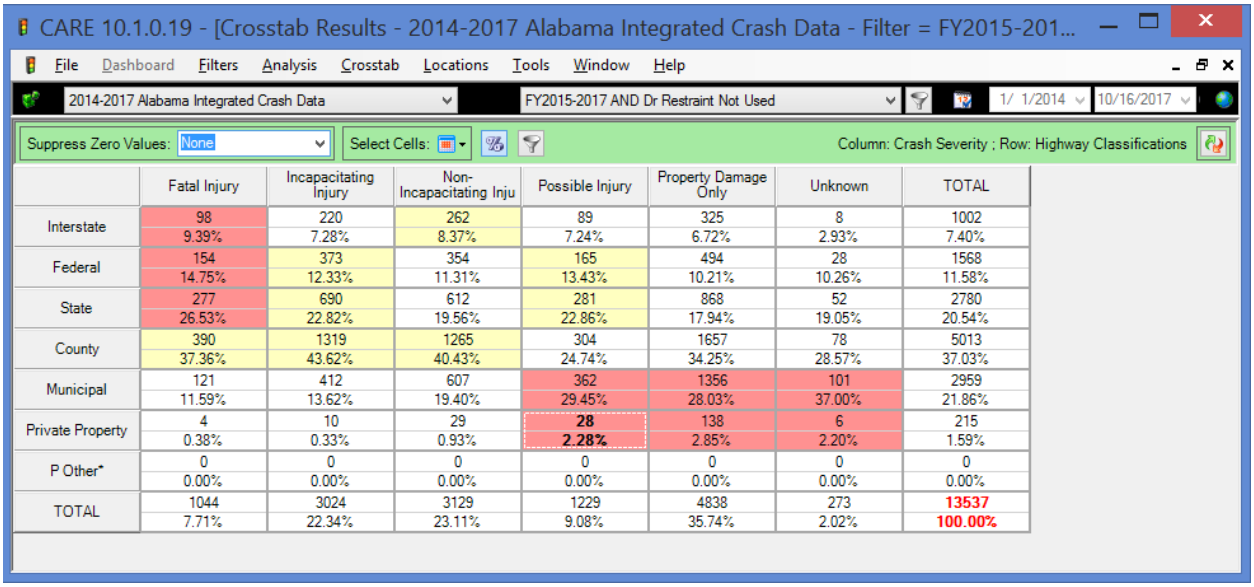
5.1 Crash Severity



Fatal, incapacitating, and non-incapacitating injuries are all extremely overrepresented in crashes that occurred without the use of restraints, as given by the Odds Ratios that show the proportions of fatal, Incapacitation Injury and Non-incapacitating injury were about 30, 7 and 3 times expected, respectively. The first two of these ratios are up considerably from 21 and 6, respectively, found in the previous year study. While overrepresentations in these severity classifications were certainly expected, these results further quantify the effects of the benefits of restraint

use. Property damage only was far more common in crashes in which drivers employed the use of restraints.

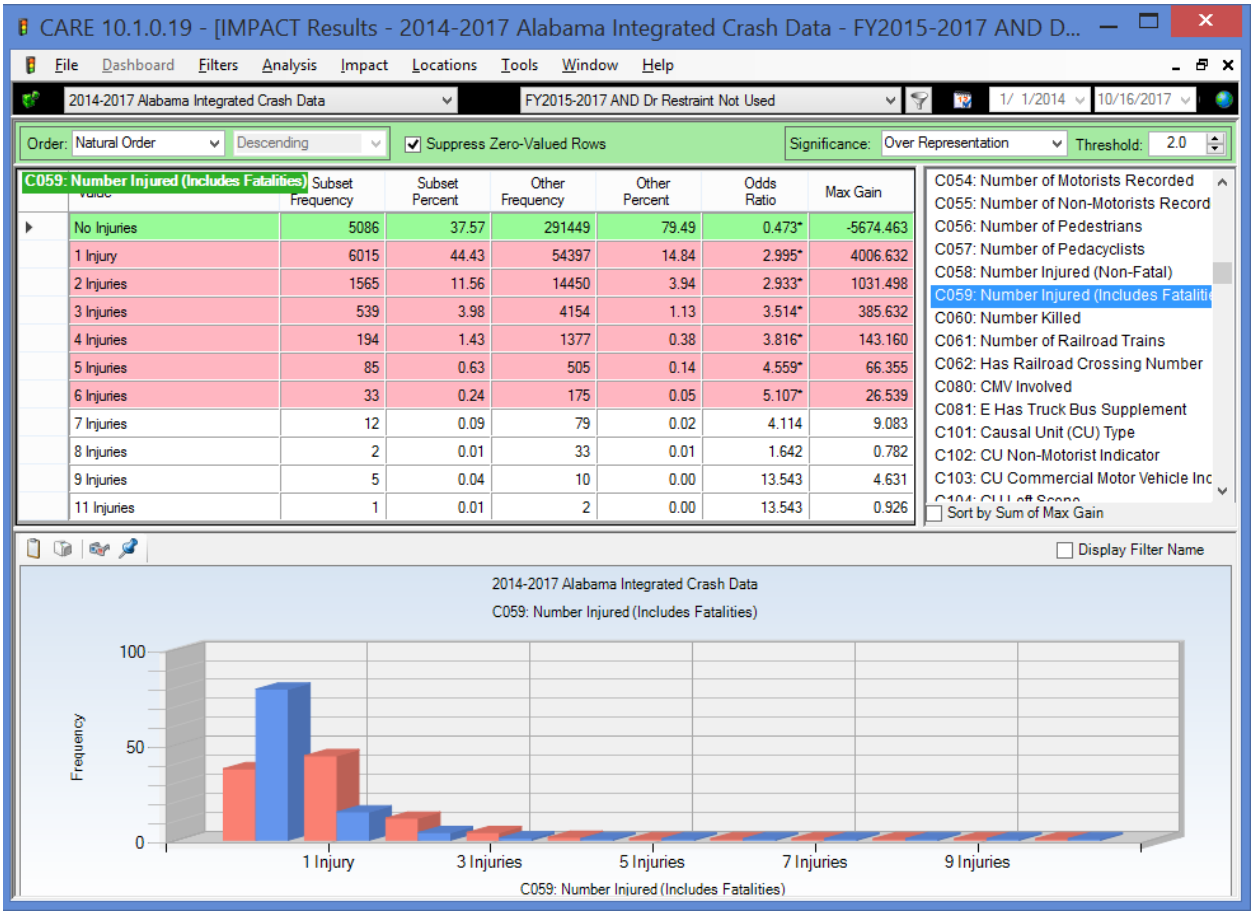
5.2 Crash Severity by Highway Classification for Driver Not Restrained



	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Interstate	98 9.39%	220 7.28%	262 8.37%	89 7.24%	325 6.72%	8 2.93%	1002 7.40%
Federal	154 14.75%	373 12.33%	354 11.31%	165 13.43%	494 10.21%	28 10.26%	1568 11.58%
State	277 26.53%	690 22.82%	612 19.56%	281 22.86%	868 17.94%	52 19.05%	2780 20.54%
County	390 37.36%	1319 43.62%	1265 40.43%	304 24.74%	1657 34.25%	78 28.57%	5013 37.03%
Municipal	121 11.59%	412 13.62%	607 19.40%	362 29.45%	1356 28.03%	101 37.00%	2959 21.86%
Private Property	4 0.38%	10 0.33%	29 0.93%	**28** **2.28%**	138 2.85%	6 2.20%	215 1.59%
P Other*	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	1044 7.71%	3024 22.34%	3129 23.11%	1229 9.08%	4838 35.74%	273 2.02%	13537 100.00%

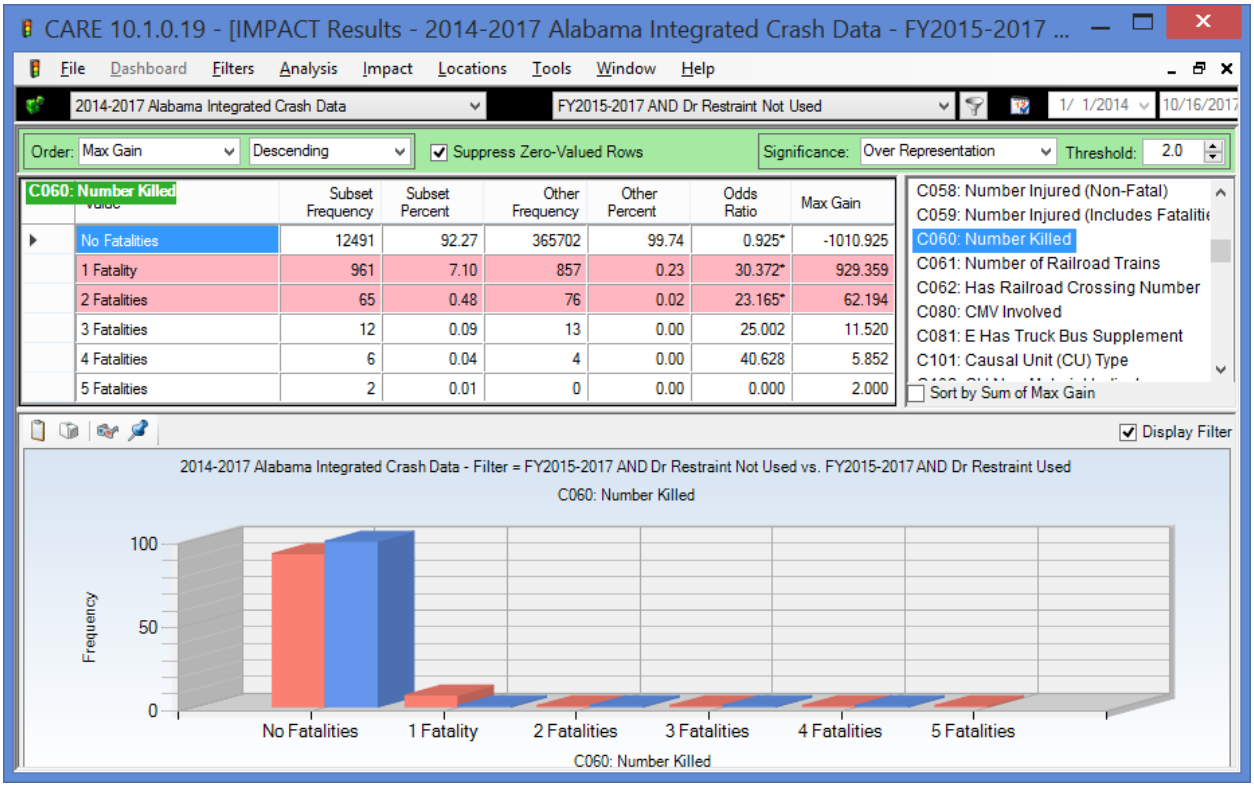
Analysis of crash severity by highway classification for crashes in which the causal driver did not use restraints shows that fatal injuries were overrepresented by greater than 10% higher proportions on Interstate, Federal and State roadways. While fatality crashes are also over-represented on County roads, the proportion of fatal crashes there (39.65%) is only about 1% higher than its overall crash proportion (38.81%). The other higher severity classifications generally follow this, but their over-representations are all less than 10% increase in the proportion as compared to their totals in the TOTAL column. Possible injuries and Property Damage Only were highly overrepresented on municipal highways and private property.

5.3 Number Injured



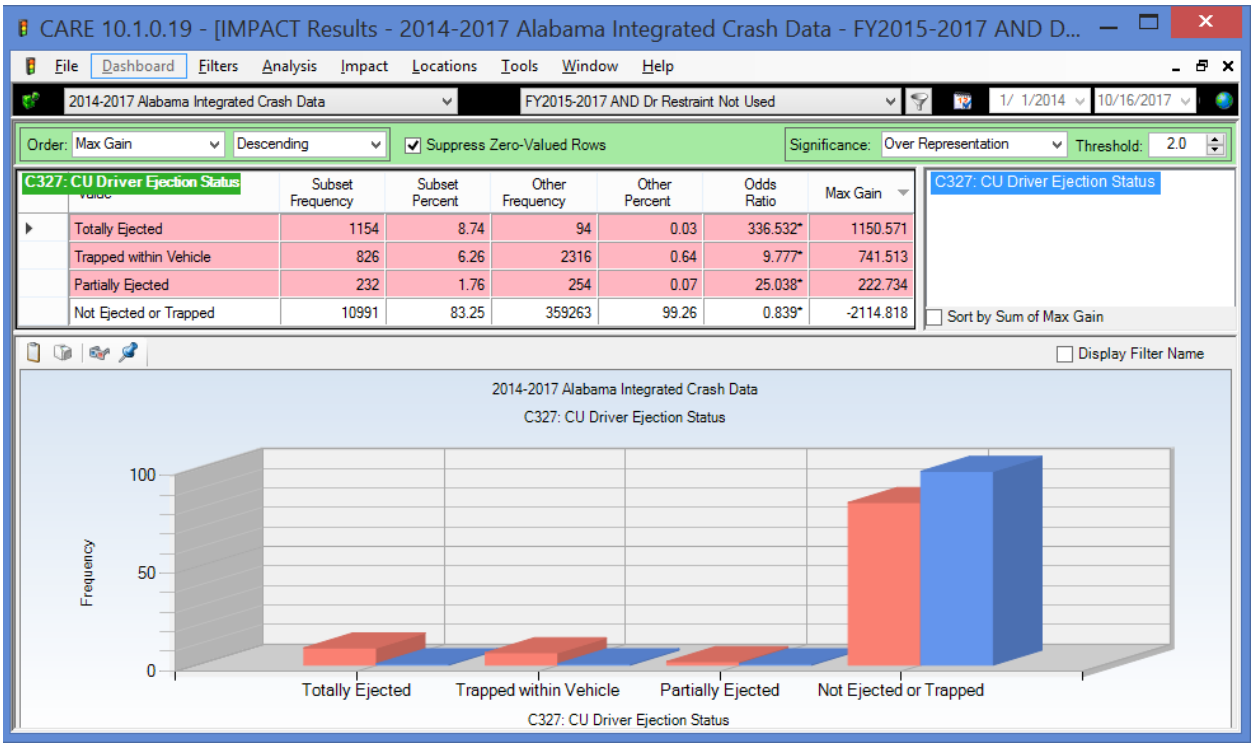
All of the multiple injury categories are given above along with the No Injuries and the 1 Injury classifications. The fact that all multiple injury classifications are over-represented is a good indication that the use of the unrestrained driver is an excellent proxy for any of the passengers in that vehicle also being unrestrained. Track down the Odds Ratio column and see how the multiple injuries increase in their over-representations right up to 7 and 8 injuries, and then they are dramatically over-represented in the 9 and 11 injuries categories. No statistical tests are done if either of the attributes being tested has a frequency of less than 20 since this would require a different statistical test than the one programmed into CARE. So while any hard conclusions regarding crashes above 6 injuries should be avoided, no doubt these high-injury crashes are greatly over-represented when considered collectively. These results show quite plainly that crashes in which the causal driver was not restrained are much more severe in their effects to all passengers and not just the causal driver. The overrepresentation of multiple injuries in the causal vehicle might also indicate a tendency of unrestrained drivers to travel with multiple individuals in the vehicle.

5.4 Number Killed



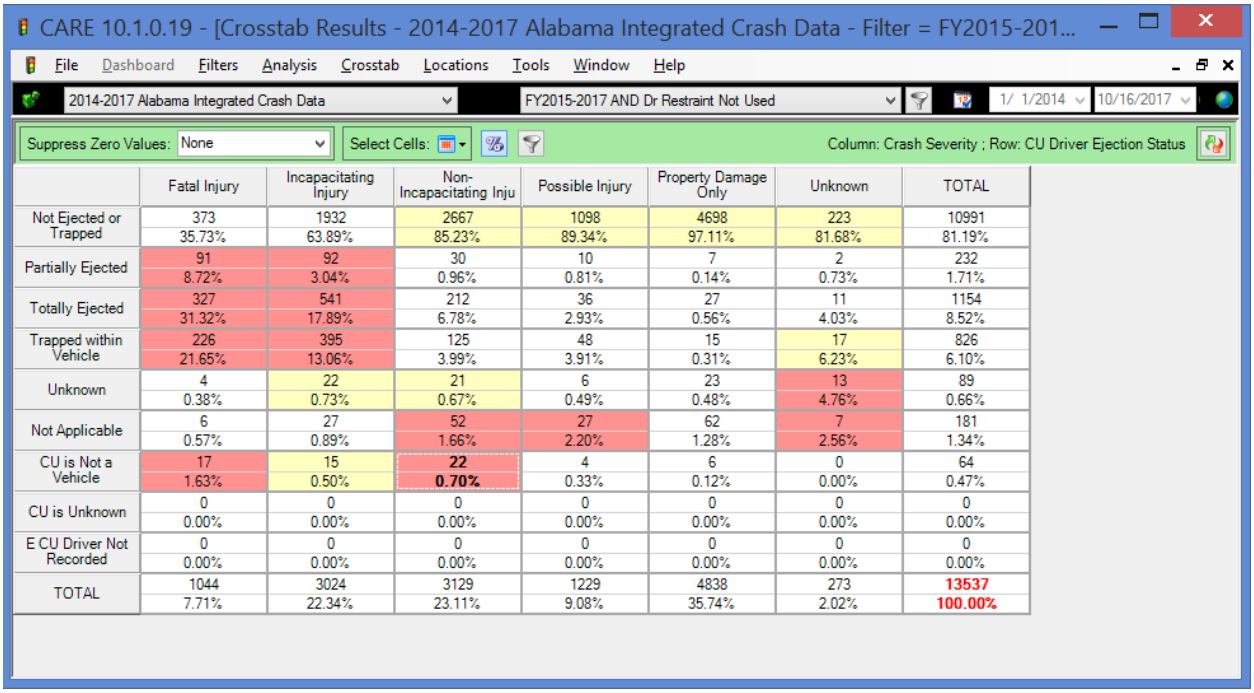
The proportion of fatalities in general as well as the proportion of multiple fatality crashes is dramatically overrepresented when restraints are not used by drivers (and inferred most other passengers) in the causal vehicle. Multiple fatality crashes were found to be a large factor in the increase of unrestrained fatalities in CY2016, and it is gratifying to see their reduction from 132 in 2016 to 85 in FY2017. The largest decrease was in the single fatality crashes, which went from 1510 in CY2016 to 961 in FY2017, a reduction of 36%.

5.5 Driver Ejection Status



Driver Totally Ejected is overrepresented by a factor of over 337 owing to the fact that only 94 (0.03%) of the crashes where the causal driver was restrained resulted in the driver being totally ejected. This compares to 1154 total ejections (8.74%) of the cases in which the causal driver was not properly restrained. This is one of the highest over-representations that we have ever seen, and it speaks to the effectiveness of seatbelts in preventing one of the most lethal events that can occur in a crash – being ejected from the vehicle. See the next section on the severity increases when ejection is involved. Partial ejection and entrapment in the vehicle are also greatly over-represented (about 25 and 10, respectively), which is also expected in crashes in which safety equipment is not properly utilized.

5.6 Ejection Status by Severity



	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Not Ejected or Trapped	373 35.73%	1932 63.89%	2667 85.23%	1098 89.34%	4698 97.11%	223 81.68%	10991 81.19%
Partially Ejected	91 8.72%	92 3.04%	30 0.96%	10 0.81%	7 0.14%	2 0.73%	232 1.71%
Totally Ejected	327 31.32%	541 17.89%	212 6.78%	36 2.93%	27 0.56%	11 4.03%	1154 8.52%
Trapped within Vehicle	226 21.65%	395 13.06%	125 3.99%	48 3.91%	15 0.31%	17 6.23%	826 6.10%
Unknown	4 0.38%	22 0.73%	21 0.67%	6 0.49%	23 0.48%	13 4.76%	89 0.66%
Not Applicable	6 0.57%	27 0.89%	52 1.66%	27 2.20%	62 1.28%	7 2.56%	181 1.34%
CU is Not a Vehicle	17 1.63%	15 0.50%	**22** **0.70%**	4 0.33%	6 0.12%	0 0.00%	64 0.47%
CU is Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
E CU Driver Not Recorded	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	1044 7.71%	3024 22.34%	3129 23.11%	1229 9.08%	4838 35.74%	273 2.02%	13537 100.00%

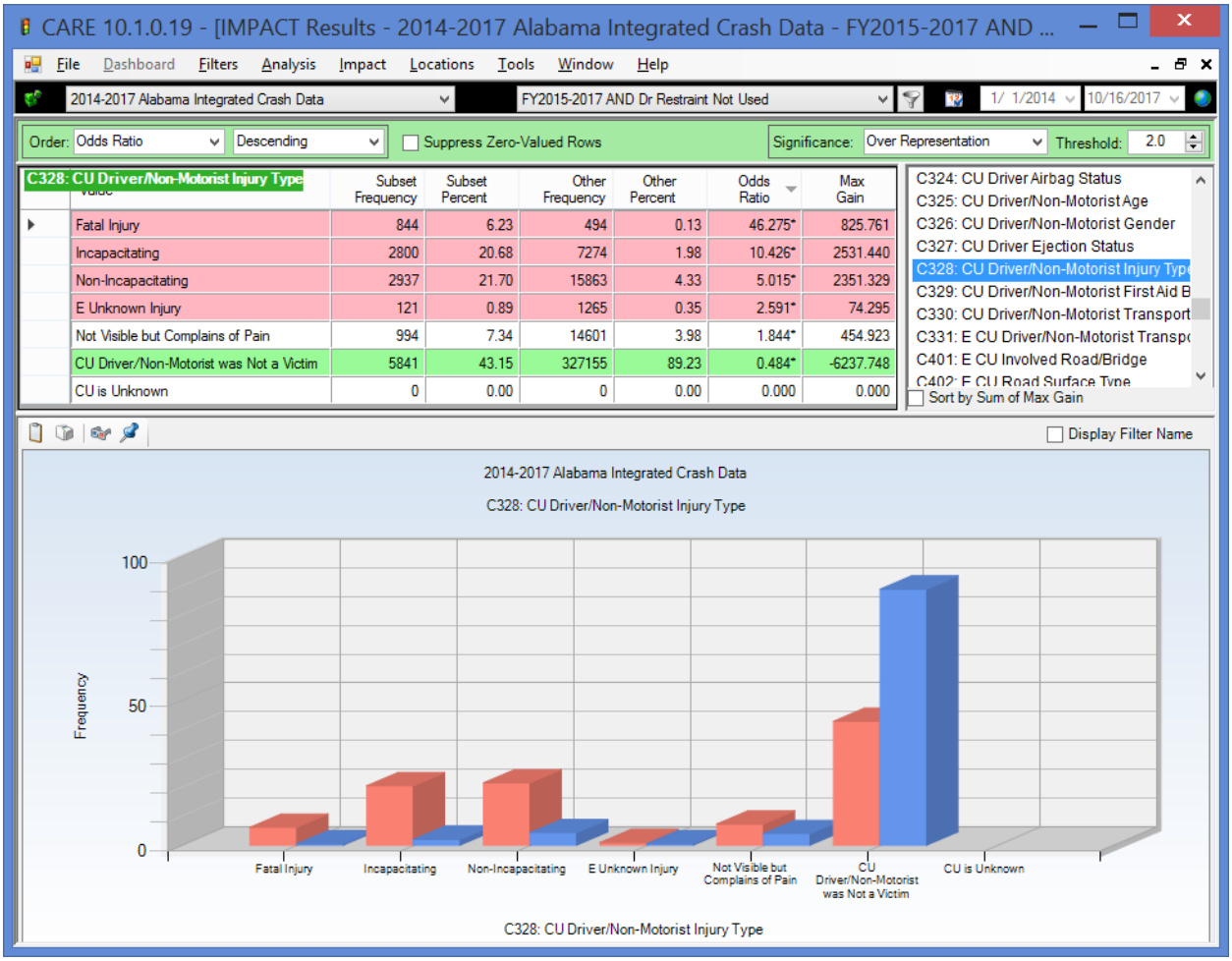
All crashes in the above cross-tabulation involved drivers who were not properly restrained. In evaluating crash severity by ejection status, data show that fatal and incapacitating injuries were significantly overrepresented in crashes in which the driver was partially ejected, totally ejected, or trapped within the vehicle. Because the ejection status is strongly associated with the use of restraints, this data indicates that failure to use restraints results in a dramatic increase in the severity of injuries in those crashes. The table given above quantifies this increase in severity. The probability of any given crash being fatal over the three years (FY2015-FY2017) of the study was 0.57% (including all crashes whether the driver/passengers were restrained or not). The following table give the multipliers to this probability (0.59%) of a crash being a fatal crash for the various ejection conditions.

Fatality Multipliers for Unrestrained Driver Persons Involved

Ejection Status	Probability of Fatality	Multiplier from All Crashes	All=1 in 175
Not Ejected	3.40%	5.95	1 in 29.47
Partially Ejected	39.22%	68.82	1 in 2.55
Totally Ejected	28.34%	49.71	1 in 3.53
Trapped in Vehicle	27.36%	48.00	1 in 3.66

The non-ejection has a multiplier of 5.95 because it is being compared to all crashes, of which a large number (over 90% of passengers) are restrained. Partial ejection is the worst case scenario with a multiplier of over 68. For totally ejected or trapped causal vehicle drivers this is in the 48-50 range, but is still dramatically worse than not being ejected even if unrestrained.

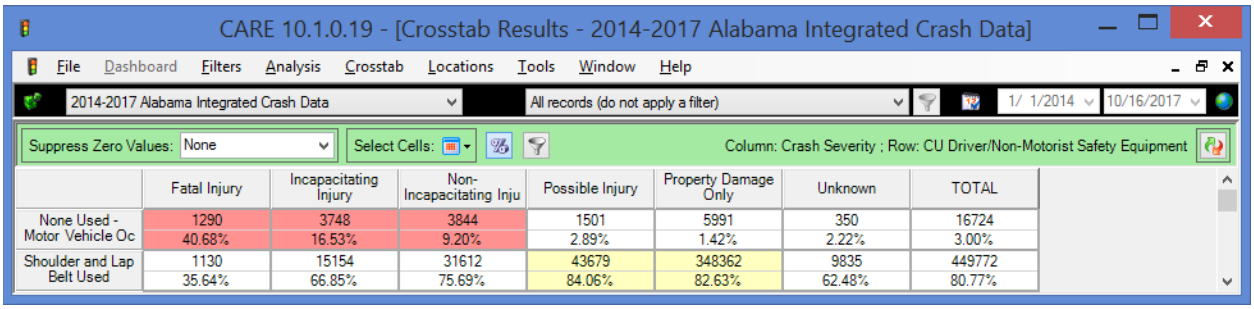
5.7 Driver Injury Type



Various types of driver injuries, including fatalities, are consistently overrepresented in crashes where no restraints were used by the driver. Fatalities in these crashes are overrepresented by a factor of over 46.275. In crashes in which safety restraints were used, drivers and non-motorists were far less likely to be injured. All three non-fatal injury classifications were also significantly over-represented at about 10, 5 and 3 times their expectations, respectively.

5.8 Fatality Probability by Restraint Use

The following is for all crashes over the FY2014-FY2017 time frame.



	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
None Used - Motor Vehicle Oc	1290 40.68%	3748 16.53%	3844 9.20%	1501 2.89%	5991 1.42%	350 2.22%	16724 3.00%
Shoulder and Lap Belt Used	1130 35.64%	15154 66.85%	31612 75.69%	43679 84.06%	348362 82.63%	9835 62.48%	449772 80.77%

The probability that any given crash will be classified as a fatal crash is calculated by the number in any specific category divided by the total number in that general category. From the above, the probability of a fatality of those who are properly restrained is given by:

1130 Fatal Crashes/449,772 Total Restraint Used Crashes = 0.25% (about 1 in every 400 crashes).

The same calculation for the None Used row is:

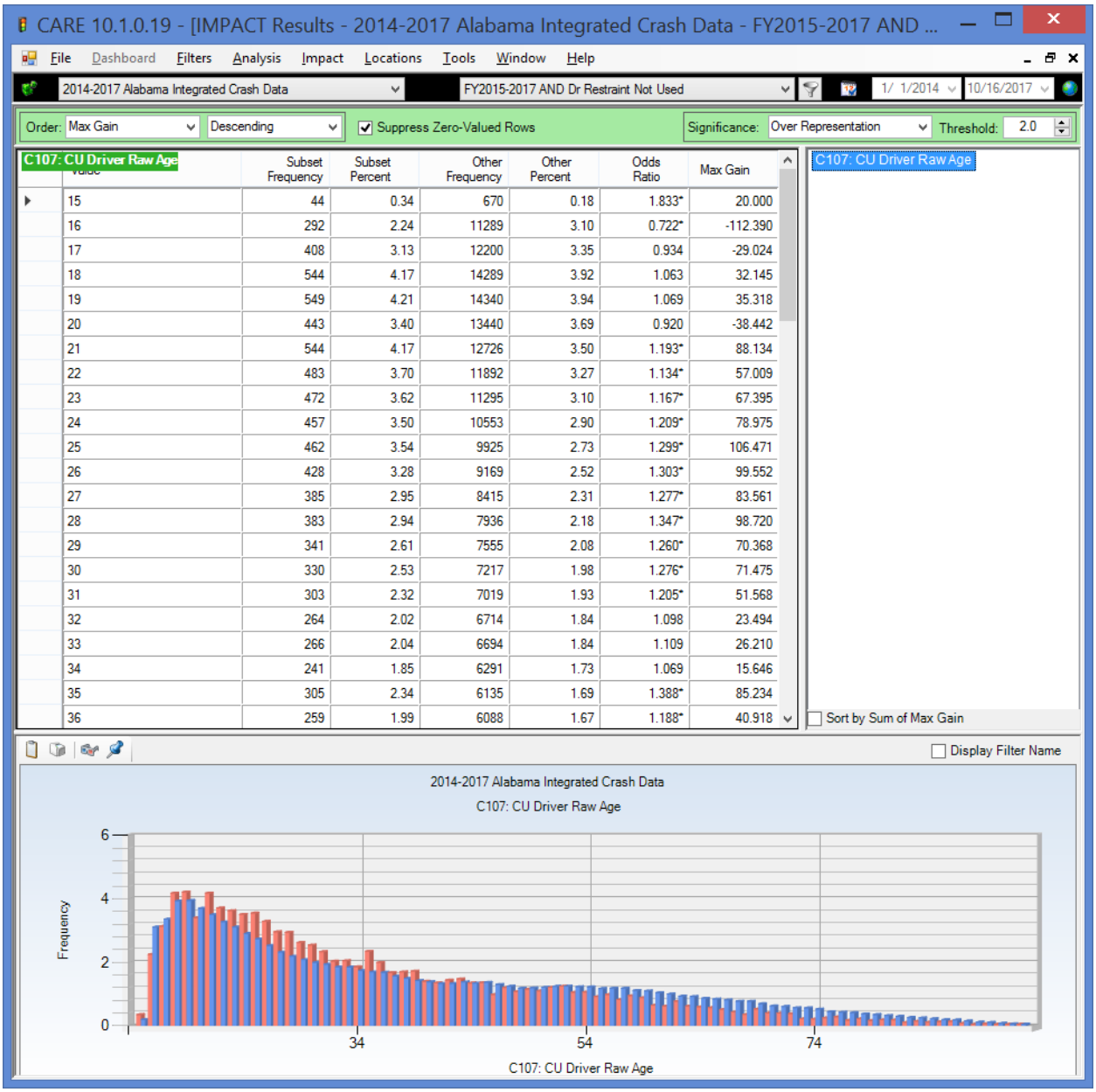
1290 Fatal Crashes/16,724 Total None Used Crashes = 7.71% = (about 1 in every 13 crashes).

These figures show that the probability of being killed in a crash goes up by a factor of about 31 times the probability of being killed given proper restraints.

6 Driver Demographics

The study of driver demographics provides information about which gender or age groups are more likely to be involved in these crashes in which no restraints are used. Determination of overrepresentation can help to target the gender or age group that is more likely to be involved in this type of crash.

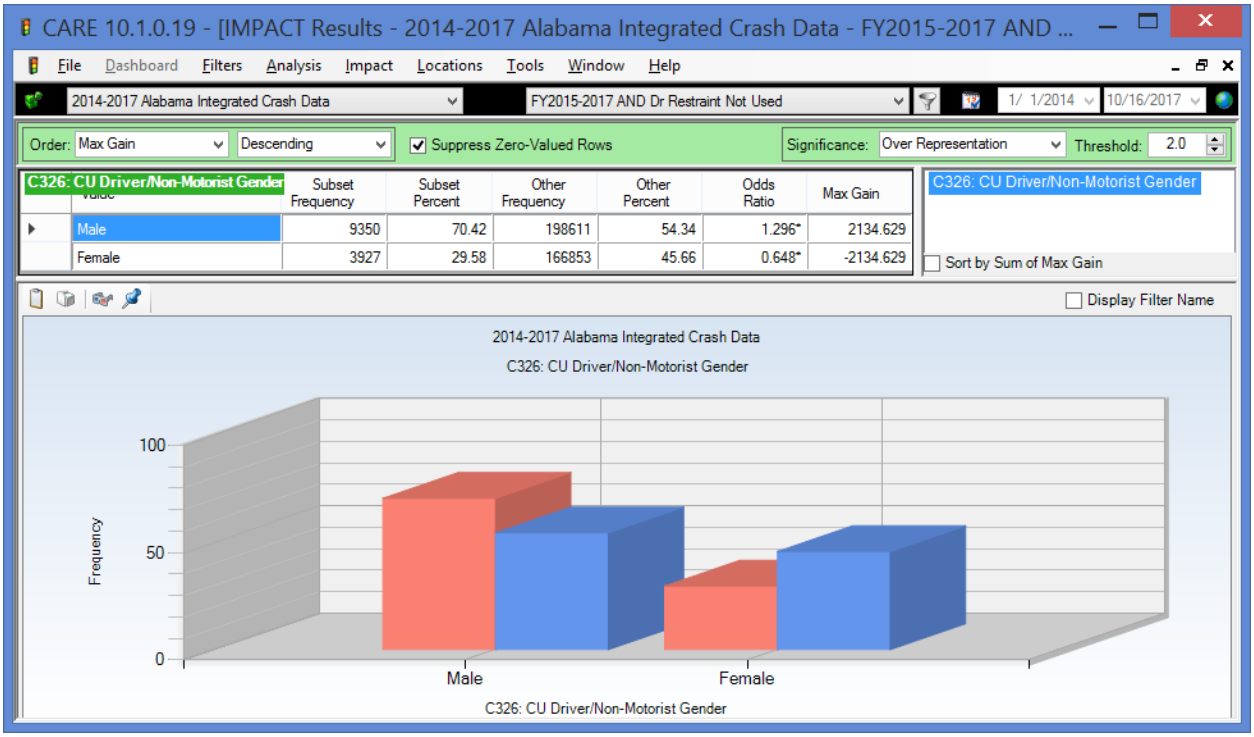
6.1 Driver Age



Analysis of individual driver ages indicates that crashes involving no restraints are overrepresented in the years above the teen-drivers (age range 21-36, all of which are shown in the table above the chart). While it appears that 16-18 teen-aged drivers are more likely to use safety

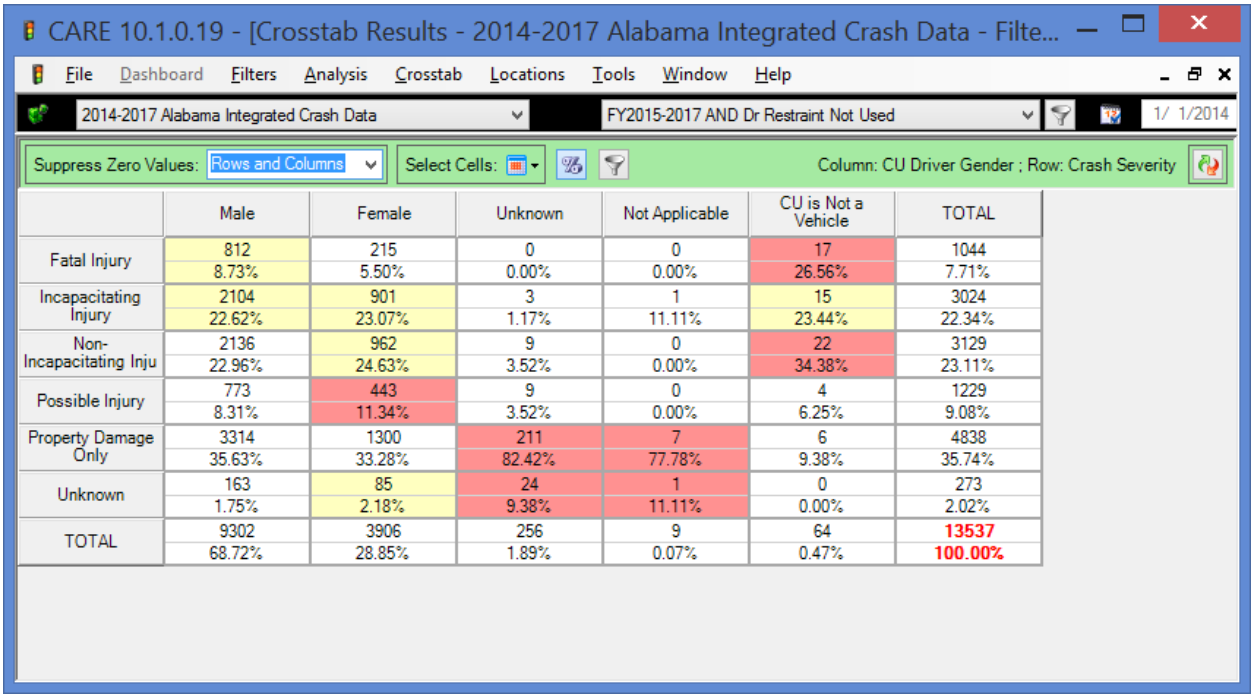
equipment (perhaps due to the emphasis on it placed during training), there is still a very large proportion that are unrestrained, and this problem is multiplied by their overrepresentation in crashes in general (note that, for crashes in general, they are at least twice the average of the other ages). The tendency toward risk-taking is generally thought to end at age 25. This distribution correlates very strongly with crashes in which the causal driver was impaired by drugs (including alcohol), in the significant over-representations being in the ages above 20.

6.2 Driver Gender



Males account for 70.42% of crashes in which restraints are not used, and they are overrepresented by a factor of 1.296. Since males also do the majority of the driving, they become a clear target for restraint countermeasures.

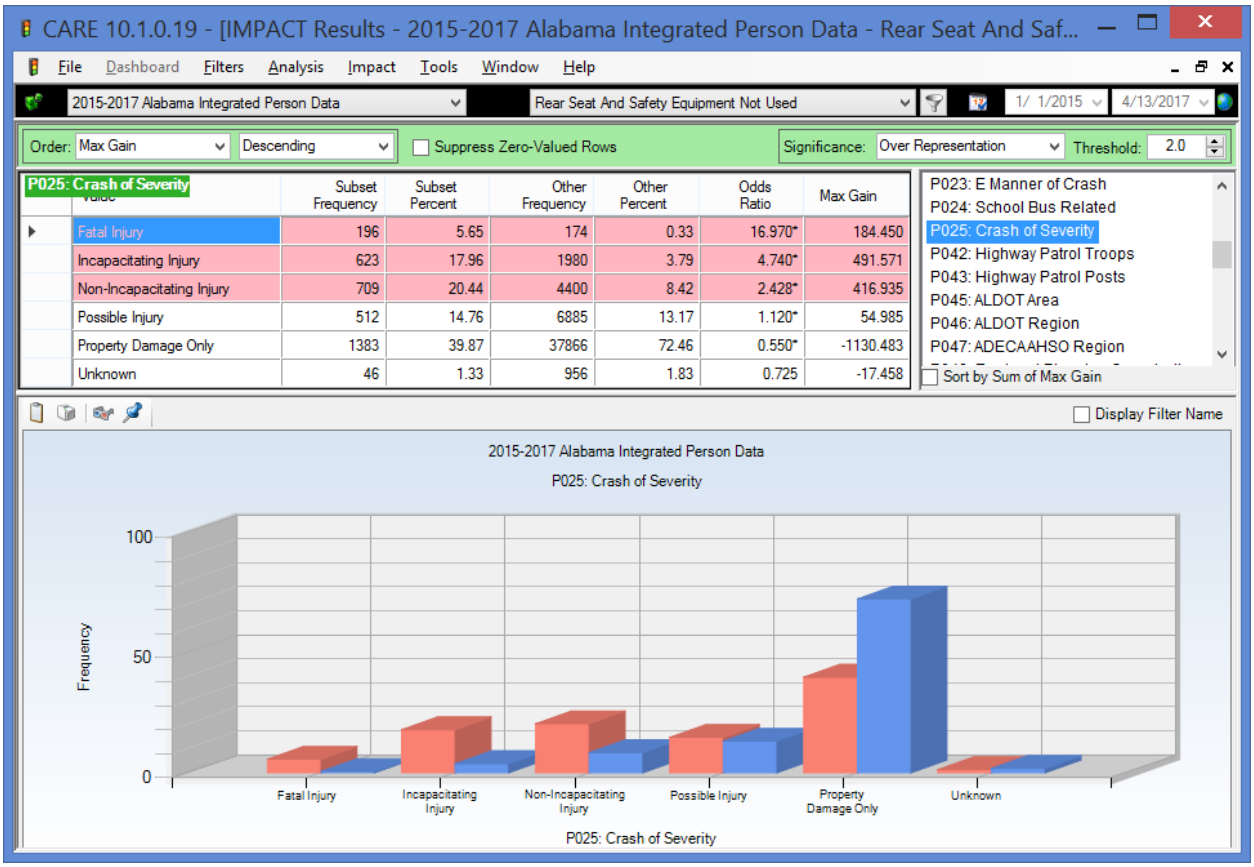
6.3 Driver Gender by Severity for Unrestrained Causal Drivers



	Male	Female	Unknown	Not Applicable	CU is Not a Vehicle	TOTAL
Fatal Injury	812 8.73%	215 5.50%	0 0.00%	0 0.00%	17 26.56%	1044 7.71%
Incapacitating Injury	2104 22.62%	901 23.07%	3 1.17%	1 11.11%	15 23.44%	3024 22.34%
Non-Incapacitating Inju	2136 22.96%	962 24.63%	9 3.52%	0 0.00%	22 34.38%	3129 23.11%
Possible Injury	773 8.31%	443 11.34%	9 3.52%	0 0.00%	4 6.25%	1229 9.08%
Property Damage Only	3314 35.63%	1300 33.28%	211 82.42%	7 77.78%	6 9.38%	4838 35.74%
Unknown	163 1.75%	85 2.18%	24 9.38%	1 11.11%	0 0.00%	273 2.02%
TOTAL	9302 68.72%	3906 28.85%	256 1.89%	9 0.07%	64 0.47%	13537 100.00%

The only injury proporrtion that deviated by more that 10% of its expected value for all drivers of all genders was the 443 (11.34%) for Female drivers who sustained Possible Injuries. Generally, the distribution of severity is skewed toward more severe injuries for unrestrained male drivers in the Fatal and Incapacitating Injury categories. The probability that any of these (unrestrained driver) crashes resulted in a fatality was 8.73% for male drivers and 5.50% for female drivers.

7 Analysis of Back Seat Occupants



Back seat occupants who are not properly restrained have close to 17 times the probability of being killed as do those who are properly restrained. The other highest two severity classifications are also very highly significant in their over-representations, having Odds Ratio multipliers of 4.740 for Incapacitating Injury and 2.428 for Non-Incapacitating Injury.

Looking at the numbers, over the three year period, there were 196 back seat occupants killed, which is about 65 per year. Question: how many of these would have been saved had they been properly restrained? Applying the 0.33% (probability of being killed if restrained) to the total unrestrained (sum of the Subset Frequency column, which is 3,469) yields 11.45 total fatalities expected in any event from the 3,469 unrestrained victims. This means that the total fatality savings over the five years would have been 196-11=185 fatalities, or saving about 62 lives per year.

8 Summary and Conclusions

The following summarizes the findings of the analysis:

- Geographical Factors
    - Counties with the greatest overrepresentation factors for unrestrained driver crashes include Walker, Talladega, Jackson, DeKalb, Monroe and Cullman,
    - The number of crashes involving drivers who use no restraints is greatly overrepresented in rural areas in comparison to the urban areas. The odds ratio for rural areas is about 2.5 times that of what would be expected if rural and urban restraint use were the same.
    - The most overrepresented (worst) areas are the rural county areas in Walker, Talladega, Mobile, Tuscaloosa and Cullman Counties.
    - The most underrepresented (best) cities are Birmingham, Mobile, Montgomery, and Huntsville.
    - Crash incidents with no driver restraints being used are greatly overrepresented on county highways, with 2.75 times the expected number of crashes. County and State were the only roadway classification that were overrepresented. Federal, Interstate and Municipal roads were significantly under-represented.
    - In the analysis of locale, crashes involving no restraints are most commonly overrepresented in Open Country areas, and Shopping or Business locales are the most significantly under-represented.

- Time Factors
    - The weekend days are the most overrepresented days of the week for crashes in which drivers did not use restraints. This correlates highly with impaired driving crashes.
    - In the evaluation of time of day, overrepresentations peak during the 7 PM to 6 AM time periods and then taper off, falling back below crashes involving causal drivers who use restraints in the 7 AM to 7 PM time periods. Additional cross-tabulations were performed for crashes involving injury.

- Analysis of Time of Day by Day of Week.
    - Crosstab analyses of time of day by day of the week of crashes in which restraints were not used enables officers to determine target times and days to enforce restraint laws so that severe crashes may be prevented. Two analyses were performed and compared for all crashes with restraint deficiencies and injury crashes for restraint deficiencies. The late night and early morning over-representations were largely on the weekend days starting on Friday night and ending on Sunday morning.

- The cross-tabulation of time of day by day of the week that was restricted to injury crashes showed a very high resemblance to the same analysis for impaired driving (alcohol and other drugs involvement).

- Crash Causal Factors
  - The overrepresentation factors indicate that certain risk-taking behaviors are often associated with crashes in which restraints are not used, including DUI, over the speed limit, aggressive operation, running off the road, and fatigue/sleep.
  - Crashes attributed to drivers who used no restraints are greatly overrepresented in vehicles with model years 1960-2004, which could be attributed to the lack of standard safety restraints in some of these older model vehicles, or perhaps the removal of these safety devices over time.
  - The speed at impact for crashes for restraint-deficient crashes is significantly overrepresented in all of the categories above 45 MPH, indicating that these crashes consistently occur at higher speeds than crashes in which restraints were used by the causal driver. This is highly correlated with rural driving and risk taking.
- Severity Factors
  - Fatal, incapacitating, and non-incapacitating injuries are all overrepresented in crashes where drivers were not restrained; this analysis quantified the benefits of the restraint use.
  - Fatal injuries in crashes where no restraints are used are highly overrepresented on interstate, federal and state roadways. "Possible Injuries and Property Damage Only were highly overrepresented on municipal highways.
  - Analysis of number injuried shows that the proportion of injuries (including fatalities) in unrestrained driver crashes is overrepresented from 1 to 6 injuries per crash. Crashes without restraints are clearly causing much more severe injuries and a greater number of injuries and fatalities per crash.
  - The proportion of fatalities in general as well as the proportion of multiple fatality crashes is dramatically overrepresented in crashes where the causal driver is unrestrained.
  - As expected, ejection of the unrestrained driver is overrepresented, indicating one major cause for many fatalities in which safety equipment is not properly utilized.
  - All types of injuries, including fatalities, are consistently overrepresented in crashes where no restraints were used.

- Driver Demographics
  - Analysis of individual driver ages indicates that crashes involving no restraints are overrepresented in drivers in and immediately above the teen driver classification (age range 19-39).

    - Male drivers account for a majority of crashes in which restraints are not used, and they are overrepresented by a factor of 1.296.

- Ejection and Back Seat Analysis
    - The non-restrained person is over 300 times more likely to be totally ejected than those who are properly restrained.
    - Being ejected results in a probability of death about 50 times that of those not ejected.
    - If all back-seat occupants were properly restrained it would result in an estimated saving of 62 lives per year.

For general information on restraints from NHTSA and other sources, please see “Restraints” in: http://www.safehomealabama.gov/safety-topics/