Vehicle Defect IMPACT Analysis
2022 Update 2017-2021 Data

David B. Brown
University of Alabama Center for Advanced Public Safety (CAPS)
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For more information on this subject from NHTSA and other sources, please see:
http://www.safehomealabama.gov/tag/defects-recalls/

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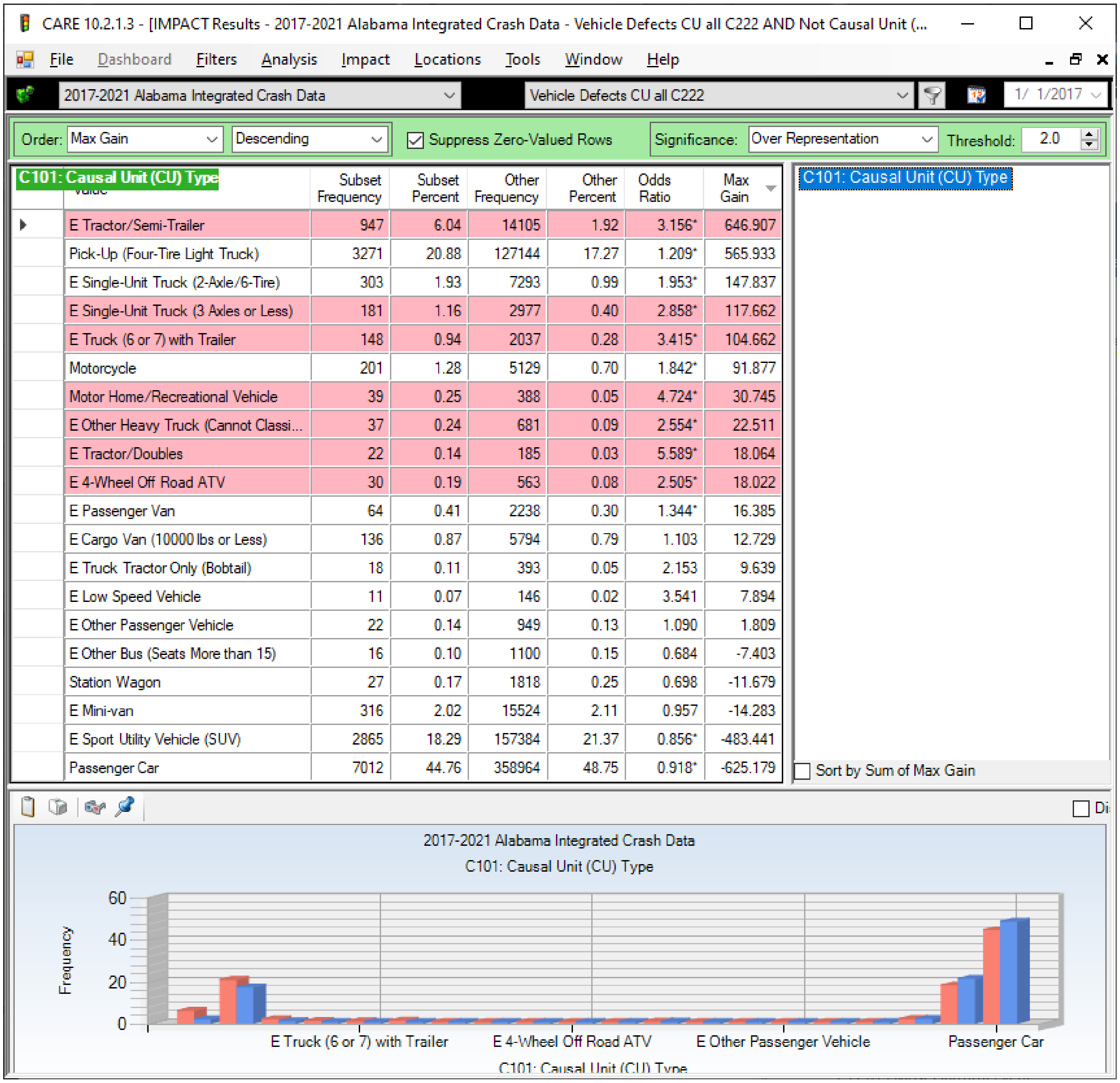
1.0 Introduction: All Unit types and All Vehicle Defect Types

1.1 C101 Causal Unit Type

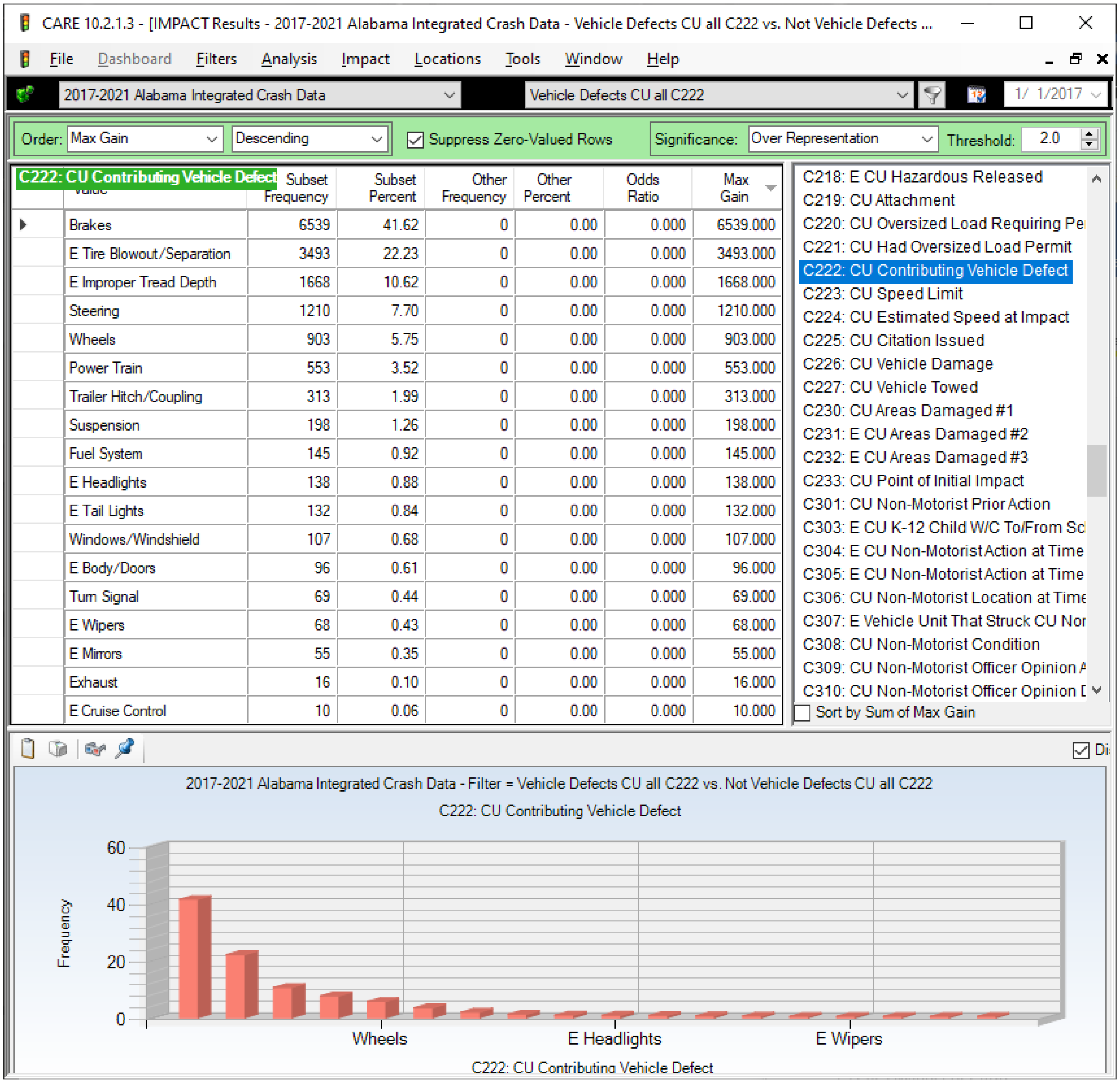
The high level analysis of vehicles in general for vehicle defects showed a high correlation of the defect type and the vehicle type, which is expected since certain defects apply only to trucks and other specialized vehicles. The Causal Unit analysis given immediately below establishes that: (1) the most over-represented vehicles are heavy trucks (as we might expect), but (2) the highest frequency is in the Passenger Cars and SUVs, which are the most UNDER-represented.



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tractor/Semi-Trailer	947	6.04	14105	1.92	3.156*	646.907
Pick-Up (Four-Tire Light Truck)	3271	20.88	127144	17.27	1.209*	565.933
E Single-Unit Truck (2-Axle/6-Tire)	303	1.93	7293	0.99	1.953*	147.837
E Single-Unit Truck (3 Axles or Less)	181	1.16	2977	0.40	2.858*	117.662
E Truck (6 or 7) with Trailer	148	0.94	2037	0.28	3.415*	104.662
Motorcycle	201	1.28	5129	0.70	1.842*	91.877
Motor Home/Recreational Vehicle	39	0.25	388	0.05	4.724*	30.745
E Other Heavy Truck (Cannot Classi...	37	0.24	681	0.09	2.554*	22.511
E Tractor/Doubles	22	0.14	185	0.03	5.589*	18.064
E 4-Wheel Off Road ATV	30	0.19	563	0.08	2.505*	18.022
E Passenger Van	64	0.41	2238	0.30	1.344*	16.385
E Cargo Van (10000 lbs or Less)	136	0.87	5794	0.79	1.103	12.729
E Truck Tractor Only (Bobtail)	18	0.11	393	0.05	2.153	9.639
E Low Speed Vehicle	11	0.07	146	0.02	3.541	7.894
E Other Passenger Vehicle	22	0.14	949	0.13	1.090	1.809
E Other Bus (Seats More than 15)	16	0.10	1100	0.15	0.684	-7.403
Station Wagon	27	0.17	1818	0.25	0.698	-11.679
E Mini-van	316	2.02	15524	2.11	0.957	-14.283
E Sport Utility Vehicle (SUV)	2865	18.29	157384	21.37	0.856*	-483.441
Passenger Car	7012	44.76	358964	48.75	0.918*	-625.179

The display above shows that Passenger Cars and SUVs are getting the highest number of vehicle defect crashes, not because they have more defects per vehicle, but because of their sheer number on the roadway. This is demonstrated by the under-representation of Passenger Cars and Sport Utility Vehicles (SUVs) when they are compared to the same vehicles without defect-caused crashes. Another very common passenger vehicle, that, in this case, is shown to be over-represented in vehicle-defect crashes is Pick Up trucks (second from the top).

1.2 Listing of <u>All</u> C222 CU Contributing Vehicle Defects

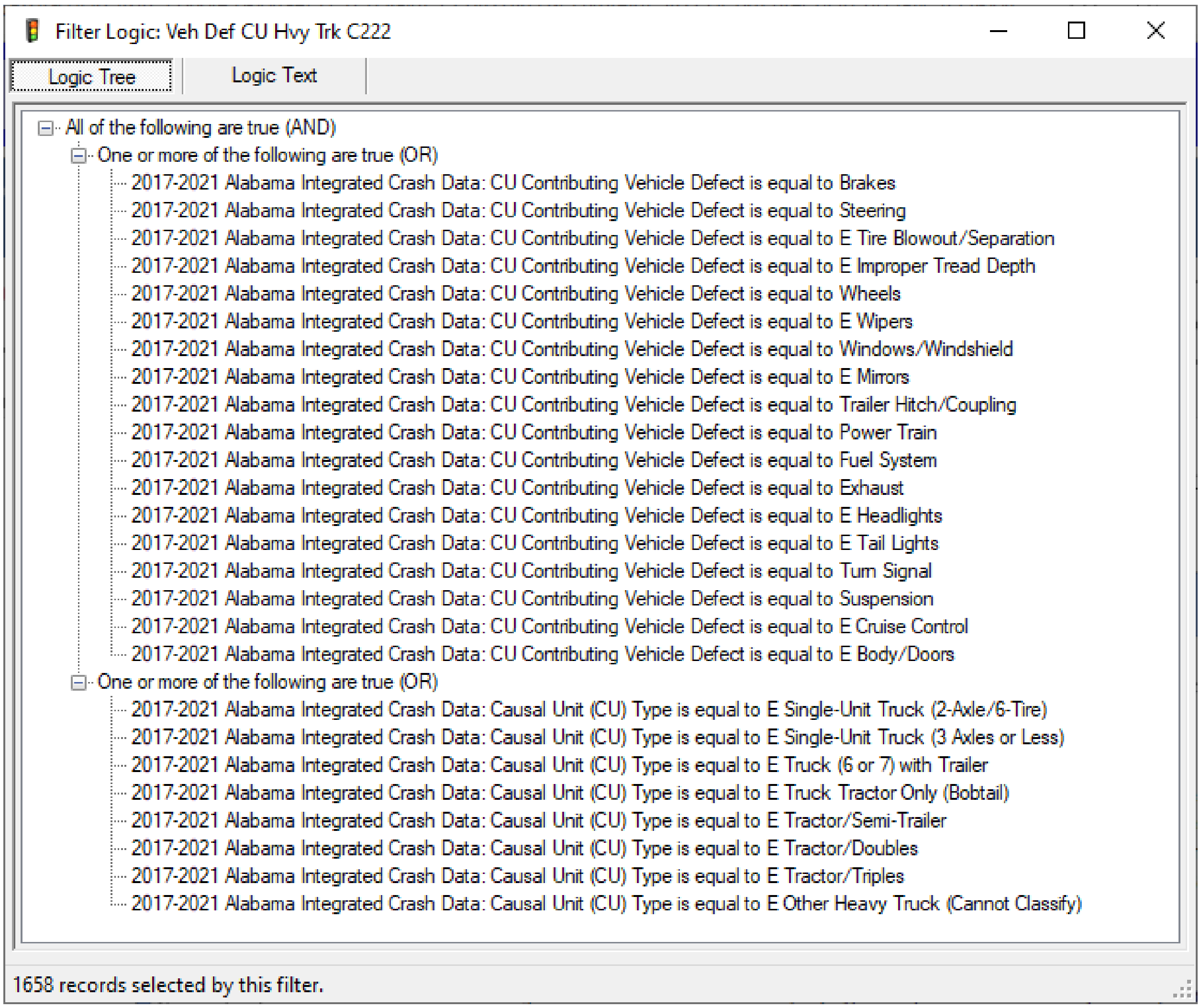


C222: CU Contributing Vehicle Defect Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Brakes	6539	41.62	0	0.00	0.000	6539.000
E Tire Blowout/Separation	3493	22.23	0	0.00	0.000	3493.000
E Improper Tread Depth	1668	10.62	0	0.00	0.000	1668.000
Steering	1210	7.70	0	0.00	0.000	1210.000
Wheels	903	5.75	0	0.00	0.000	903.000
Power Train	553	3.52	0	0.00	0.000	553.000
Trailer Hitch/Coupling	313	1.99	0	0.00	0.000	313.000
Suspension	198	1.26	0	0.00	0.000	198.000
Fuel System	145	0.92	0	0.00	0.000	145.000
E Headlights	138	0.88	0	0.00	0.000	138.000
E Tail Lights	132	0.84	0	0.00	0.000	132.000
Windows/Windshield	107	0.68	0	0.00	0.000	107.000
E Body/Doors	96	0.61	0	0.00	0.000	96.000
Turn Signal	69	0.44	0	0.00	0.000	69.000
E Wipers	68	0.43	0	0.00	0.000	68.000
E Mirrors	55	0.35	0	0.00	0.000	55.000
Exhaust	16	0.10	0	0.00	0.000	16.000
E Cruise Control	10	0.06	0	0.00	0.000	10.000

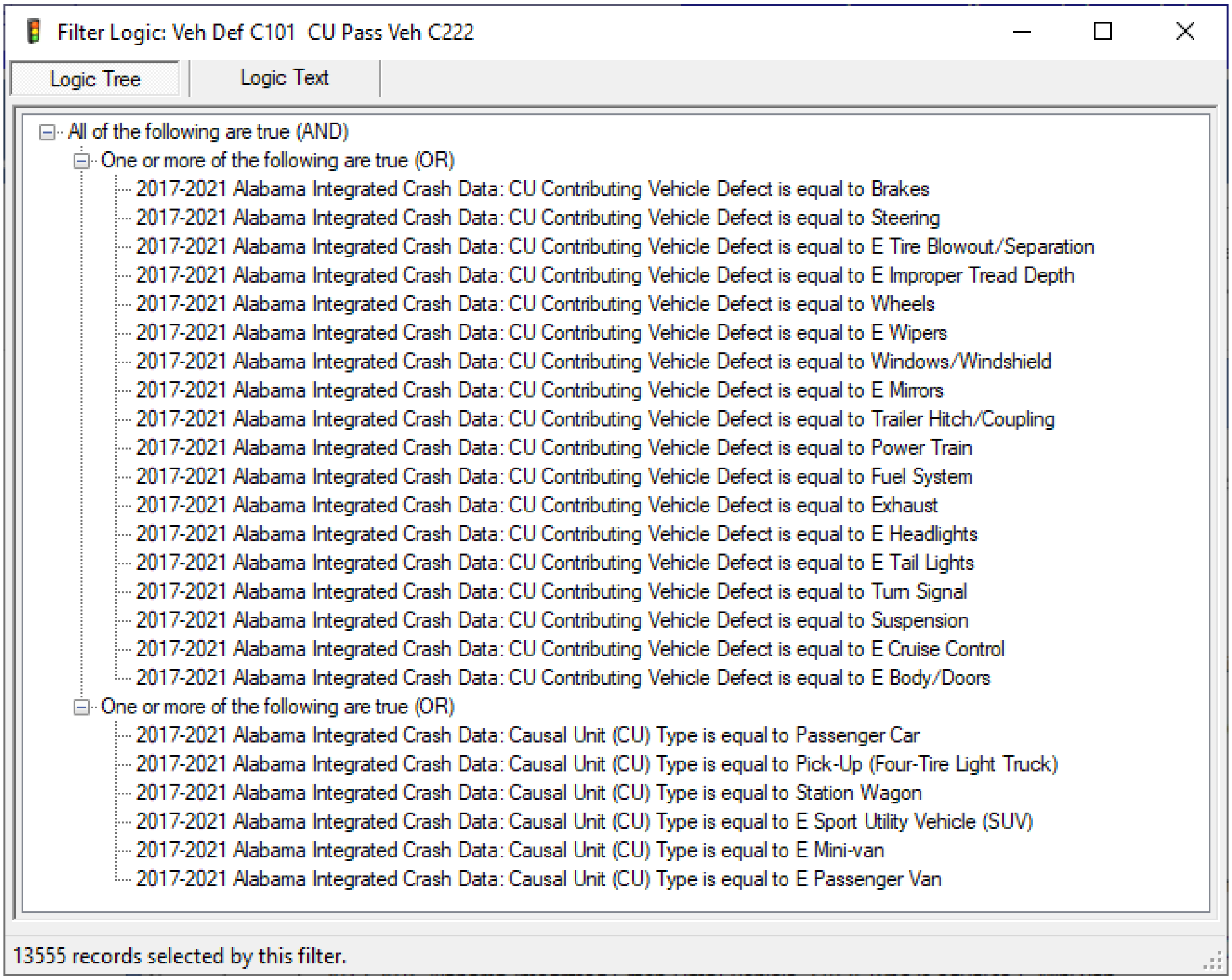
The above display is in Subset Frequency order. The Other Frequencies are all 0 indicating that there are no vehicle-defect caused crashes in the Other Frequency (i.e., the control) subset. Clearly, Brakes (6,539) and Tires (3,493 + 1,668 = 5,161) are the two highest frequency vehicle defects, and these will be given concentrated study below. This does not mean that other defects should be ignored. Each individual vehicle should be reviewed in terms of all of it potential defects to determine how to best maintain it so as to reduce these crash causes.

1.3 Filters for the Analyses

The results above led to the decision to separate the most common passenger vehicles from large trucks in Sections 2 and 3 below. Considering the passenger cars simultaneously with the large trucks would produce ambiguous results. To solve this problem, two separate runs were performed, where the subdivision is based on C101 – CU Unit Type. Specifically, the display below indicates how Large Trucks with vehicle defects were defined for this study. The details for this analysis is given in Section 2.



Similarly, the display below shows how the common "Passenger Cars" were defined for this study. This analysis is given in Section 3.


Filter Logic: Veh Def C101 CU Pass Veh C222

Logic Tree | Logic Text

All of the following are true (AND)
One or more of the following are true (OR)
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Brakes
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Steering
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Tire Blowout/Separation
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Improper Tread Depth
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Wheels
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Wipers
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Windows/Windshield
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Mirrors
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Trailer Hitch/Coupling
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Power Train
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Fuel System
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Exhaust
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Headlights
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Tail Lights
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Turn Signal
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to Suspension
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Cruise Control
2017-2021 Alabama Integrated Crash Data: CU Contributing Vehicle Defect is equal to E Body/Doors
One or more of the following are true (OR)
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Passenger Car
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Pick-Up (Four-Tire Light Truck)
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Station Wagon
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Sport Utility Vehicle (SUV)
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Mini-van
2017-2021 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Passenger Van

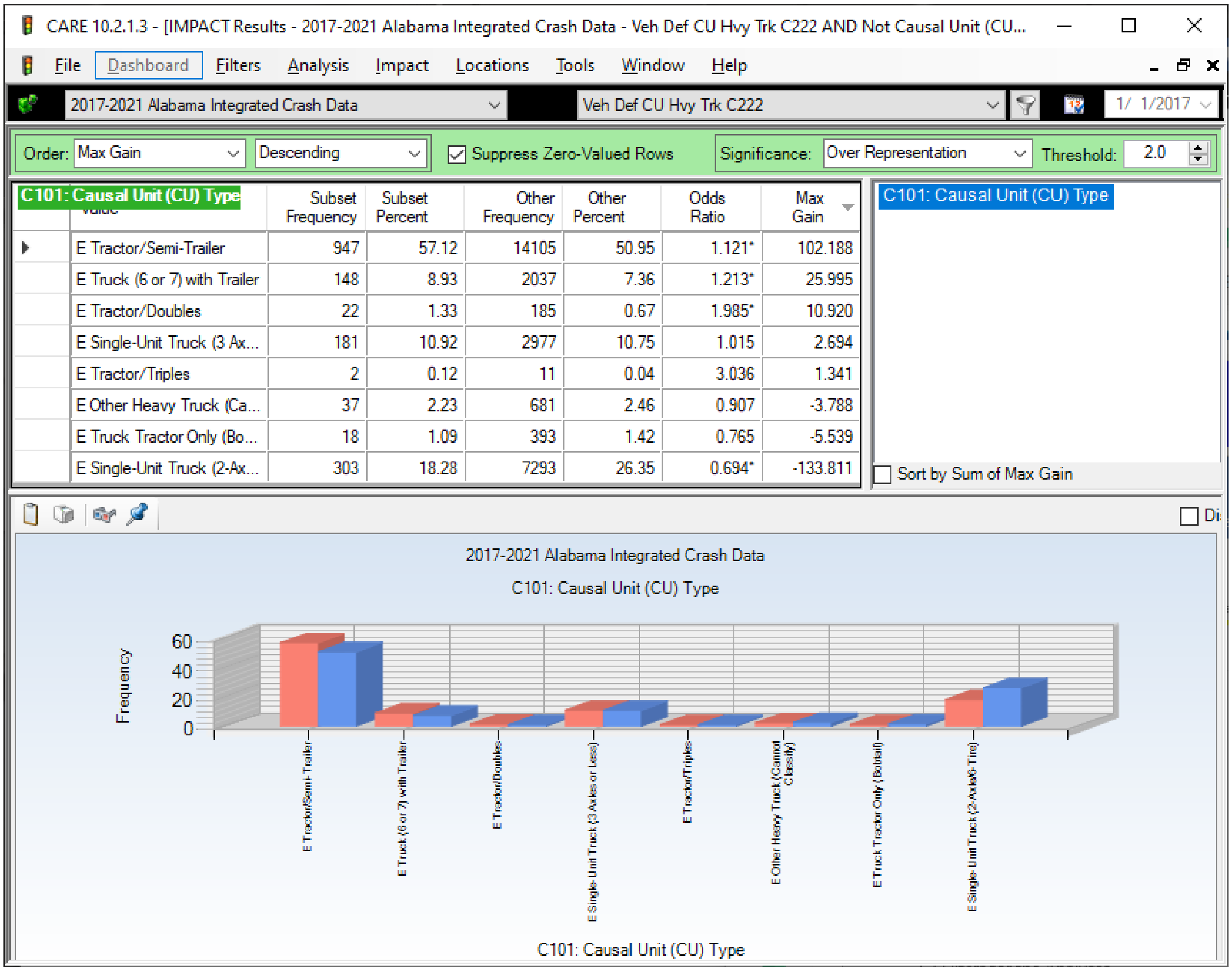
13555 records selected by this filter.

The goal of both analyses was to determine the other attributes given on the crash reports that are correlated with vehicle defects. These are given in the Table of Contents for Sections 2 and 3 above. Each of the analyses will start out with a summary of the Causal Unit (CU) vehicle defects themselves (C222 CU Contributing Vehicle Defect). This is followed by IMPACT analyses on a number of attributes that were considered to be relevant.

2.0 Large Truck Analysis

2.1 C101 Causal Unit (CU) Type Analysis When Large Truck Involved

This comparison is between vehicles with defects against the same type units without defects, restricted to crashes that involved the respective large trucks (on both sides of the comparison). Most of the two-vehicle crashes involve a passenger car, since truck-truck crashes are relatively rare. The following display indicates the vehicle type for each defective vehicle type that caused the crashes. The assumption is that the recording officer would not indicate a vehicle defect for a vehicle if that vehicle did not cause the crash.



C101: Causal Unit (CU) Type Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tractor/Semi-Trailer	947	57.12	14105	50.95	1.121*	102.188
E Truck (6 or 7) with Trailer	148	8.93	2037	7.36	1.213*	25.995
E Tractor/Doubles	22	1.33	185	0.67	1.985*	10.920
E Single-Unit Truck (3 Ax...	181	10.92	2977	10.75	1.015	2.694
E Tractor/Triples	2	0.12	11	0.04	3.036	1.341
E Other Heavy Truck (Ca...	37	2.23	681	2.46	0.907	-3.788
E Truck Tractor Only (Bo...	18	1.09	393	1.42	0.765	-5.539
E Single-Unit Truck (2-Ax...	303	18.28	7293	26.35	0.694*	-133.811

The output above is ordered by Max Gain, which considers both the number of crashes in which the unit caused (the first numerical column) and the over-representation (as measured by the Odds Ratio). The Max Gain is the number of crashes that would be eliminated if there was some countermeasure implemented that could cause its Subset Percent to be the same as the control (Other Percent). For example, in the first item list, which has a causal frequency of 947 crashes, 102 of these could be eliminated if the effect of vehicle defects were eliminated (making the value in the Subset Percent list to be 50.95). This list enables motor-carrier professionals to determine which vehicle types need the greatest emphasis when it comes to reducing their vehicle defects.

We will continue with the IMPACT results that had the highest total Max Gains, and also those with the most practical significance.

2.2 C222 CU Contributing Vehicle Defect by CU Unit Type Cross-tabulation

The cross-tabulation below shows what defects this analysis is considering; and it answers the question of: in general, what vehicle defects are included in the analysis given above. This is a cross-tabulation of C101 (Vehicle Type) by C222 (Vehicle Defect) for the large truck study.

CARE 10.2.1.3 - [Crosstab Results - 2017-2021 Alabama Integrated Crash Data - Filter = Veh Def CU Hvy Trk C222]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2017-2021 Alabama Integrated Crash Data | Veh Def CU Hvy Trk C222 | 1/ 1/2017 | 12/31/2021

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Causal Unit (CU) Type ; Row: CU Contributing Vehicle Defect

	E Single-Unit Truck (2-Axle/6-Ti	E Single-Unit Truck (3 Axles or	E Truck (6 or 7) with Trailer	E Truck Tractor Only (Bobtail)	E Tractor/Semi-Trailer	E Tractor/Doubles	E Tractor/Triples	E Other Heavy Truck (Cannot Cla	TOTAL
Brakes	108	71	21	5	210	3	1	16	435
Steering	30	7	4	2	36	0	0	3	82
E Tire Blowout/Separatio	79	68	46	5	503	14	1	4	720
E Improper Tread Depth	6	1	3	0	9	0	0	1	20
Wheels	21	8	18	1	66	0	0	2	116
E Wipers	1	0	0	0	1	0	0	0	2
Windows/Windshield	2	1	0	0	2	0	0	0	5
E Mirrors	3	0	1	0	1	1	0	0	6
Trailer Hitch/Coupling	5	0	26	0	27	3	0	2	63
Power Train	28	16	6	3	57	1	0	0	111
Fuel System	5	1	2	1	10	0	0	0	19
Exhaust	0	1	0	0	1	0	0	0	2
E Headlights	2	0	1	1	1	0	0	0	5
E Tail Lights	2	0	13	0	2	0	0	3	20
Turn Signal	1	0	2	0	3	0	0	3	9
Suspension	2	4	3	0	11	0	0	0	20
E Cruise Control	0	0	0	0	1	0	0	0	1
E Body/Doors	8	3	2	0	6	0	0	3	22
TOTAL	303	181	148	18	947	22	2	37	1658

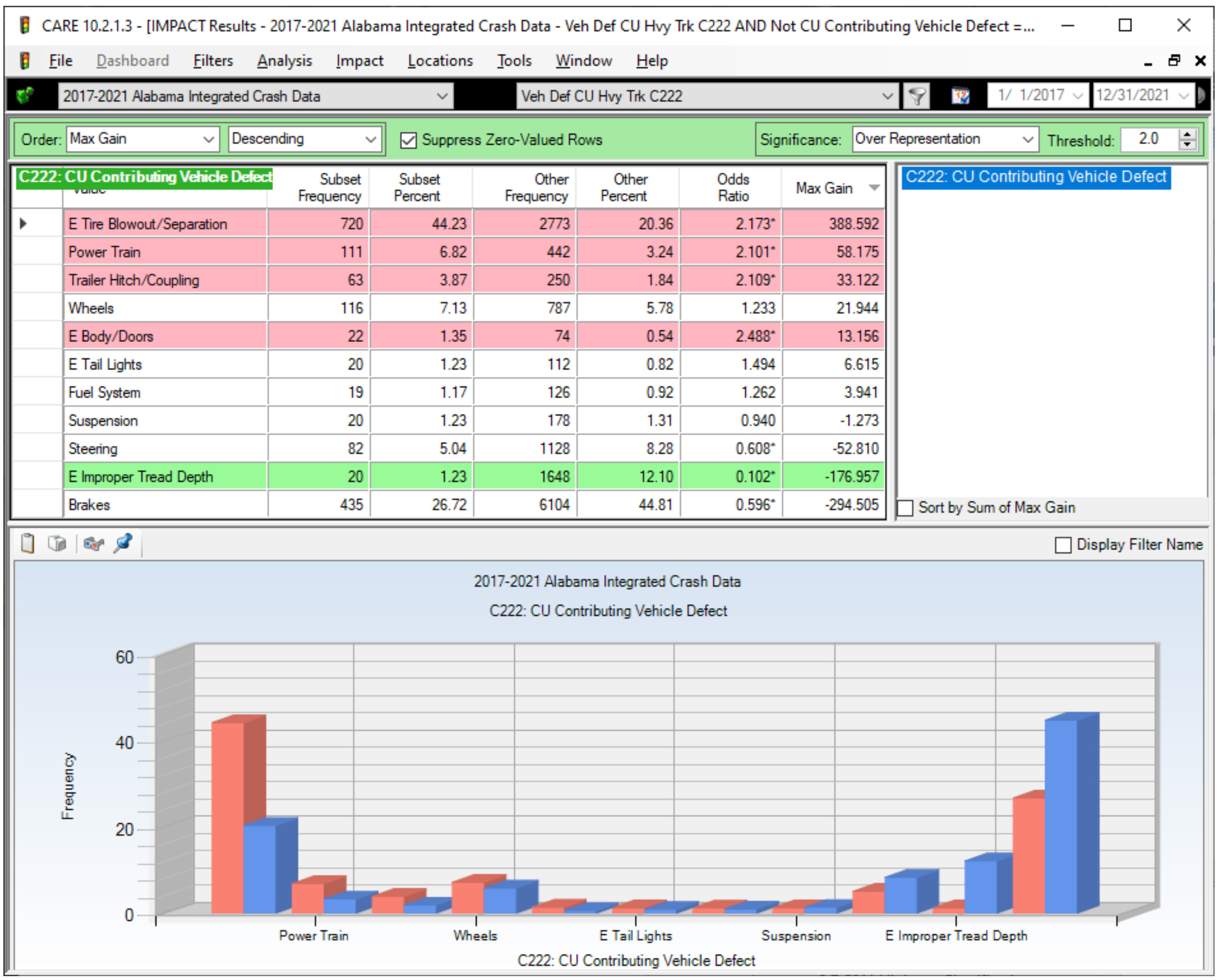
For some examples, brakes are more of a problem with both types of single-unit trucks than with other truck types, with the exception of Tractor/Semi Trailer, which has almost half of the Brakes total frequency.

2.3 Large Truck Defect Crashes (LTDC) Compared Non-LTDC

The displays that follow compare Large Truck Defect Crashes (LTDC) against all crashes that were not LTDC independent of their vehicle type or whether defects were involved in the crash (henceforth called Non-LTFC).

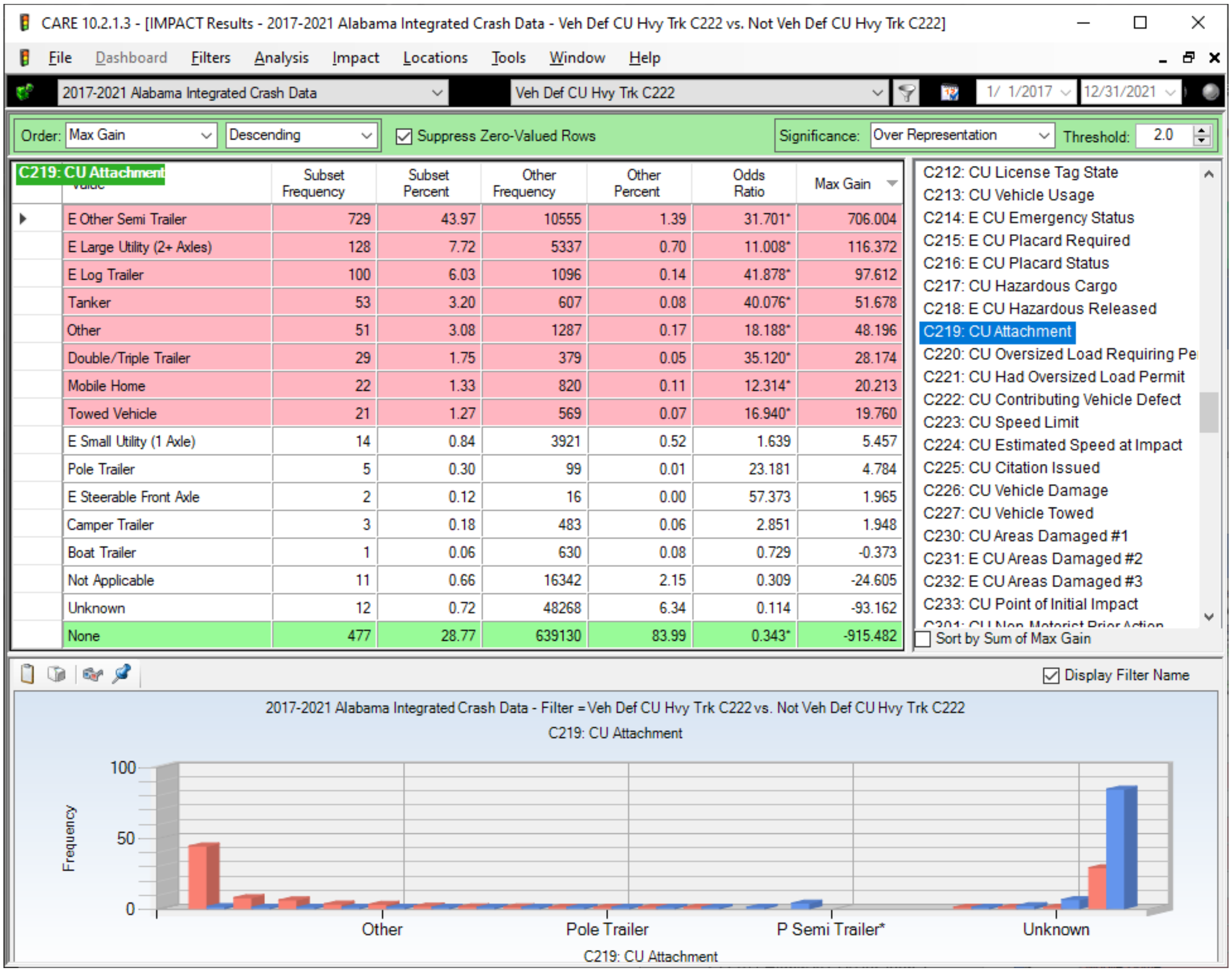
2.3.1 C222 Causal Unit Vehicle Defect in LTDC vs Non-LTDC

The display below gives the distribution of the vehicle defects that occurred in the vehicles given in the defects analysis in Section 2.1. The table indicates that Tire Blowout/Separation is the highest frequency (720), followed by Brakes (425, under-represented), Wheels (116). and Power Train (111). following. Apparently Improper Tread Depth is not as large a problem for large trucks as it is for passenger cars. We expect this is because of the continual inspections given to large trucks by FMCSA and the ALEA Motor Carrier unit.



C222: CU Contributing Vehicle Defect	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tire Blowout/Separation	720	44.23	2773	20.36	2.173*	388.592
Power Train	111	6.82	442	3.24	2.101*	58.175
Trailer Hitch/Coupling	63	3.87	250	1.84	2.109*	33.122
Wheels	116	7.13	787	5.78	1.233	21.944
E Body/Doors	22	1.35	74	0.54	2.488*	13.156
E Tail Lights	20	1.23	112	0.82	1.494	6.615
Fuel System	19	1.17	126	0.92	1.262	3.941
Suspension	20	1.23	178	1.31	0.940	-1.273
Steering	82	5.04	1128	8.28	0.608*	-52.810
E Improper Tread Depth	20	1.23	1648	12.10	0.102*	-176.957
Brakes	435	26.72	6104	44.81	0.596*	-294.505

2.3.2 C219 CU Attachment

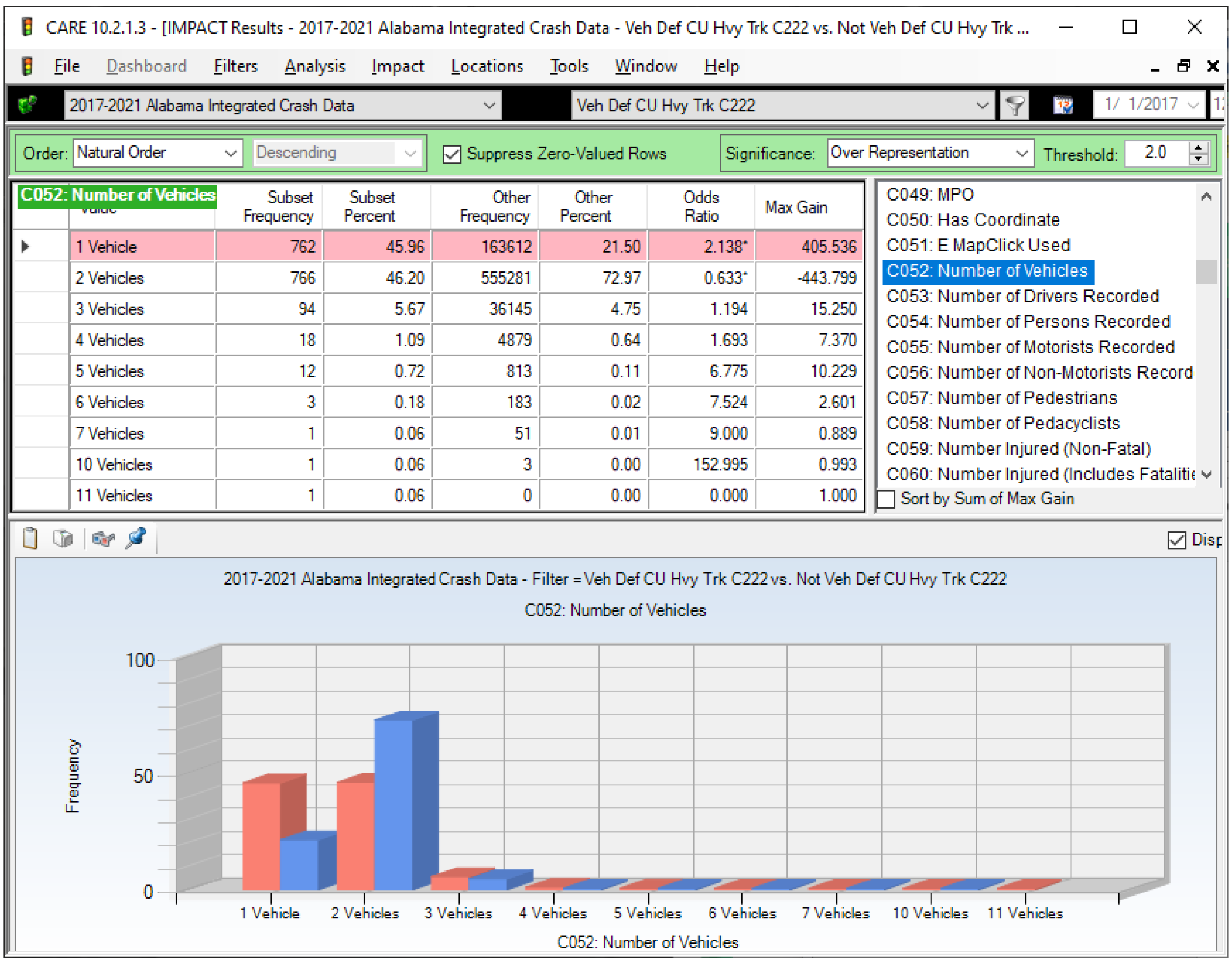


C219: CU Attachment Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Other Semi Trailer	729	43.97	10555	1.39	31.701*	706.004
E Large Utility (2+ Axles)	128	7.72	5337	0.70	11.008*	116.372
E Log Trailer	100	6.03	1096	0.14	41.878*	97.612
Tanker	53	3.20	607	0.08	40.076*	51.678
Other	51	3.08	1287	0.17	18.188*	48.196
Double/Triple Trailer	29	1.75	379	0.05	35.120*	28.174
Mobile Home	22	1.33	820	0.11	12.314*	20.213
Towed Vehicle	21	1.27	569	0.07	16.940*	19.760
E Small Utility (1 Axle)	14	0.84	3921	0.52	1.639	5.457
Pole Trailer	5	0.30	99	0.01	23.181	4.784
E Steerable Front Axle	2	0.12	16	0.00	57.373	1.965
Camper Trailer	3	0.18	483	0.06	2.851	1.948
Boat Trailer	1	0.06	630	0.08	0.729	-0.373
Not Applicable	11	0.66	16342	2.15	0.309	-24.605
Unknown	12	0.72	48268	6.34	0.114	-93.162
None	477	28.77	639130	83.99	0.343*	-915.482

The CU Attachment display above tends to indicate the causal vehicle use. For the Subset Frequencies, the causal vehicle would, except in rare cases, have the vehicle defect. The above comparison is Large Trucks with Defects Crashes (LTDC) against both large trucks without defects and all other vehicle types whether they had defects or not (Non-LTDC). As an example, Log Trailers (third attachment listed) had 6.03% of the LTDC crashes, but only 0.14% of all of the other vehicle crashes (Non-LTDC), creating an extremely large odds ratio (41.878). The Max Gain of 97.612 crashes represents the number that could be reduced if the over-representation was eliminated (i.e., the Odds Ratio somehow was forced to be 1; reducing the 6.03% to its expected value of 0.14%.

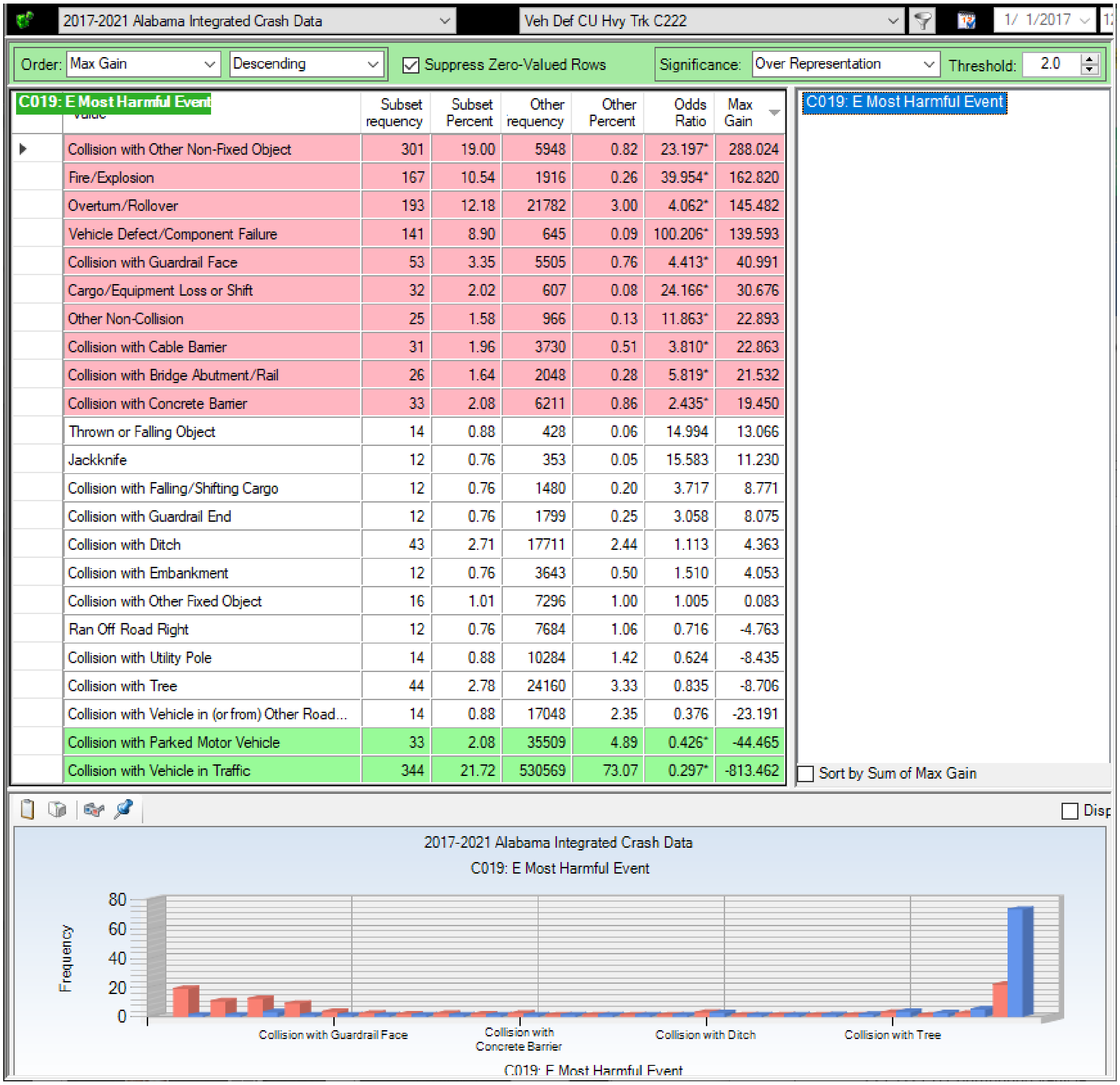
2.4 C052 Number of Vehicles

Single vehicle crashes are over-represented, in the Large Truck Defect Crashes (LTDCs) as are all multi-vehicle crashes with three or more vehicles. Two-vehicle crashes are under-represented with 0.633 of the proportion that occurs in Non-LTDCs. The Odds Ratio indicates that single vehicle crashes occur over twice (2.138) their expected proportion. These results are quite similar to those for passenger cars (Section 3.3).



C052: Number of Vehicles Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	762	45.96	163612	21.50	2.138*	405.536
2 Vehicles	766	46.20	555281	72.97	0.633*	-443.799
3 Vehicles	94	5.67	36145	4.75	1.194	15.250
4 Vehicles	18	1.09	4879	0.64	1.693	7.370
5 Vehicles	12	0.72	813	0.11	6.775	10.229
6 Vehicles	3	0.18	183	0.02	7.524	2.601
7 Vehicles	1	0.06	51	0.01	9.000	0.889
10 Vehicles	1	0.06	3	0.00	152.995	0.993
11 Vehicles	1	0.06	0	0.00	0.000	1.000

2.5 C019 Most Harmful Event

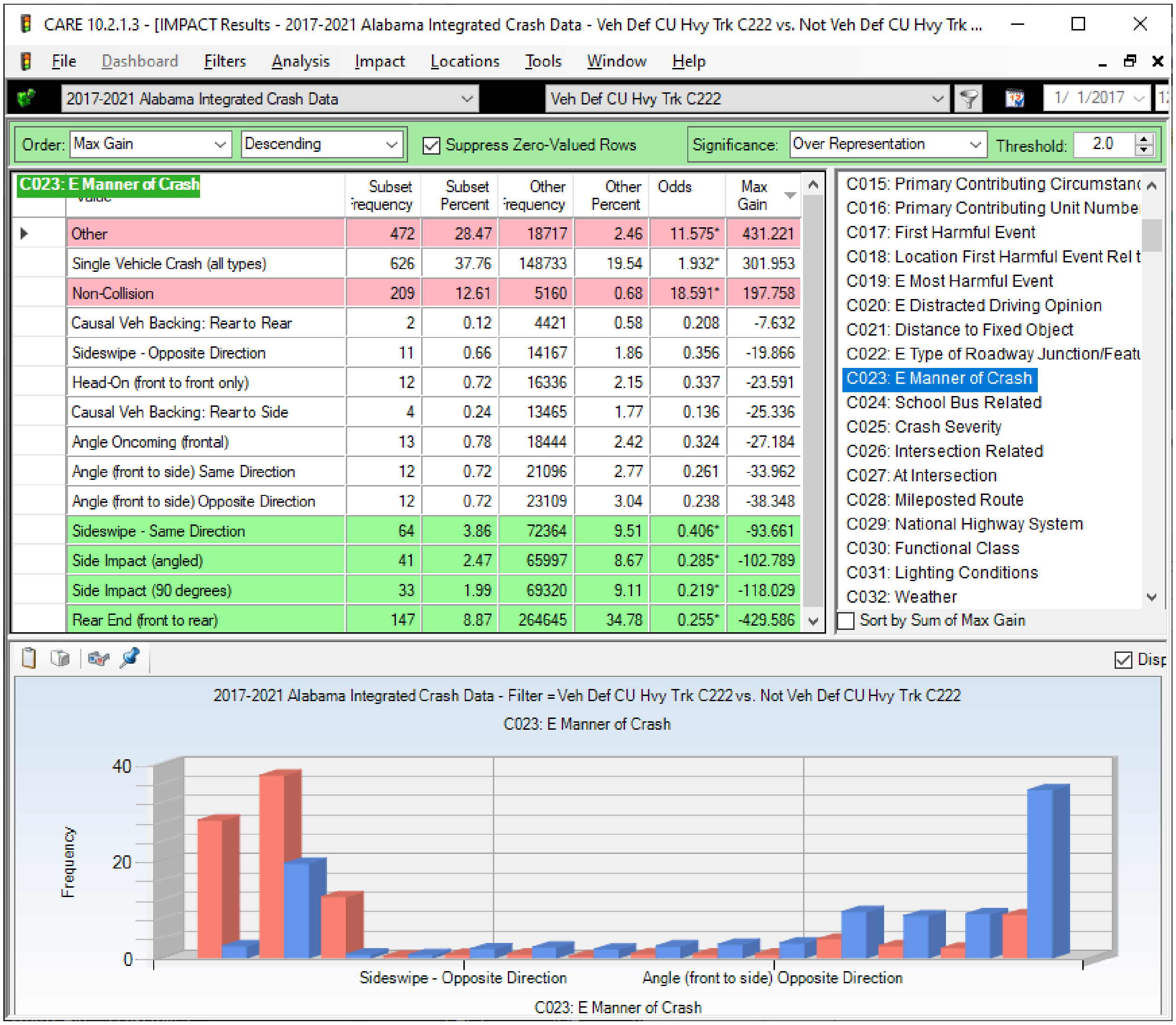


C019: E Most Harmful Event	Subset requency	Subset Percent	Other requency	Other Percent	Odds Ratio	Max Gain
Collision with Other Non-Fixed Object	301	19.00	5948	0.82	23.197*	288.024
Fire/Explosion	167	10.54	1916	0.26	39.954*	162.820
Overturn/Rollover	193	12.18	21782	3.00	4.062*	145.482
Vehicle Defect/Component Failure	141	8.90	645	0.09	100.206*	139.593
Collision with Guardrail Face	53	3.35	5505	0.76	4.413*	40.991
Cargo/Equipment Loss or Shift	32	2.02	607	0.08	24.166*	30.676
Other Non-Collision	25	1.58	966	0.13	11.863*	22.893
Collision with Cable Barrier	31	1.96	3730	0.51	3.810*	22.863
Collision with Bridge Abutment/Rail	26	1.64	2048	0.28	5.819*	21.532
Collision with Concrete Barrier	33	2.08	6211	0.86	2.435*	19.450
Thrown or Falling Object	14	0.88	428	0.06	14.994	13.066
Jackknife	12	0.76	353	0.05	15.583	11.230
Collision with Falling/Shifting Cargo	12	0.76	1480	0.20	3.717	8.771
Collision with Guardrail End	12	0.76	1799	0.25	3.058	8.075
Collision with Ditch	43	2.71	17711	2.44	1.113	4.363
Collision with Embankment	12	0.76	3643	0.50	1.510	4.053
Collision with Other Fixed Object	16	1.01	7296	1.00	1.005	0.083
Ran Off Road Right	12	0.76	7684	1.06	0.716	-4.763
Collision with Utility Pole	14	0.88	10284	1.42	0.624	-8.435
Collision with Tree	44	2.78	24160	3.33	0.835	-8.706
Collision with Vehicle in (or from) Other Road...	14	0.88	17048	2.35	0.376	-23.191
Collision with Parked Motor Vehicle	33	2.08	35509	4.89	0.426*	-44.465
Collision with Vehicle in Traffic	344	21.72	530569	73.07	0.297*	-813.462

The display above was trimmed to exclude all events that had less than ten occurrences. Red in the tabular background portion of the output indicates that that the Harmful Event had an over-representation for LTDCs of at least twice its expectation (odds ratio > 2) when compared to crashes for that harmful event that were Non-LTDC. Green in the background indicate an under-representation of 0.500 or less. Clearly there are many Most Harmful Events whose probabilities of occurrence are greatly increased by vehicle defects.

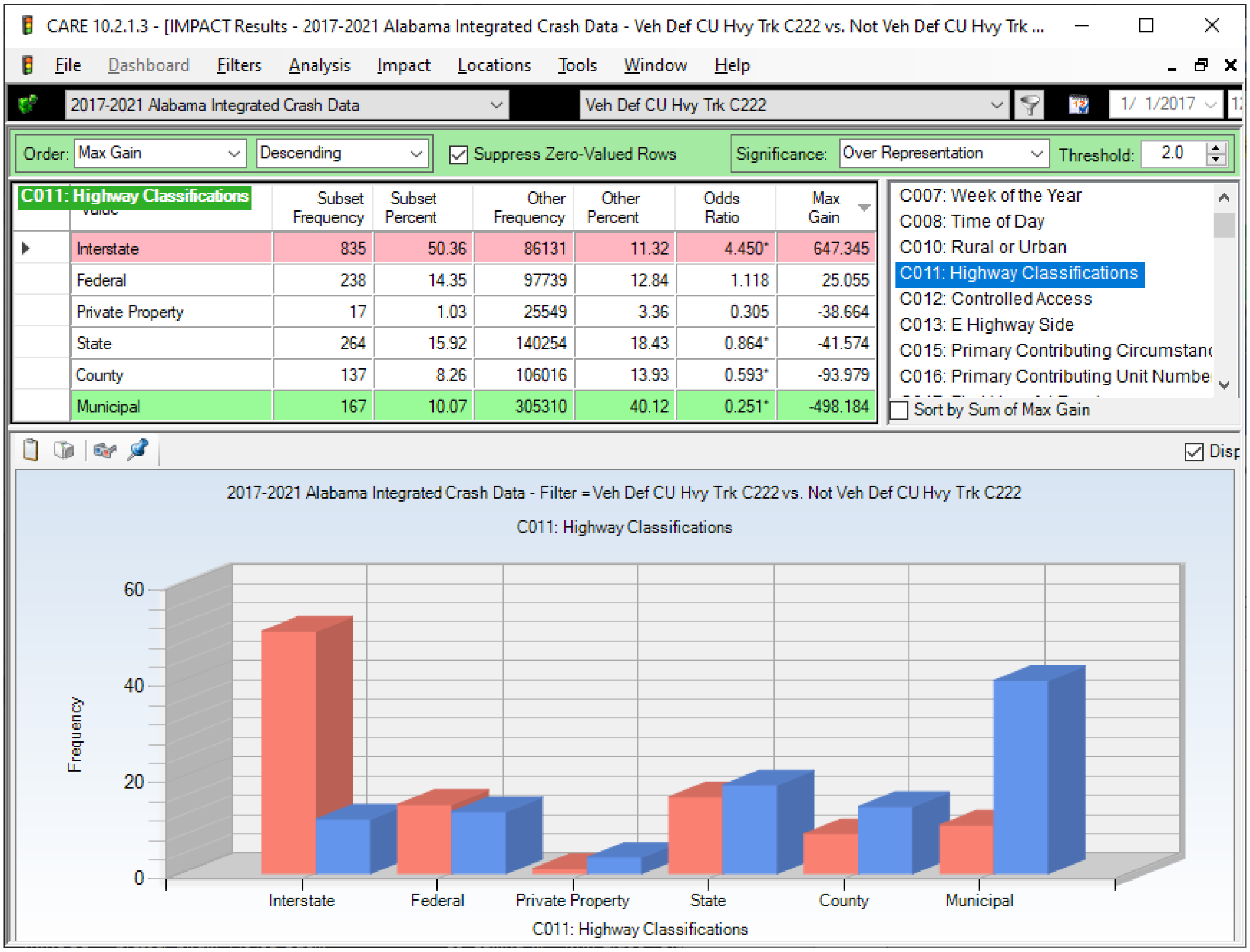
2.6 C023 Manner of Crash

For two-vehicle crashes, this gives an idea of how the two vehicles came together. But note that a large plurality of crashes (37.76%) were single vehicle, much higher than the 19.54 expected compared to the Non-LTDC crashes. The same over-representation of LTDCs holds for the Non-Collision category. An example of Non-Collision might be where a defective tire caused a vehicle to run off the road and the incident was reported even though no collision with another vehicle or other obstacle resulted.



C023: E Manner of Crash	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain
Other	472	28.47	18717	2.46	11.575*	431.221
Single Vehicle Crash (all types)	626	37.76	148733	19.54	1.932*	301.953
Non-Collision	209	12.61	5160	0.68	18.591*	197.758
Causal Veh Backing: Rear to Rear	2	0.12	4421	0.58	0.208	-7.632
Sideswipe - Opposite Direction	11	0.66	14167	1.86	0.356	-19.866
Head-On (front to front only)	12	0.72	16336	2.15	0.337	-23.591
Causal Veh Backing: Rear to Side	4	0.24	13465	1.77	0.136	-25.336
Angle Oncoming (frontal)	13	0.78	18444	2.42	0.324	-27.184
Angle (front to side) Same Direction	12	0.72	21096	2.77	0.261	-33.962
Angle (front to side) Opposite Direction	12	0.72	23109	3.04	0.238	-38.348
Sideswipe - Same Direction	64	3.86	72364	9.51	0.406*	-93.661
Side Impact (angled)	41	2.47	65997	8.67	0.285*	-102.789
Side Impact (90 degrees)	33	1.99	69320	9.11	0.219*	-118.029
Rear End (front to rear)	147	8.87	264645	34.78	0.255*	-429.586

2.7 C011 Highway Classification and Speeds



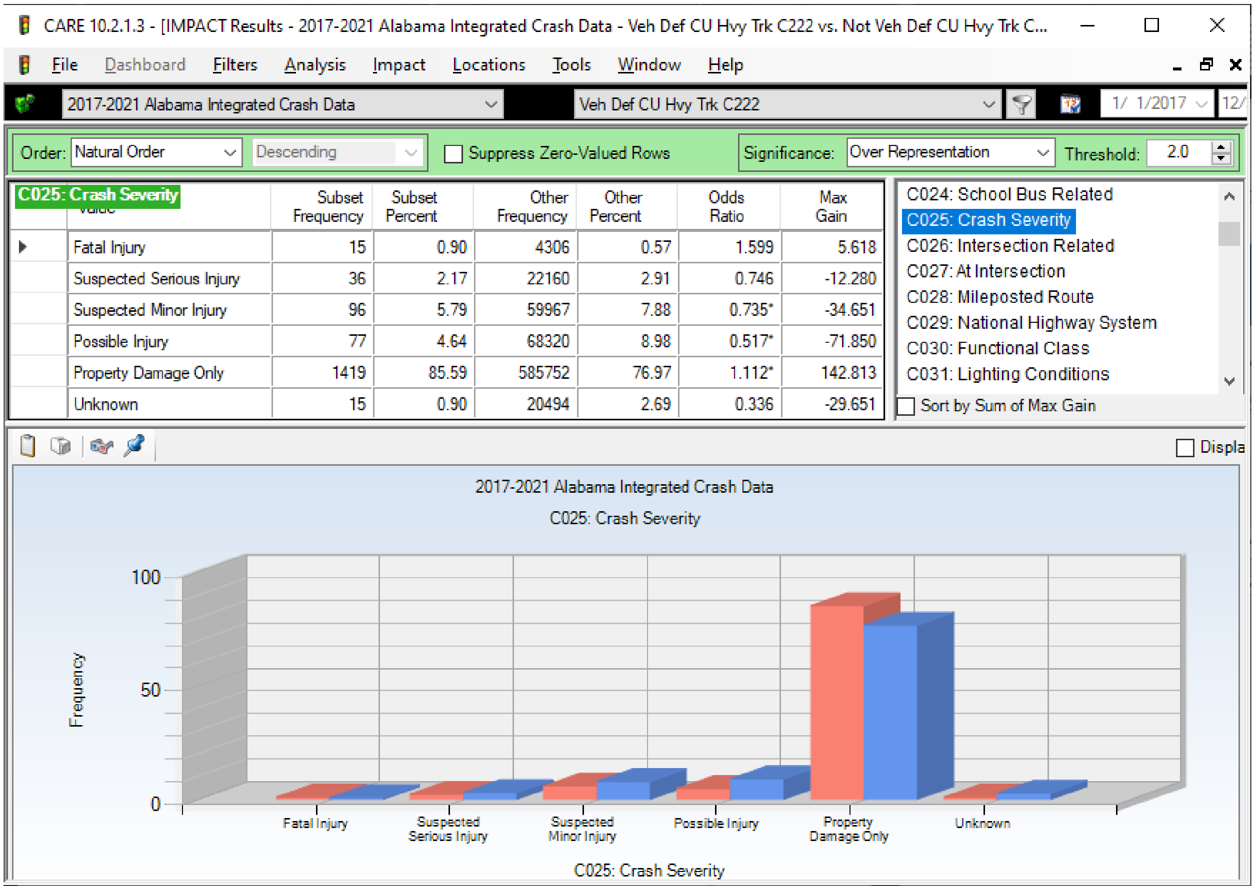
All other things being equal, it is expected that each Highway Classification will have the same proportion of LTDC crashes as the defective vehicle-miles traveled on it over the course of the study. In this case, Interstates probably have over twice the traffic of vehicle-miles (in this case by large trucks) that might have vehicle defects. So the over-representation on Interstate highways is reasonable. Also, tire blowouts tend to occur at higher speeds, which would favor Federal and State routes over County and Municipal. Note the speeds of blowouts shown in the following cross-tabulation of impact speeds by vehicle defect.

2.8 Cross-tab of C224 Impact Speeds by C222 Defect Type for LTDC Vehicles

	31 to 35 MPH	36 to 40 MPH	41 to 45 MPH	46 to 50 MPH	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH
Brakes	16	17	45	17	30	15	30	18	0
Steering	4	4	12	4	11	6	9	11	0
E Tire Blowout/Separation	4	5	21	30	59	72	218	212	10
E Improper Tread Depth	0	0	1	2	4	3	0	2	0
Wheels	1	5	13	6	16	7	14	17	0
E Wipers	0	0	0	0	0	0	0	0	0
Windows/Windshield	0	0	0	3	0	0	1	0	0
E Mirrors	0	0	0	1	1	0	0	0	0
Trailer Hitch/Coupling	3	2	4	9	2	1	2	5	0
Power Train	4	6	5	3	12	7	10	29	0
Fuel System	0	0	0	0	0	4	2	2	0
Exhaust	0	0	0	0	1	0	0	0	0
E Headlights	0	0	2	1	1	0	0	0	0
E Tail Lights	1	1	1	0	1	0	1	0	0
Turn Signal	0	0	0	0	1	0	0	0	0
Suspension	0	0	0	0	6	0	2	0	1
E Cruise Control	0	0	0	0	0	0	1	0	0
E Body/Doors	0	0	1	0	3	0	1	3	0
TOTAL	33	40	105	76	148	115	291	299	11

Tires blow out more frequently at the higher speeds, since this puts additional stress on tires. Brakes and Steering tend to go out at any speed, since they are more evenly distributed across the impact speed range.

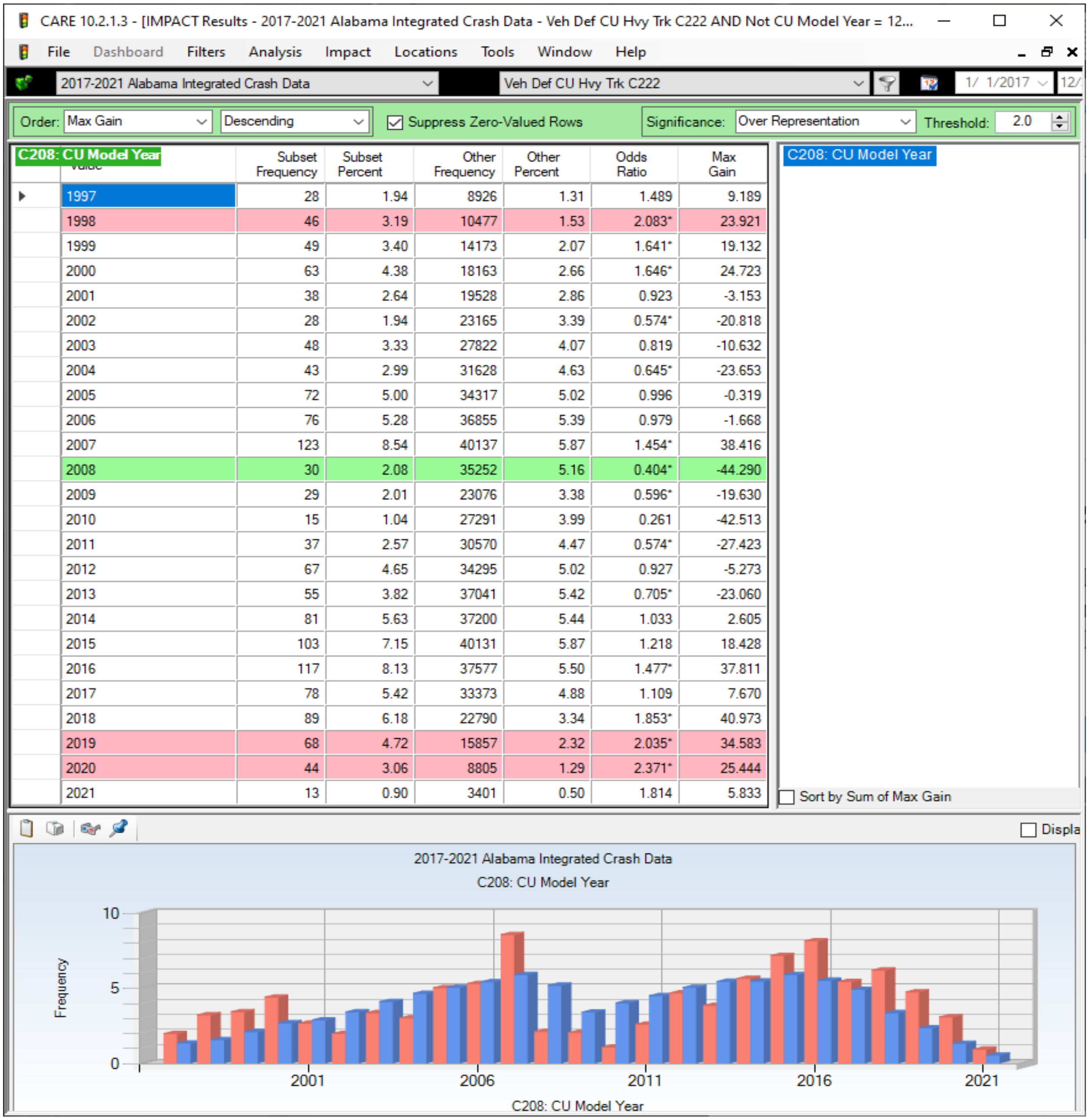
2.9 C025 Crash Severity



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	15	0.90	4306	0.57	1.599	5.618
Suspected Serious Injury	36	2.17	22160	2.91	0.746	-12.280
Suspected Minor Injury	96	5.79	59967	7.88	0.735*	-34.651
Possible Injury	77	4.64	68320	8.98	0.517*	-71.850
Property Damage Only	1419	85.59	585752	76.97	1.112*	142.813
Unknown	15	0.90	20494	2.69	0.336	-29.651

Crashes involving large trucks that were caused by vehicle defects have a larger proportion of fatal crashes (0.90% for LTDCs as opposed to 0.57 for all other vehicle crashes). No definitive conclusions can be drawn, however, with such a small sample (15 fatal crashes). The other three injury classifications are under-represented, and PDO crashes are significantly over-represented. It is possible that in many cases drivers can sense when there is a vehicle defect, and they slow down or stop to address the problem. Even if they only reduce speed in anticipation of a potential problem, this can dramatically lower the severity of the crash or chances of a fatality. Other studies have shown that the probability of a fatality is approximately cut in half for every 10 MPH reduction in the impact speed.

2.10 C208 CU Model Year



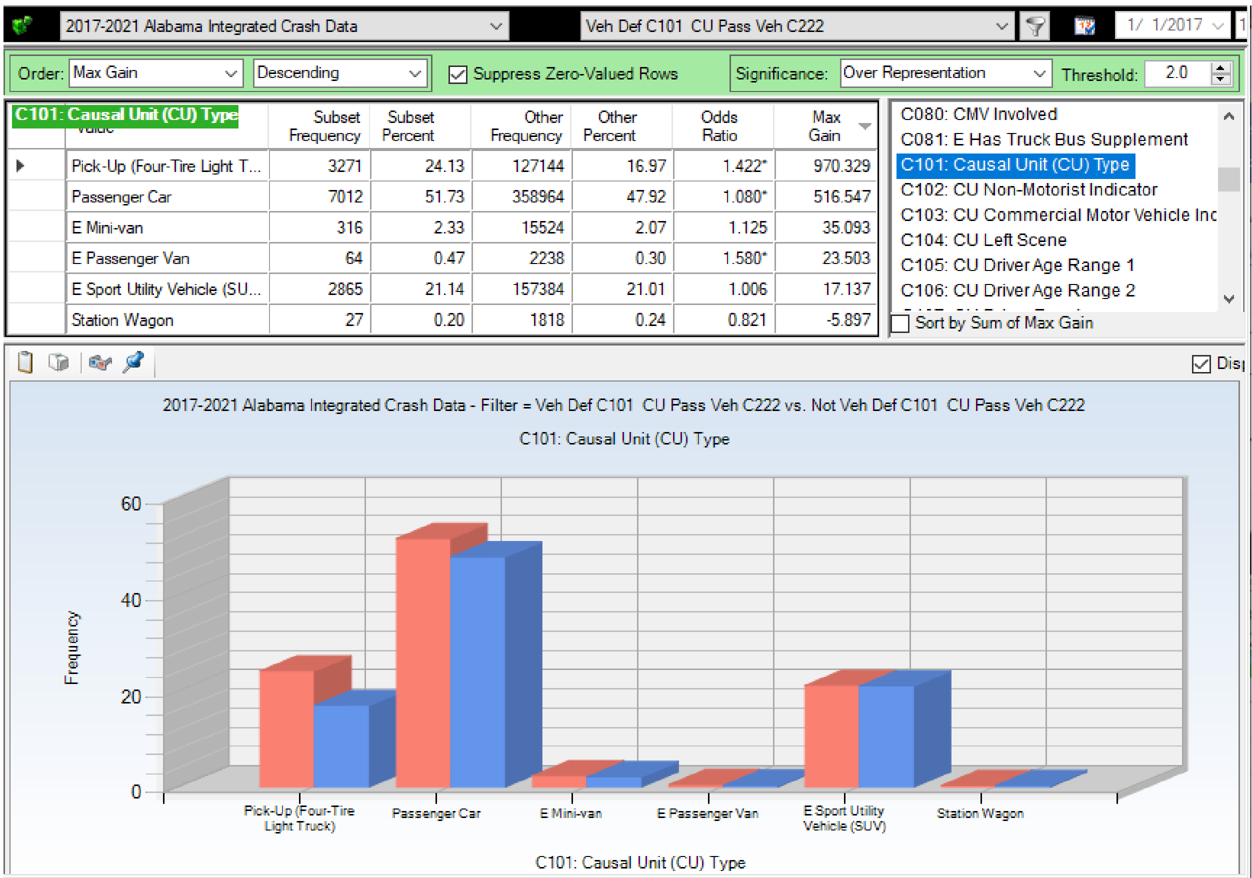
C208: CU Model Year	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1997	28	1.94	8926	1.31	1.489	9.189
1998	46	3.19	10477	1.53	2.083*	23.921
1999	49	3.40	14173	2.07	1.641*	19.132
2000	63	4.38	18163	2.66	1.646*	24.723
2001	38	2.64	19528	2.86	0.923	-3.153
2002	28	1.94	23165	3.39	0.574*	-20.818
2003	48	3.33	27822	4.07	0.819	-10.632
2004	43	2.99	31628	4.63	0.645*	-23.653
2005	72	5.00	34317	5.02	0.996	-0.319
2006	76	5.28	36855	5.39	0.979	-1.668
2007	123	8.54	40137	5.87	1.454*	38.416
2008	30	2.08	35252	5.16	0.404*	-44.290
2009	29	2.01	23076	3.38	0.596*	-19.630
2010	15	1.04	27291	3.99	0.261	-42.513
2011	37	2.57	30570	4.47	0.574*	-27.423
2012	67	4.65	34295	5.02	0.927	-5.273
2013	55	3.82	37041	5.42	0.705*	-23.060
2014	81	5.63	37200	5.44	1.033	2.605
2015	103	7.15	40131	5.87	1.218	18.428
2016	117	8.13	37577	5.50	1.477*	37.811
2017	78	5.42	33373	4.88	1.109	7.670
2018	89	6.18	22790	3.34	1.853*	40.973
2019	68	4.72	15857	2.32	2.035*	34.583
2020	44	3.06	8805	1.29	2.371*	25.444
2021	13	0.90	3401	0.50	1.814	5.833

The age of the vehicle would definitely impact its chances for its containing defective components. The model years begin to be significantly over-represented in 1998, and this continues through 2000, after which they generally become under-represented up until 2016. From that model year and above there seems to be more vehicle defect crashes than would be expected from a comparison with the Non-LTDC subset.

3.0 Passenger Vehicle Analysis

3.1 C101 Causal Unit (CU) for Passenger Vehicles Involved

The filter used to perform this study required that a passenger vehicle under consideration in the Subset Frequency list was the Causal Unit. Large trucks were not excluded from consideration in the control group, but unlike the analysis above, there was no requirement for the presence of a large truck in the crashes being considered in the Subset. See the Introduction (Section 1.0) above for a formal definition of the particular vehicle types that had to be involved to qualify for these analyses. Note that the Display Filter Name will be turned on for all IMPACT analyses that are not pruned. Pruning is made obvious when all of the Cxxx attributes except the particular one selected appear in the attribute choice list (column to the extreme right of the display).



As is true of most of the IMPACT analyses, the above display is listed out in order of Max Gain. While pick-up trucks have the highest Max Gain, Passenger Cars have over twice the frequency. Despite their over-representation, Pick-ups account for less than a quarter (24.13%) of the LTDC crashes. The combination of pick-ups and passenger cars adds up to over 10,000 crashes (about 75%), and most of the rest are Sport Utility Vehicles (SUV).

3.2 C222 CU Contributing Vehicle Defect

Per-vehicle-type defect analyses are easily obtainable by a cross-tabulation of C101 by C222. The following is the example for passenger vehicles and vehicle defects. It is interesting that some cells with only one crash are still higher in proportion than the summary value, and thus have a red background. It is clear that brakes and the two tire defects produce the largest numbers. We will see below that tire problems eclipse the braking issues when it comes to causing fatalities.

CARE 10.2.1.3 - [Crosstab Results - 2017-2021 Alabama Integrated Crash Data - Filter = Veh Def C101 CU Pass Veh C222]

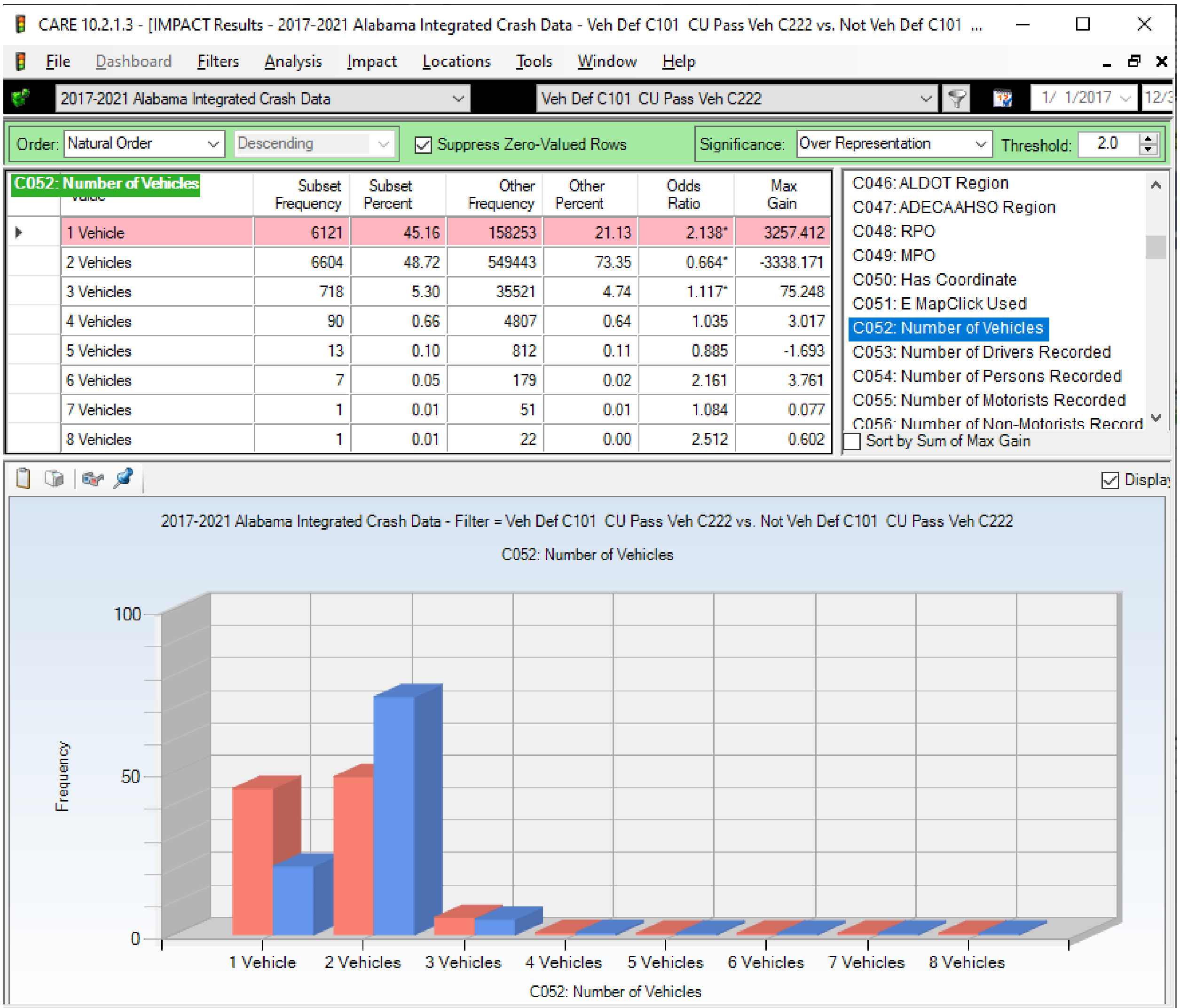
2017-2021 Alabama Integrated Crash Data | Veh Def C101 CU Pass Veh C222

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Causal Unit (CU) Type ; Row: CU Contributing Vehicle Defect

	Passenger Car	Station Wagon	Pick-Up (Four-Tire Light Truck)	E Sport Utility Vehicle (SUV)	E Mini-van	E Passenger Van	TOTAL
Brakes	3226 54.76%	11 0.19%	1248 21.18%	1206 20.47%	180 3.06%	20 0.34%	5891 43.46%
Steering	602 54.63%	2 0.18%	254 23.05%	214 19.42%	25 2.27%	5 0.45%	1102 8.13%
E Tire Blowout/Separatio	1332 49.89%	5 0.19%	640 23.97%	608 22.77%	65 2.43%	20 0.75%	2670 19.70%
E Improper Tread Depth	907 56.41%	5 0.31%	315 19.59%	365 22.70%	12 0.75%	4 0.25%	1608 11.86%
Wheels	344 45.38%	2 0.26%	243 32.06%	158 20.84%	9 1.19%	2 0.26%	758 5.59%
E Wipers	32 49.23%	0 0.00%	15 23.08%	16 24.62%	1 1.54%	1 1.54%	65 0.48%
Windows/Windshi eld	50 49.50%	0 0.00%	27 26.73%	21 20.79%	2 1.98%	1 0.99%	101 0.75%
E Mirrors	25 53.19%	0 0.00%	13 27.66%	8 17.02%	1 2.13%	0 0.00%	47 0.35%
Trailer Hitch/Coupling	11 4.60%	0 0.00%	182 76.15%	42 17.57%	1 0.42%	3 1.26%	239 1.76%
Power Train	201 48.20%	2 0.48%	104 24.94%	104 24.94%	4 0.96%	2 0.48%	417 3.08%
Fuel System	51 42.50%	0 0.00%	46 38.33%	20 16.67%	1 0.83%	2 1.67%	120 0.89%
Exhaust	6 50.00%	0 0.00%	3 25.00%	2 16.67%	1 8.33%	0 0.00%	12 0.09%
E Headlights	70 60.87%	0 0.00%	14 12.17%	26 22.61%	4 3.48%	1 0.87%	115 0.85%
E Tail Lights	12 11.54%	0 0.00%	72 69.23%	16 15.38%	3 2.88%	1 0.96%	104 0.77%
Turn Signal	11 20.37%	0 0.00%	32 59.26%	8 14.81%	2 3.70%	1 1.85%	54 0.40%
Suspension	85 48.85%	0 0.00%	45 25.86%	42 24.14%	2 1.15%	0 0.00%	174 1.28%
E Cruise Control	5 55.56%	0 0.00%	1 11.11%	0 0.00%	2 22.22%	1 11.11%	9 0.07%
E Body/Doors	42 60.87%	0 0.00%	17 24.64%	9 13.04%	1 1.45%	0 0.00%	69 0.51%
TOTAL	7012 51.73%	27 0.20%	3271 24.13%	2865 21.14%	316 2.33%	64 0.47%	13555 100.00%

3.3 C052 Number of Vehicles

This attribute plays a large role in many of those discussed below. Single vehicle crashes are over-represented, as are all multi-vehicle crashes with three or more vehicles, except that of five vehicles. Two-vehicle crashes are under-represented with 0.664 of the proportion that occurs in non-vehicle-defect crashes. The Odds Ratio indicates that single vehicle crashes occur over twice their expected proportion.



C052: Number of Vehicles	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	6121	45.16	158253	21.13	2.138*	3257.412
2 Vehicles	6604	48.72	549443	73.35	0.664*	-3338.171
3 Vehicles	718	5.30	35521	4.74	1.117*	75.248
4 Vehicles	90	0.66	4807	0.64	1.035	3.017
5 Vehicles	13	0.10	812	0.11	0.885	-1.693
6 Vehicles	7	0.05	179	0.02	2.161	3.761
7 Vehicles	1	0.01	51	0.01	1.084	0.077
8 Vehicles	1	0.01	22	0.00	2.512	0.602

3.4 C019 Most Harmful Event

What types of crashes are caused by these vehicle defects? The next two pages contain the cross-tabulation for the most harmful events for each of the passenger vehicle types.

2017-2021 Alabama Integrated Crash Data | Veh Def C101 CU Pass Veh C222 | 1/ 1/2017

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Causal Unit (CU) Type ; Row: E Most Harmful Event

	Passenger Car	Station Wagon	Pick-Up (Four-Tire Light Truck)	E Sport Utility Vehicle (SUV)	E Mini-van	E Passenger Van	TOTAL
Ran Off Road Right	199	2	49	51	7	0	308
Ran Off Road Straight	22	0	7	8	2	0	39
Ran Off Road Left	88	0	26	35	6	0	155
Evasive Action (Swerve/Brake)	17	0	10	8	3	0	38
Downhill Runaway	4	0	3	2	0	0	9
Cargo/Equipment Loss or Shift	7	0	22	8	1	0	38
Vehicle Defect/Componen	165	1	122	72	6	1	367
Separation of Units	1	0	12	3	0	0	16
Overturn/Rollover	251	1	245	291	11	9	808
Jackknife	0	0	13	7	0	1	21
Fire/Explosion	85	1	50	52	5	3	196
Immersion	0	0	2	2	1	0	5
Non-Contact Vehicle	5	0	4	2	0	0	11
Fell/Jumped from Motor Vehicle	3	0	2	1	0	0	6
Thrown or Falling Object	10	0	11	2	0	0	23
Other Non-Collision	29	0	23	18	0	2	72
Collision with Non-Motorist: Pedestri	12	0	3	1	4	0	20
Collision with Non-Motorist: Pedalcy	3	0	0	2	0	0	5
Collision with Vehicle in Traffic	3245	13	1458	1233	164	29	6142
Collision with Vehicle in (or from	104	0	43	33	4	1	185
Collision with Parked Motor Veh	250	1	101	85	13	1	451
Collision with Railway Vehicle/T	3	0	1	0	1	0	5
Collision with Animal: Deer	9	0	1	2	0	0	12
Collision with Animal: Farm/Ran	1	0	1	0	1	0	3
Collision with Animal: Other	1	0	0	1	0	0	2
Collision with Falling/Shifting Ca	3	0	15	6	0	1	25
Collision with Work Zone/Maint	2	0	1	1	0	0	4
Collision with Other Non-Fixed	59	0	118	58	1	4	240
Collision with Bridge Abutment/	71	0	19	25	3	0	118

3.4 C019 Most Harmful Event (continued)

CARE 10.2.1.3 - [Crosstab Results - 2017-2021 Alabama Integrated Crash Data - Filter = Veh Def C101 CU Pass Veh C222]

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

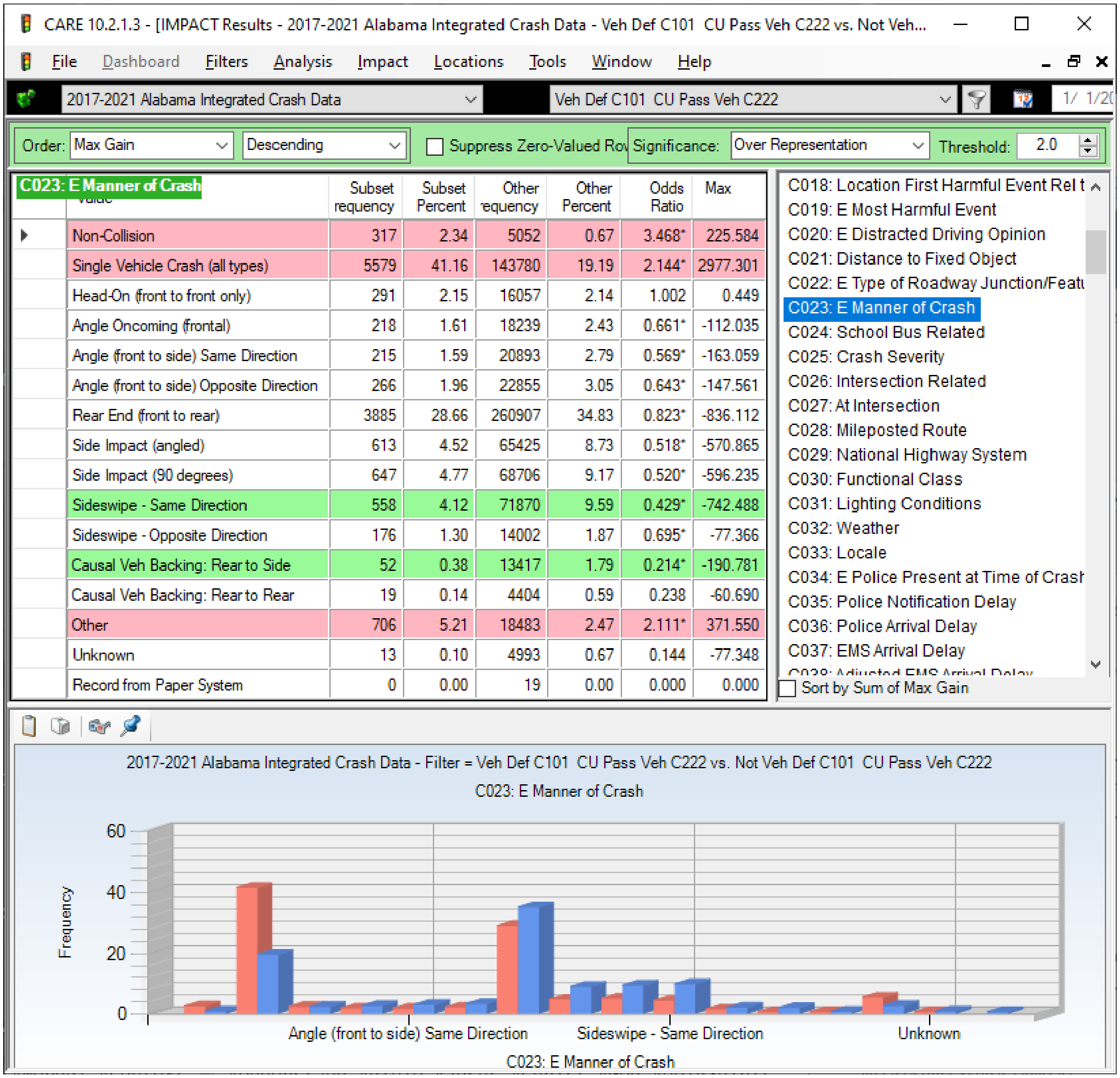
2017-2021 Alabama Integrated Crash Data | Veh Def C101 CU Pass Veh C222 | 1/ 1/2017

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Causal Unit (CU) Type ; Row: E Most Harmful Event

	Passenger Car	Station Wagon	Pick-Up (Four-Tire Light Truck)	E Sport Utility Vehicle (SUV)	E Mini-van	E Passenger Van	TOTAL
Collision with Bridge Support/C	6	0	3	3	1	0	13
Collision with Overhead Object/	6	0	1	9	1	0	17
Collision with Culvert Headwall	42	0	16	24	0	0	82
Collision with Ditch	391	1	134	125	15	2	668
Collision with Embankment	90	0	40	33	2	1	166
Collision with Curb/Island/Raise	76	1	5	14	2	0	98
Collision with Guardrail Face	192	0	57	67	10	2	328
Collision with Guardrail End	58	0	26	20	1	0	105
Collision with Concrete Barrier	230	0	74	95	6	1	406
Collision with Cable Barrier	155	1	42	53	7	1	259
Collision with Other Traffic Barri	4	0	1	1	0	0	6
Collision with Tree	408	2	242	147	15	3	817
Collision with Utility Pole	191	0	79	77	6	0	353
Collision with Light Pole (Break	24	0	11	8	3	0	46
Collision with Light Pole (Non-B	25	0	7	8	1	1	42
Collision with Traffic Signal Pole	5	0	5	1	0	0	11
Collision with Sign Post	88	0	25	29	4	1	147
Collision with Other Post/Pole/S	24	0	14	12	1	0	51
Collision with Fence	95	2	27	40	2	0	166
Collision with Mailbox	53	0	12	17	1	0	83
Collision with Impact Attenuator	1	0	1	1	0	0	3
Collision with Other Fixed Objec	165	1	58	56	4	0	284
Crossed Centerline	8	0	5	2	0	0	15
Crossed Median	1	0	1	0	0	0	2
Re-entering Roadway	3	0	0	1	0	0	4
Other	22	0	23	13	1	0	59
TOTAL	7012	27	3271	2865	316	64	13555

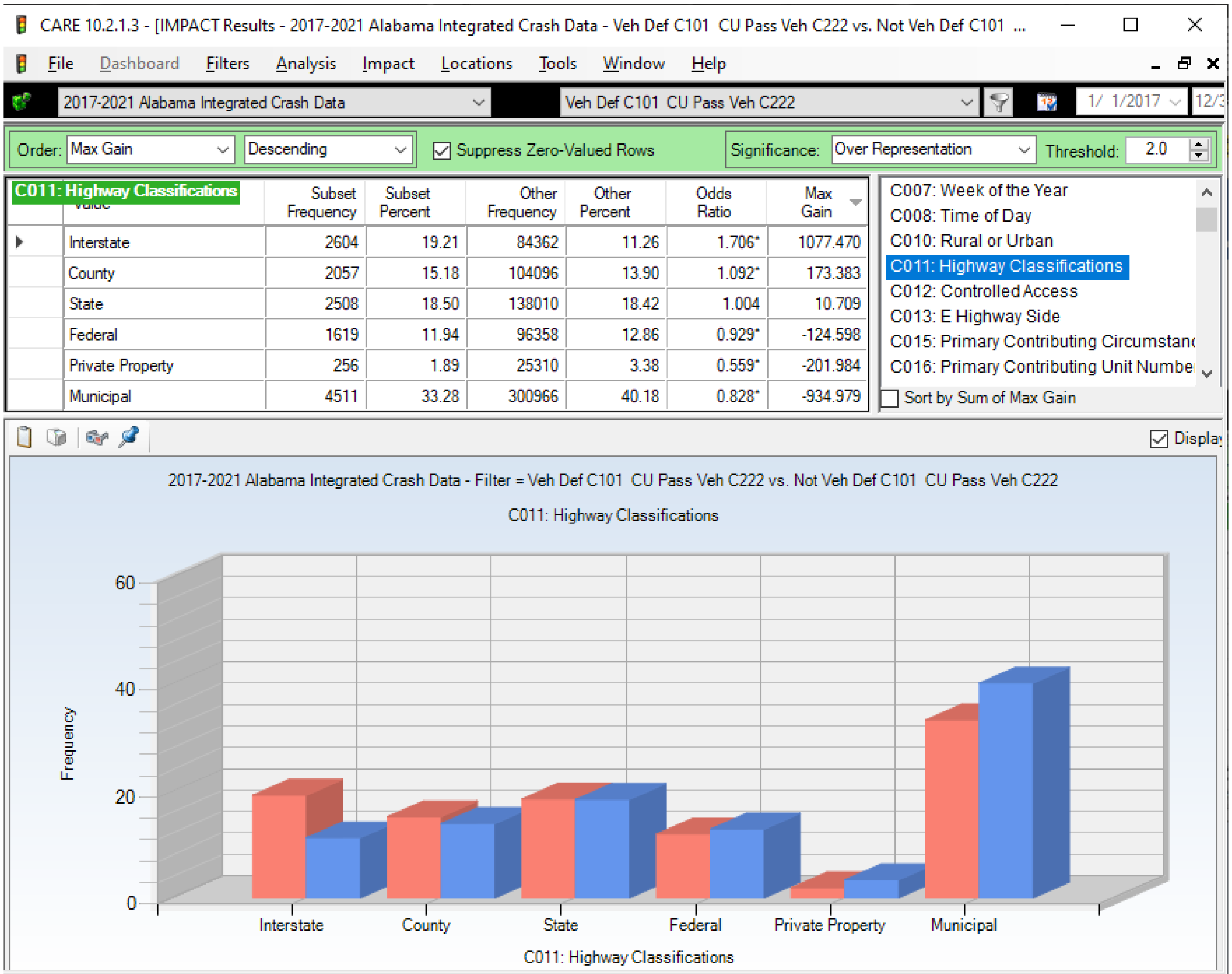
3.5 C023 Manner of Crash

The following presents a summary of the Manner of Crash for passenger car vehicle defect crashes. It gives insight especially into those crashes that did not involve just a single vehicle. The top three in the table below are over-represented, but Head-On (front to front only) has almost identical proportions (2.15% and 2.14%) for the vehicle defects and the control group. All of the other items are under-represented, meaning that the control subset (crashes not involving vehicle defects) have proportions that are greater than those of defective vehicles.



C023: E Manner of Crash	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Non-Collision	317	2.34	5052	0.67	3.468*	225.584
Single Vehicle Crash (all types)	5579	41.16	143780	19.19	2.144*	2977.301
Head-On (front to front only)	291	2.15	16057	2.14	1.002	0.449
Angle Oncoming (frontal)	218	1.61	18239	2.43	0.661*	-112.035
Angle (front to side) Same Direction	215	1.59	20893	2.79	0.569*	-163.059
Angle (front to side) Opposite Direction	266	1.96	22855	3.05	0.643*	-147.561
Rear End (front to rear)	3885	28.66	260907	34.83	0.823*	-836.112
Side Impact (angled)	613	4.52	65425	8.73	0.518*	-570.865
Side Impact (90 degrees)	647	4.77	68706	9.17	0.520*	-596.235
Sideswipe - Same Direction	558	4.12	71870	9.59	0.429*	-742.488
Sideswipe - Opposite Direction	176	1.30	14002	1.87	0.695*	-77.366
Causal Veh Backing: Rear to Side	52	0.38	13417	1.79	0.214*	-190.781
Causal Veh Backing: Rear to Rear	19	0.14	4404	0.59	0.238	-60.690
Other	706	5.21	18483	2.47	2.111*	371.550
Unknown	13	0.10	4993	0.67	0.144	-77.348
Record from Paper System	0	0.00	19	0.00	0.000	0.000

3.6 C011 Highway Classifications



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Interstate	2604	19.21	84362	11.26	1.706*	1077.470
County	2057	15.18	104096	13.90	1.092*	173.383
State	2508	18.50	138010	18.42	1.004	10.709
Federal	1619	11.94	96358	12.86	0.929*	-124.598
Private Property	256	1.89	25310	3.38	0.559*	-201.984
Municipal	4511	33.28	300966	40.18	0.828*	-934.979

All other things being equal, it is expected that each Highway Classification will have the same proportion of defective vehicle crashes as the defective vehicles traveling on it over the course of the study. This distribution varies sharply from that of large trucks, especially in the Municipal road category. While Interstate highways still show close to twice (1.706) the expected proportion, the proportion of total vehicle defect crashes in Interstate highways is 19.21% for passenger cars, while it was over twice that at 50.36% for large trucks. See the cross-tabulation below for one potential cause of tire problems.

3.7 C222 Vehicle Defects by C224 Impact Speed

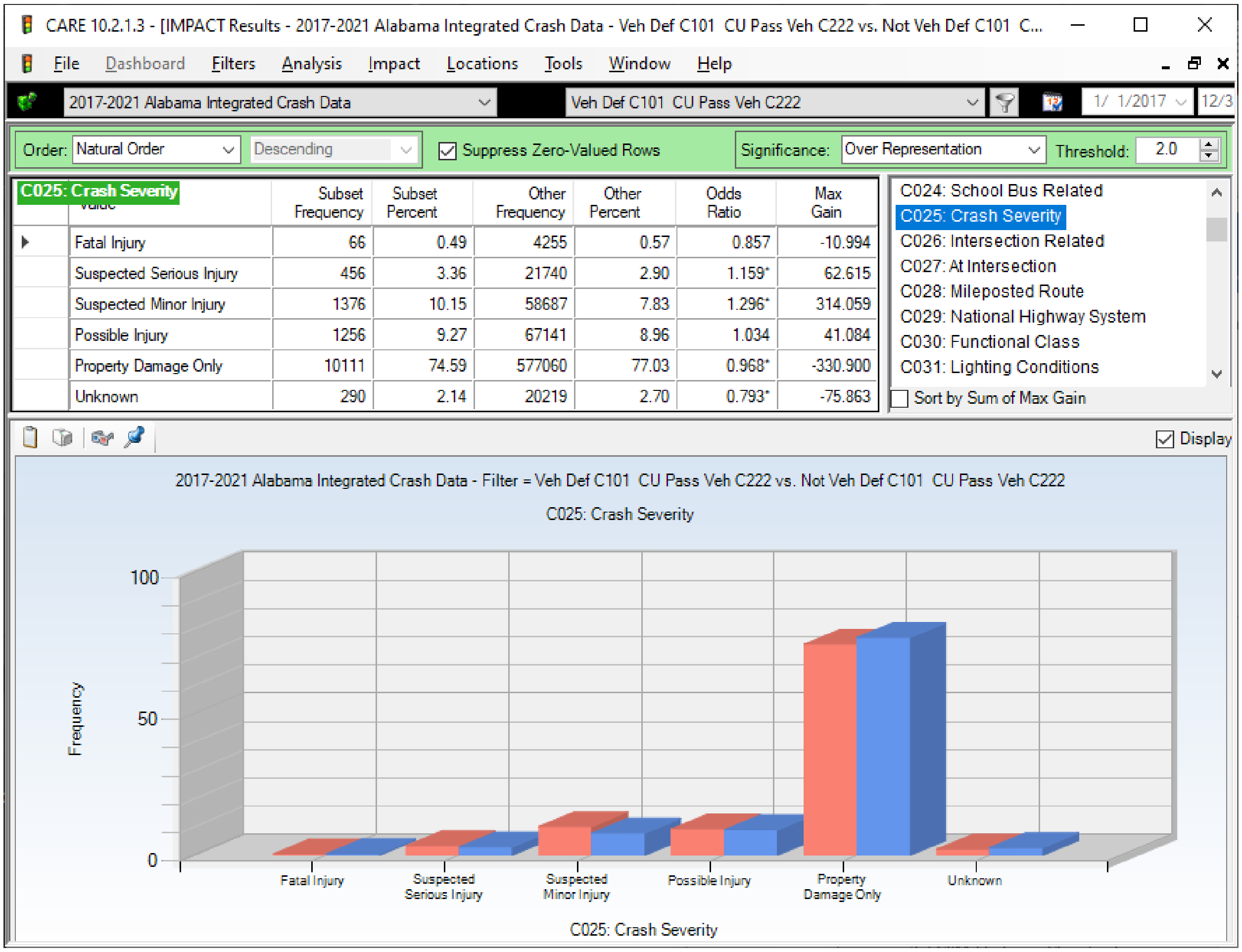
Tire blowouts and tread depth issues tend to occur at higher speeds, as shown in the following cross-tabulation of impact speeds by vehicle defect. This accounts for their increased occurrence on higher-speed roadways (e.g., Interstates). It also accounts for their increased severity, which is covered in the next section.

CARE 10.2.1.3 - [Crosstab Results - 2017-2021 Alabama Integrated Crash Data - Filter = Veh Def C101 CU Pass Veh C222]

Column: CU Estimated Speed at Impact ; Row: CU Contributing Vehicle Defect

	36 to 40 MPH	41 to 45 MPH	46 to 50 MPH	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH	76 to 80 MPH
Brakes	321	351	152	145	62	47	43	15	7
Steering	47	130	57	91	35	38	50	16	7
E Tire Blowout/Separatio	91	195	129	213	150	252	536	102	45
E Improper Tread Depth	91	159	106	217	143	154	136	33	25
Wheels	40	75	43	75	37	39	54	5	3
E Wipers	5	7	0	5	0	1	0	0	1
Windows/Windshield	1	6	2	3	0	5	4	0	0
E Mirrors	4	1	1	5	0	1	0	0	0
Trailer Hitch/Coupling	14	28	9	20	18	8	15	1	0
Power Train	9	29	11	23	14	12	43	3	0
Fuel System	8	6	4	10	3	3	9	0	0
Exhaust	0	1	0	1	1	0	1	1	0
E Headlights	9	13	5	11	1	5	3	0	0
E Tail Lights	1	2	4	3	1	2	1	0	1
Turn Signal	1	1	1	0	1	0	0	0	0
Suspension	10	14	12	22	7	10	13	2	0
E Cruise Control	1	0	0	3	0	0	1	0	0
E Body/Doors	2	1	2	3	3	5	10	0	0
TOTAL	655	1019	538	850	476	582	919	178	89

3.8 C025 Crash Severity



C025: Crash Severity Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	66	0.49	4255	0.57	0.857	-10.994
Suspected Serious Injury	456	3.36	21740	2.90	1.159*	62.615
Suspected Minor Injury	1376	10.15	58687	7.83	1.296*	314.059
Possible Injury	1256	9.27	67141	8.96	1.034	41.084
Property Damage Only	10111	74.59	577060	77.03	0.968*	-330.900
Unknown	290	2.14	20219	2.70	0.793*	-75.863

The severities of vehicle defect crashes are not nearly as reduced (comparatively speaking) with the passenger car subset as we saw they were with large trucks. The difference in Fatal Injury is not statistically significant, and the increases in both Suspected Serious Injury and Suspected Minor Injury types are significantly higher in proportion than what is expected from the non-vehicle-defect group. To analyze this attribute further, a cross-tabulation was run that analyzed the various severity levels by the vehicle defect type, as given below.

3.9 C222 Vehicle Defects by C025 Crash Severity

CARE 10.2.1.3 - [Crosstab Results - 2017-2021 Alabama Integrated Crash Data - Filter = Veh Def C101 CU Pass Veh C222]

Column: Crash Severity ; Row: CU Contributing Vehicle Defect

	Fatal Injury	Suspected Serious Injury	Suspected Minor Injury	Possible Injury	Property Damage Only	Unknown	TOTAL
Brakes	5 7.58%	107 23.46%	550 39.97%	644 51.27%	4441 43.92%	144 49.66%	5891 43.46%
Steering	1 1.52%	47 10.31%	116 8.43%	94 7.48%	814 8.05%	30 10.34%	1102 8.13%
E Tire Blowout/Separatio	16 24.24%	129 28.29%	291 21.15%	222 17.68%	1967 19.45%	45 15.52%	2670 19.70%
E Improper Tread Depth	40 60.61%	102 22.37%	232 16.86%	145 11.54%	1065 10.53%	24 8.28%	1608 11.86%
Wheels	1 1.52%	24 5.26%	56 4.07%	44 3.50%	621 6.14%	12 4.14%	758 5.59%
E Wipers	0 0.00%	3 0.66%	5 0.36%	5 0.40%	50 0.49%	2 0.69%	65 0.48%
Windows/Windshield	0 0.00%	2 0.44%	7 0.51%	8 0.64%	82 0.81%	2 0.69%	101 0.75%
E Mirrors	0 0.00%	0 0.00%	3 0.22%	5 0.40%	38 0.38%	1 0.34%	47 0.35%
Trailer Hitch/Coupling	0 0.00%	5 1.10%	19 1.38%	11 0.88%	201 1.99%	3 1.03%	239 1.76%
Power Train	0 0.00%	7 1.54%	31 2.25%	26 2.07%	350 3.46%	3 1.03%	417 3.08%
Fuel System	0 0.00%	3 0.66%	7 0.51%	4 0.32%	103 1.02%	3 1.03%	120 0.89%
Exhaust	0 0.00%	0 0.00%	0 0.00%	1 0.08%	11 0.11%	0 0.00%	12 0.09%
E Headlights	0 0.00%	8 1.75%	20 1.45%	15 1.19%	69 0.68%	3 1.03%	115 0.85%
E Tail Lights	1 1.52%	5 1.10%	15 1.09%	9 0.72%	71 0.70%	3 1.03%	104 0.77%
Turn Signal	0 0.00%	2 0.44%	2 0.15%	4 0.32%	42 0.42%	4 1.38%	54 0.40%
Suspension	1 1.52%	9 1.97%	20 1.45%	16 1.27%	124 1.23%	4 1.38%	174 1.28%
E Cruise Control	0 0.00%	1 0.22%	2 0.15%	2 0.16%	3 0.03%	1 0.34%	9 0.07%
E Body/Doors	1 1.52%	2 0.44%	0 0.00%	1 0.08%	59 0.58%	6 2.07%	69 0.51%
TOTAL	66 0.49%	456 3.36%	1376 10.15%	1256 9.27%	10111 74.59%	290 2.14%	13555 100.00%

Clearly tire issues are the major factors for both severe injury and deaths. The two tire defects are quite different in the way that they cause crashes. Tire Blowout/Separation is quite intuitive in the way it would cause a loss of control. Improper Tread Depth, however, would usually have other contributing factors, such as a wet road surface, speed, or both to result in the loss of control. No doubt, tire issues rise to the top concern of passenger car crashes. Brake defects are a distant second priority, albeit with a much higher overall frequency (5,891 for brakes, as compared to the tire issues of 2,670 for blowouts, and 1,608 for tread depth).

3.10 C208 CU Model Year

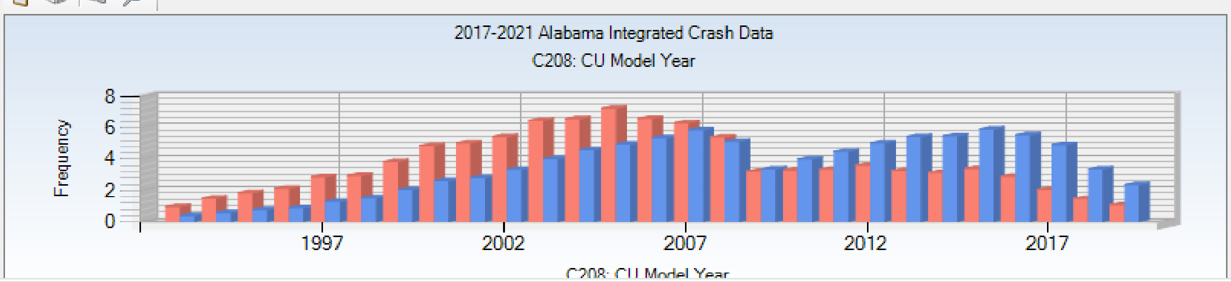
2017-2021 Alabama Integrated Crash Data | Veh Def C101 CU Pass Veh C222 | 1/ 1/2

Order: Max Gain | Descending | ☑ Suppress Zero-Valued Ro | Significance: Over Representation | Threshold: 2.0

C208: CU Model Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1993	122	0.95	2619	0.39	2.456*	72.331
1994	190	1.48	3894	0.57	2.573*	116.151
1995	236	1.83	5099	0.75	2.440*	139.298
1996	270	2.10	5926	0.87	2.402*	157.614
1997	364	2.83	8590	1.27	2.234*	201.092
1998	375	2.92	10148	1.50	1.949*	182.544
1999	490	3.81	13732	2.02	1.882*	229.574
2000	622	4.84	17604	2.60	1.863*	288.142
2001	643	5.00	18923	2.79	1.792*	284.128
2002	695	5.40	22498	3.32	1.629*	268.328
2003	827	6.43	27043	3.99	1.613*	314.133
2004	840	6.53	30831	4.55	1.437*	255.294
2005	926	7.20	33463	4.93	1.459*	291.379
2006	843	6.55	36088	5.32	1.232*	158.596
2007	806	6.27	39454	5.82	1.077	57.760
2008	690	5.36	34592	5.10	1.052	33.967
2009	411	3.20	22694	3.35	0.955	-19.389
2010	421	3.27	26885	3.96	0.826*	-88.871
2011	426	3.31	30181	4.45	0.744*	-146.379
2012	461	3.58	33901	5.00	0.717*	-181.928
2013	417	3.24	36679	5.41	0.599*	-278.613
2014	400	3.11	36881	5.44	0.572*	-299.443
2015	434	3.37	39800	5.87	0.575*	-320.802
2016	368	2.86	37326	5.50	0.520*	-339.883
2017	263	2.04	33188	4.89	0.418*	-366.406
2018	186	1.45	22693	3.35	0.432*	-244.370
2019	137	1.07	15788	2.33	0.458*	-162.417

C208: CU Model Year

☐ Sort by Sum of Max Gain



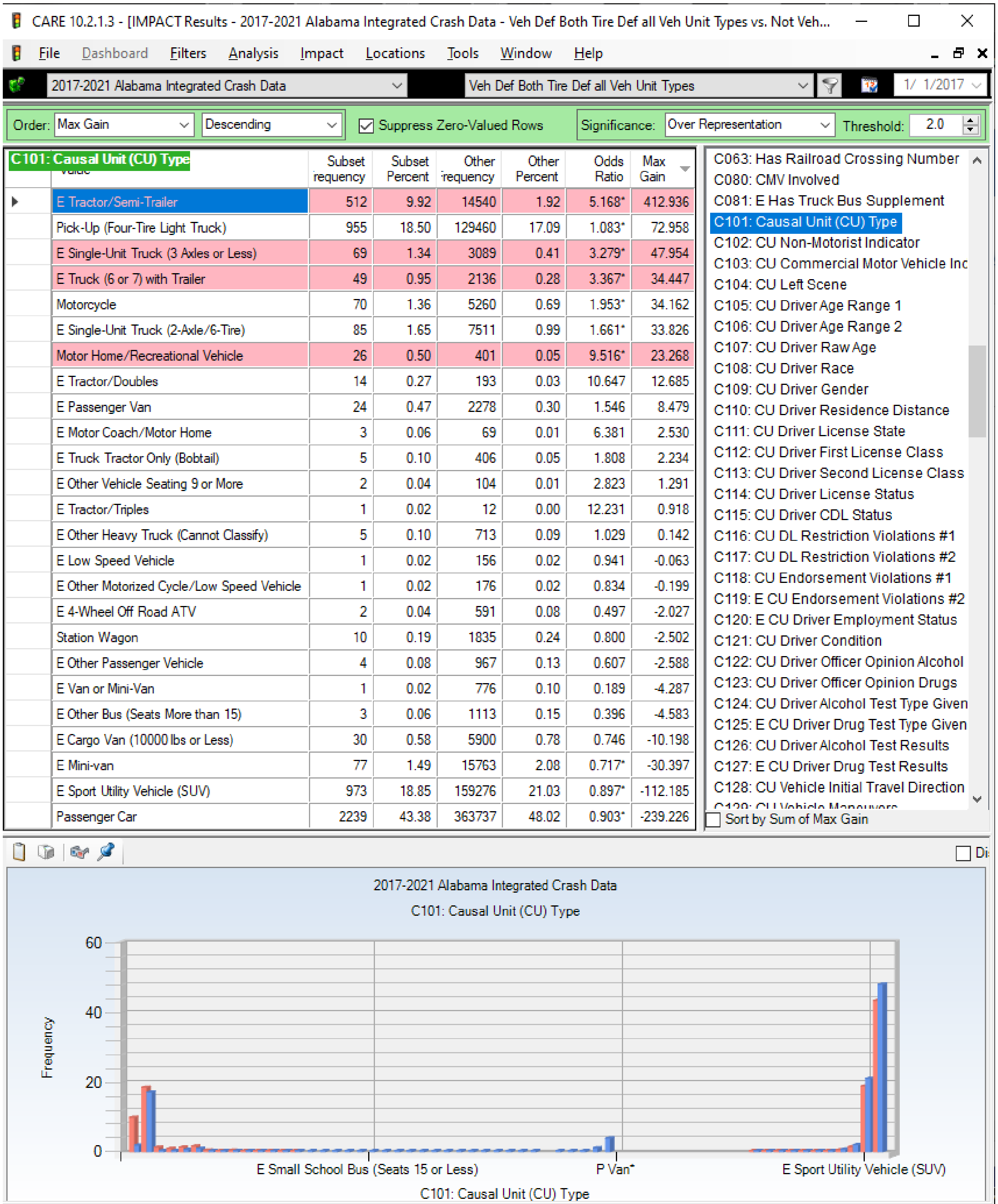
All years with less than100 crashes were removed. The significant over-represented model years are from 1993 through 2006. It is reasonable to expect that older vehicles would have more problems in this regard. However, the maximum year is 2005 with 926 Vehicle Defect crashes.

3.11 All Vehicles Tire Issues Further Analysis

The passenger car vehicle defect highest killer was in tire issues. Over five years there were 2,670 crashes caused by blowouts/tire separation, and 1,608 crashes caused by tread depth issues over the five years of the study (4,278 total for tire issues). While the cross-tabulation in Section 3.9 indicates that tread depth was a higher cause of death with 40, as opposed to blowouts, which had 16, there is no implication that the difference between these two numbers is statistically significant. The 56 tire defect fatal crashes resulted in a total of 73 fatalities (14.6 fatalities per year).

These two tire issues account for almost 85% of the passenger car vehicle defect fatalities, and the next highest (brakes) had only about 7.58%, with the remaining being distributed one-each among the other attribute values. It is clear that tire issues are head and shoulders over all other vehicle defect issues when it comes to passenger car fatalities.

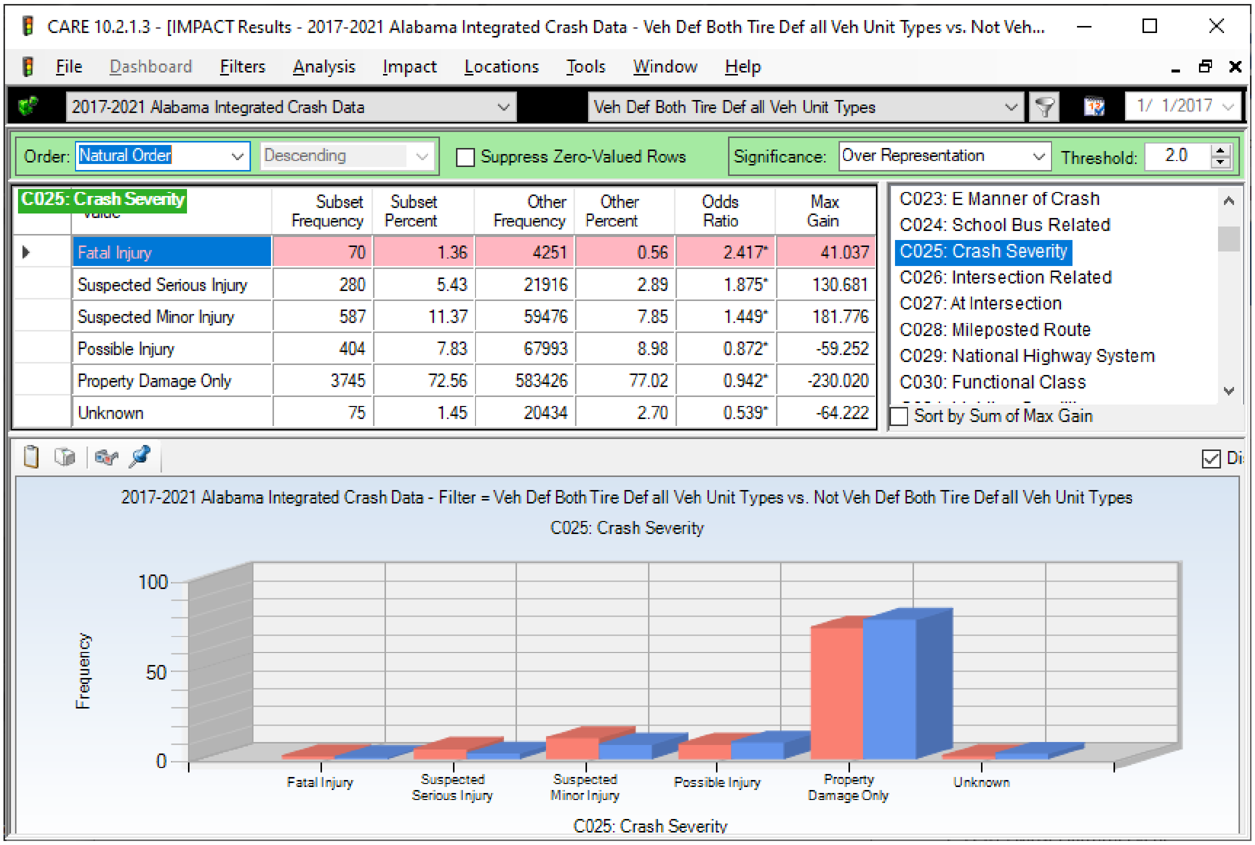
This being the case, a subset was formed of the 5,161 defective tire cases (for all vehicles, including large trucks) in an effort to flush out the demographics and focus in on the source of the tire problems. A listing of the causal units included is given in the display on the next page. The number in the Subset Frequency column is the number of tire-related crashes that each of these units had over the five years of the study.



Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tractor/Semi-Trailer	512	9.92	14540	1.92	5.168*	412.936
Pick-Up (Four-Tire Light Truck)	955	18.50	129460	17.09	1.083*	72.958
E Single-Unit Truck (3 Axles or Less)	69	1.34	3089	0.41	3.279*	47.954
E Truck (6 or 7) with Trailer	49	0.95	2136	0.28	3.367*	34.447
Motorcycle	70	1.36	5260	0.69	1.953*	34.162
E Single-Unit Truck (2-Axle/6-Tire)	85	1.65	7511	0.99	1.661*	33.826
Motor Home/Recreational Vehicle	26	0.50	401	0.05	9.516*	23.268
E Tractor/Doubles	14	0.27	193	0.03	10.647	12.685
E Passenger Van	24	0.47	2278	0.30	1.546	8.479
E Motor Coach/Motor Home	3	0.06	69	0.01	6.381	2.530
E Truck Tractor Only (Bobtail)	5	0.10	406	0.05	1.808	2.234
E Other Vehicle Seating 9 or More	2	0.04	104	0.01	2.823	1.291
E Tractor/Triples	1	0.02	12	0.00	12.231	0.918
E Other Heavy Truck (Cannot Classify)	5	0.10	713	0.09	1.029	0.142
E Low Speed Vehicle	1	0.02	156	0.02	0.941	-0.063
E Other Motorized Cycle/Low Speed Vehicle	1	0.02	176	0.02	0.834	-0.199
E 4-Wheel Off Road ATV	2	0.04	591	0.08	0.497	-2.027
Station Wagon	10	0.19	1835	0.24	0.800	-2.502
E Other Passenger Vehicle	4	0.08	967	0.13	0.607	-2.588
E Van or Mini-Van	1	0.02	776	0.10	0.189	-4.287
E Other Bus (Seats More than 15)	3	0.06	1113	0.15	0.396	-4.583
E Cargo Van (10000 lbs or Less)	30	0.58	5900	0.78	0.746	-10.198
E Mini-van	77	1.49	15763	2.08	0.717*	-30.397
E Sport Utility Vehicle (SUV)	973	18.85	159276	21.03	0.897*	-112.185
Passenger Car	2239	43.38	363737	48.02	0.903*	-239.226

3.11.1 Severity of all Tire Defect Crashes (all vehicle types)

The following gives a summary by severity as compared all tire defect crashes to all other crashes that occurred in the five year period.

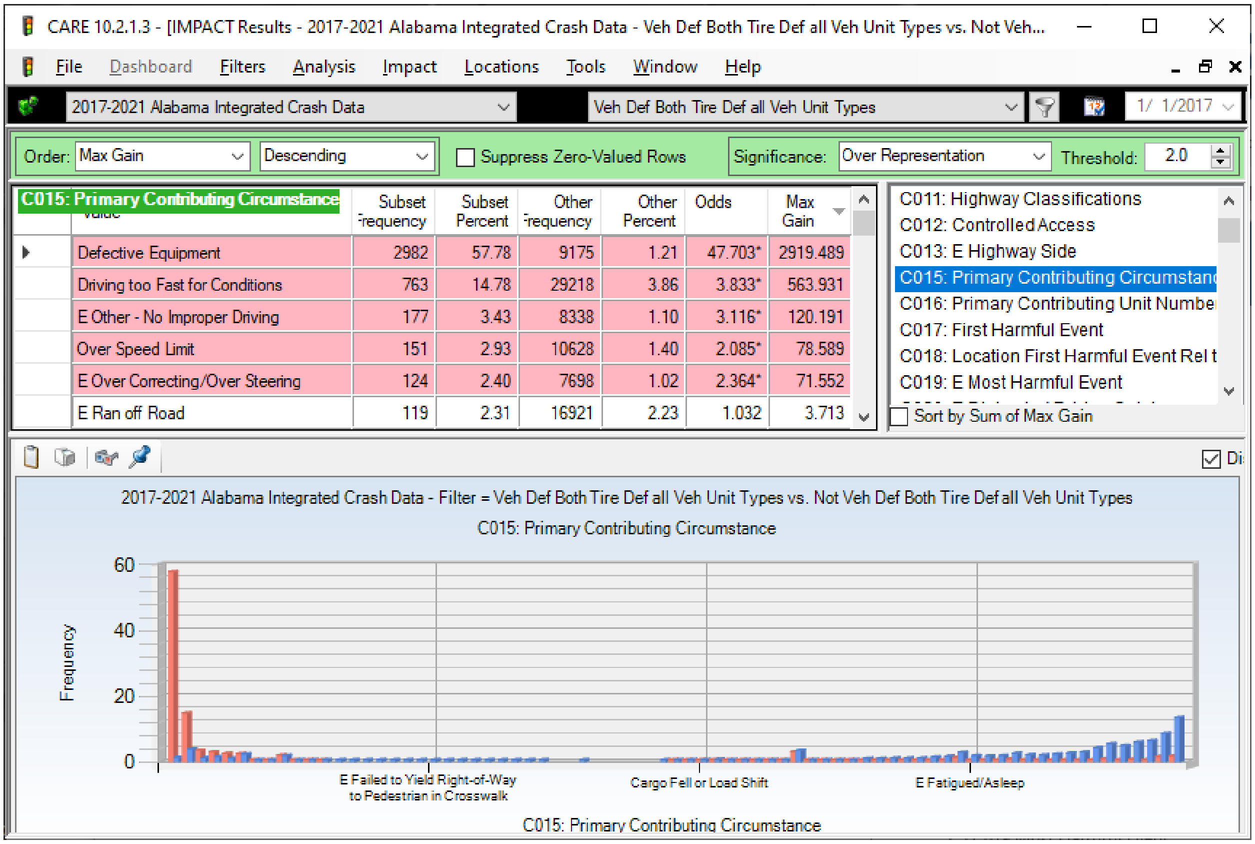


C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	70	1.36	4251	0.56	2.417*	41.037
Suspected Serious Injury	280	5.43	21916	2.89	1.875*	130.681
Suspected Minor Injury	587	11.37	59476	7.85	1.449*	181.776
Possible Injury	404	7.83	67993	8.98	0.872*	-59.252
Property Damage Only	3745	72.56	583426	77.02	0.942*	-230.020
Unknown	75	1.45	20434	2.70	0.539*	-64.222

Notice that the proportion of Fatal Injury for the Vehicle Defect crashes (1.36) is over twice (2.417 times) what it is for the non-vehicle-defect control crashes. The two highest injury categories are also over-represented significantly higher than expectation (Odds Ratios 1.875 and 1.449). Thus, we can conclude that these are not minor problems, and something should probably be done to address them, if nothing other than a PSA concentrating on tire defect issues.

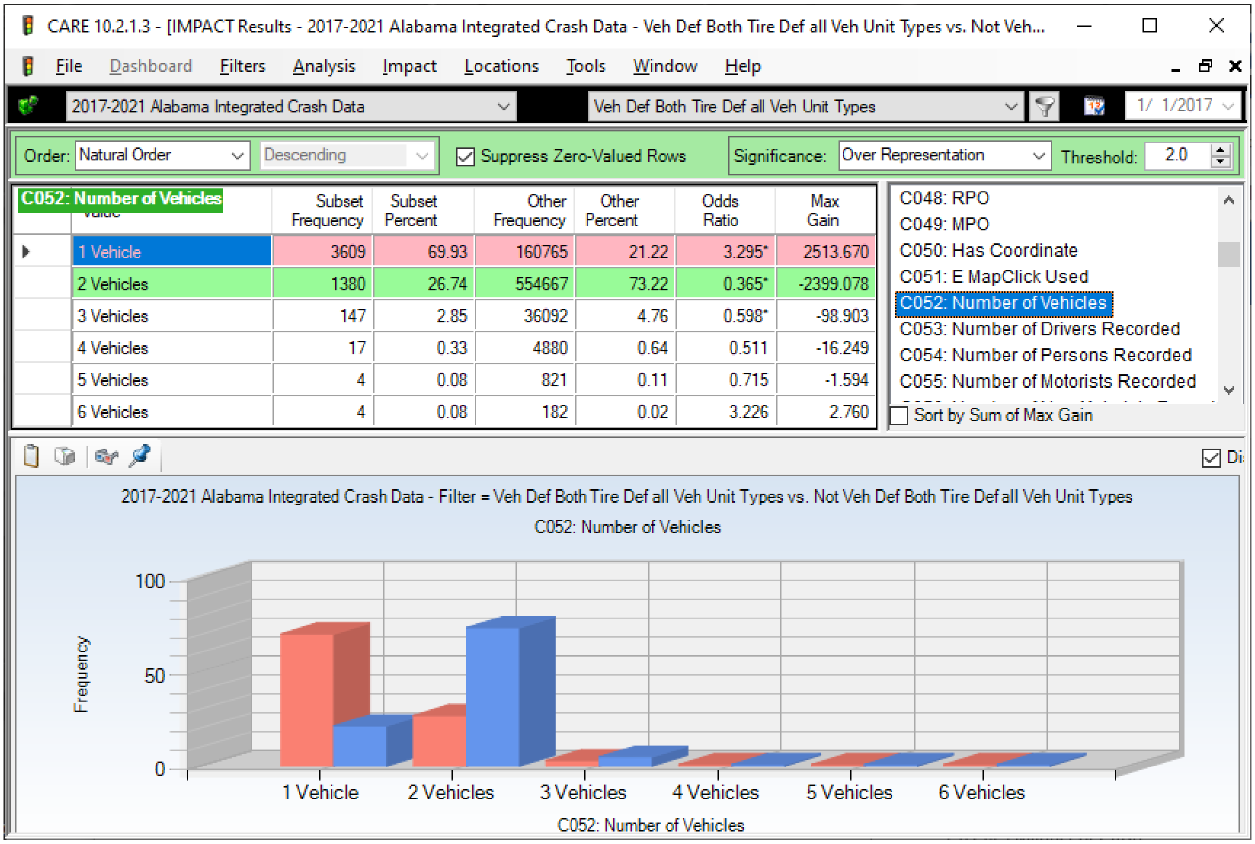
3.11.2 C015 Primary Contributing Circumstances

The following comparison for Primary Contributing Circumstances indicates that tire problems are usually coupled with another fault related to speed in order to create the crashes.



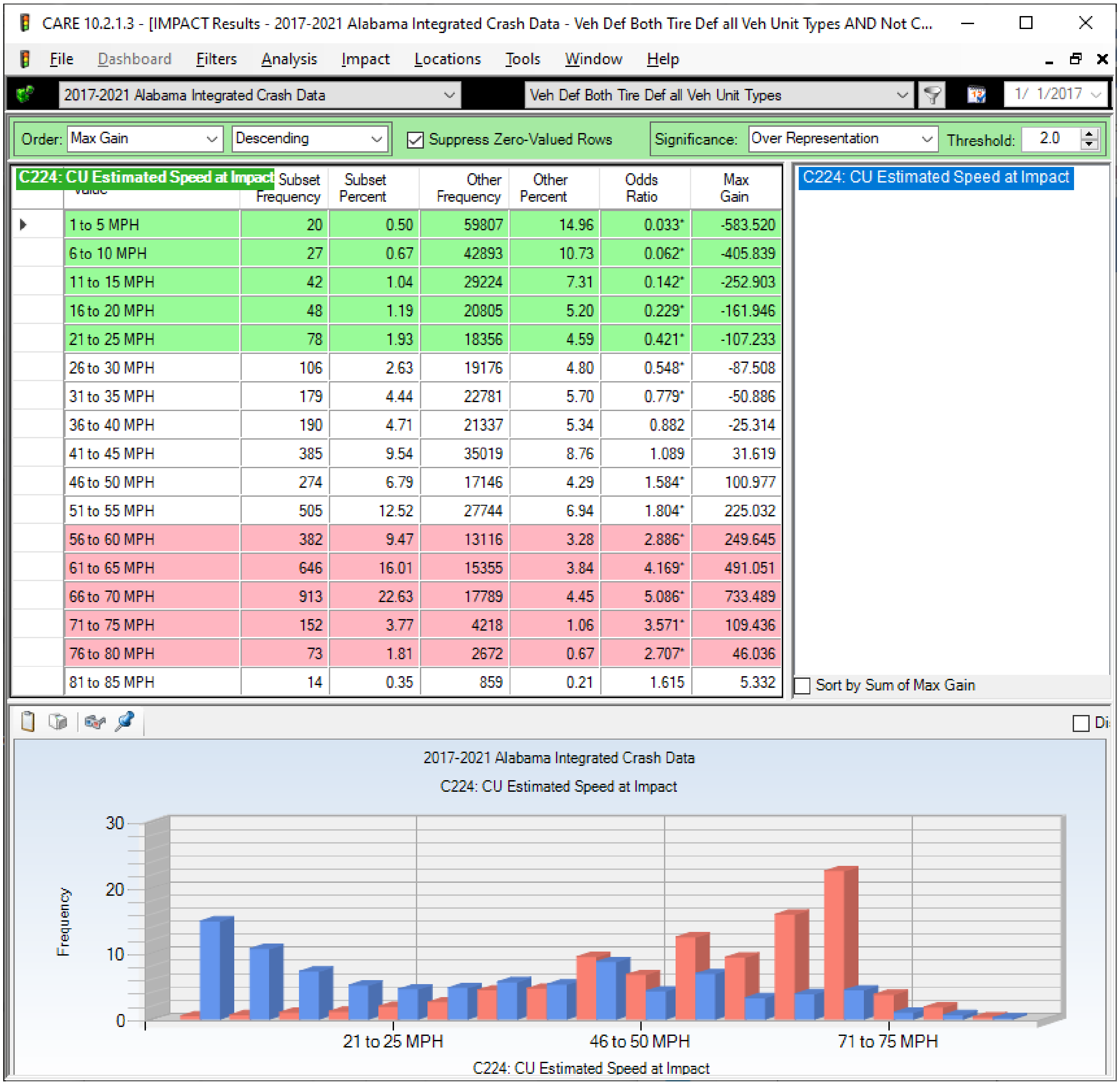
The vast majority of these crashes are single vehicle, as shown by the next display.

3.11.3 C052 Number of Vehicles (involved in these crashes)



Impact speeds for these crashes is relatively high, further reinforcing the speed cofactor, and as would be expected, they occur more in open country (rural areas).

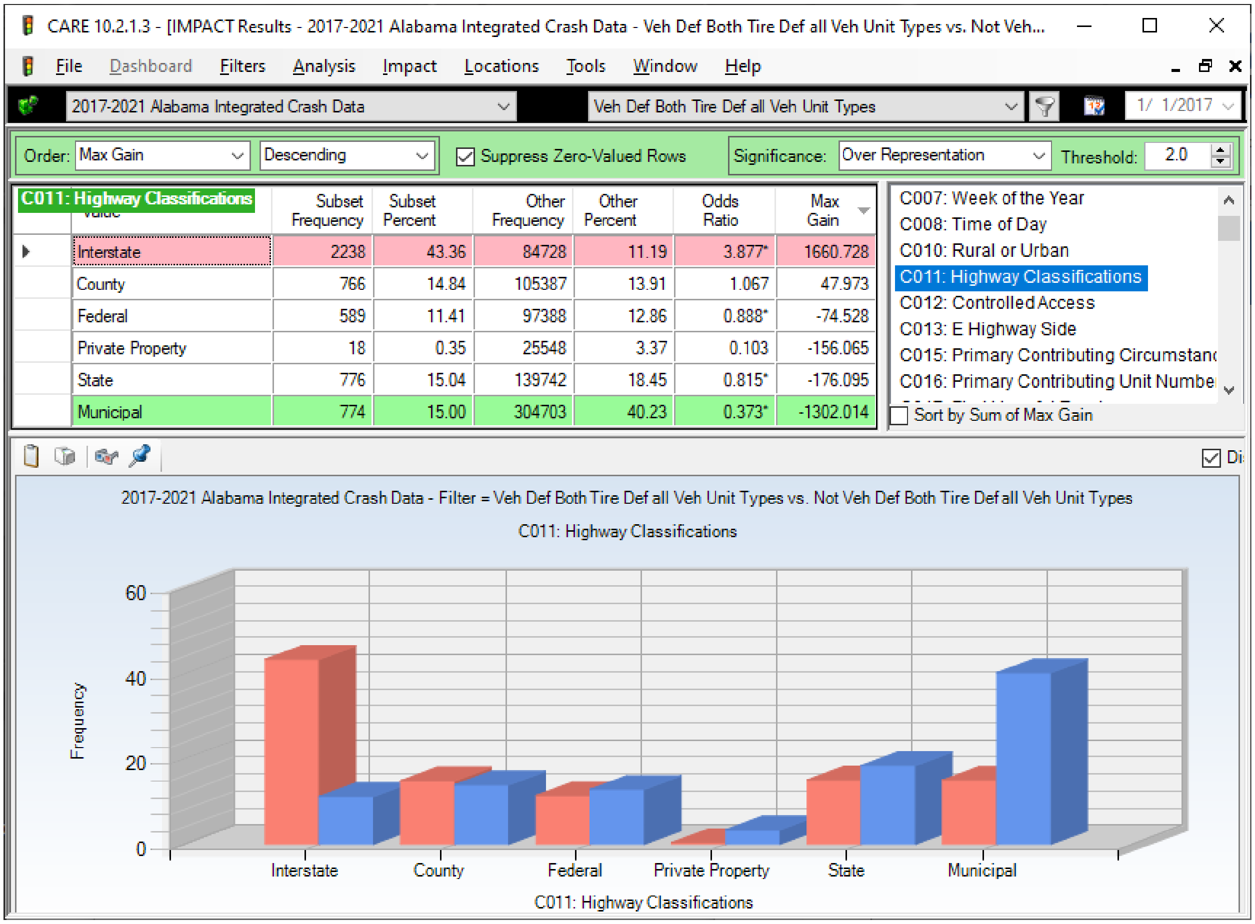
3.11.4 C224 Estimate Speed at Impact



C224: CU Estimated Speed at Impact	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 to 5 MPH	20	0.50	59807	14.96	0.033*	-583.520
6 to 10 MPH	27	0.67	42893	10.73	0.062*	-405.839
11 to 15 MPH	42	1.04	29224	7.31	0.142*	-252.903
16 to 20 MPH	48	1.19	20805	5.20	0.229*	-161.946
21 to 25 MPH	78	1.93	18356	4.59	0.421*	-107.233
26 to 30 MPH	106	2.63	19176	4.80	0.548*	-87.508
31 to 35 MPH	179	4.44	22781	5.70	0.779*	-50.886
36 to 40 MPH	190	4.71	21337	5.34	0.882	-25.314
41 to 45 MPH	385	9.54	35019	8.76	1.089	31.619
46 to 50 MPH	274	6.79	17146	4.29	1.584*	100.977
51 to 55 MPH	505	12.52	27744	6.94	1.804*	225.032
56 to 60 MPH	382	9.47	13116	3.28	2.886*	249.645
61 to 65 MPH	646	16.01	15355	3.84	4.169*	491.051
66 to 70 MPH	913	22.63	17789	4.45	5.086*	733.489
71 to 75 MPH	152	3.77	4218	1.06	3.571*	109.436
76 to 80 MPH	73	1.81	2672	0.67	2.707*	46.036
81 to 85 MPH	14	0.35	859	0.21	1.615	5.332

Speed at impact is a major factor indicating that the problem with tire defects are further compounded by excessive speeds.

3.11.5 C011 Highway Classification



C011: Highway Classifications Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Interstate	2238	43.36	84728	11.19	3.877*	1660.728
County	766	14.84	105387	13.91	1.067	47.973
Federal	589	11.41	97388	12.86	0.888*	-74.528
Private Property	18	0.35	25548	3.37	0.103	-156.065
State	776	15.04	139742	18.45	0.815*	-176.095
Municipal	774	15.00	304703	40.23	0.373*	-1302.014

County roads are about as expected (neither over- nor under-represented) perhaps because it is difficult to travel these roads at too high a rate of speed. Federal and State roads are under-represented in favor of Interstates (as are Municipal roads).

Summary of other findings. The causal unit model year follows about the same as given above in Section 3:10, with the older vehicles (up to 1993 for this subset) being over-represented. Driver ages that are over-represented are those from 18-30 years of age. Wet roadways have over twice their expected number of crashes (we suspect that further analysis will show this coming from the low tread tires as opposed to the blowouts). Males are over-represented by about 33% higher proportion than expected. While day of the week is close to the DUI pattern (over-representations on weekend days), the time of day favors the two or three hours before the typical rush hours.

4.0 Discussion on Potential Inspection System for Alabama

Most of the promotion of vehicle inspection systems within the states has been conducted in isolation. If you consider the loss of one life and multiply it over the five-year death toll of 70 fatal crashes (14 per year), the cost of implementing a vehicle inspection system is indeed cost-beneficial. If we had *certain knowledge* that even one fatality could be saved, unlimited resources would be justified. But no such certain knowledge exists.

What is rarely considered is the downside of any proposed expenditure. Please see general considerations for traffic safety investments that is given under the title of "Considerations for Optimal Traffic Safety Allocation" linked to here:

http://www.safehomealabama.gov/wp-content/uploads/2019/03/Traffic-Safety-Innov-2017-04.pdf

The failure is one of not seeing the effect that saving these 14 lives per year (or whatever savings traffic safety professionals might estimate) is going to have on failing to save even more of the total fatalities (close to 1,000 fatalities per year averaged over the last decade). Advocates (in all areas) often fail to see the downside of their actions. As a result, the consumption of traffic safety resources rarely if ever produces the maximum savings of fatalities. Most traffic safety countermeasures have several downsides, but one that is always present is the zero-sum game of the total safety budget, which any given program requiring resources must deplete.

So, for example, if a given countermeasure costs $100,000 per year these dollars will have to come from other traffic safety programs. It is not a matter of going to the general fund; and even if it were, the same argument could be made: i.e., that this $100k should go to a countermeasure that has a higher benefit to cost ratio.

The cost of most countermeasures is fairly easy to obtain; however, the benefits that any one of them will produce is highly speculative, and we must turn to the traffic safety professionals to estimate these benefits. There are a number of resources to this effect available from NHTSA e.g., *Countermeasure that Work:* https://www.nhtsa.gov/sites/nhtsa.gov/files/2021-09/Countermeasures-10th_080621_v5_tag.pdf.

Few studies of effectiveness have been performed for vehicle inspection systems for a variety of reasons. But the major issue is in isolating the number of crashes that will be reduced by implementing the program. "The program" itself is not at all defined, since there are variations in every state that has "implemented a program." So it is impossible to aggregate the results.

Please review the findings above. Recognize that large truck inspections are handled already by FMCSA mandates. In essence, they already have an inspection system. So, we are mainly talking about the second half of the findings given above – those for passenger cars. The major problem with passenger cars was found to be tires. Further analyses can and should be done if programs to address this problem are to be developed. This can easily generate the target groups and the demographics that should be employed to develop the most effective tire countermeasure program.

The big question that must be answered: is a full scale inspection system necessary to deal with the issue of car tires. Could one be developed that just concentrated on these issues and perhaps the third item, which was brakes? Would a PI&E program be just as (perhaps more) effective, but at a fraction of the cost? Could tire providers be involved in not repairing tires that are prone to be defective?

We are not prepared to answer these questions at this point; but we feel that raising them is sufficient to getting decision-makers moving in the right direction. We urge decision-makers to consider how many lives might be saved if the cost of implementing an inspection program were to be invested in other more cost-effective countermeasures. We stand ready to provide additional information from crash records to help them if they feel that such an effort would be warranted.

For more information on this subject from NHTSA and other sources, please see:
http://www.safehomealabama.gov/tag/defects-recalls/