Occupant Restraint Use in Michigan Crashes: 2014-2018

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1.0 Executive Summary

This report looks at restraint use for passenger-vehicle occupants in police-reported crashes in Michigan between 2014 and 2018. Various conditions that can influence restraint use are examined and reported.

Major findings include:

- Restraint use among crash-involved occupants has been very high in Michigan and even slightly increasing over five years; the highest rate for adults was 99.0% and for children was 98.3%, both in 2017.
- Many children involved in crashes are suboptimally restrained, particularly 5-8-year-olds, who are likely to be in lap and shoulder belts rather than booster seats.
- Restraint use is strongly associated with reduced levels of injury and fatality for adults and children, though children have generally lower rates of injury and fatality than adults. Less than 0.1% of restrained adults were killed, but more than 3.2% of unrestrained adults were killed.
- Adult and child occupants in vehicles with impaired drivers have lower restraint-use rates, with the lowest rates among those in vehicles with drivers impaired by both drugs and alcohol.
- Seat position influences restraint rates and types, especially among children. Five-to-eight-year-olds are restrained without child restraints almost 50% of the time in the second and third rows, suggesting that some parents are transitioning these children out of car seats in general. For 9-10-year-olds, just under 10% are restrained with child restraints in the second and third rows, and only 1.2% use a child restraint in the front row.
- For adult occupants, about 10% of rear-seat occupants over age 10 are unbelted, a much higher rate than for front-seat adult occupants.
- The unrestrained rate was lowest for children age 10 years at 1.4% and highest for 6-year-olds at 2.6%. Among adults, restraint use increased with age, starting at 97.9% for young teens (11-14) and rising to 99.0% for those 25 and older.
- Patterns of use rates for specific car seat types (rear-facing, front-facing, and booster) mirror the age recommendations from the National Highway Traffic Safety Administration (NHTSA). However, booster-seat use is still relatively low for ages 4-8, with 40.3% of 6-year-olds and almost 76.8% of 8-year-olds using vehicle restraints without any child restraint.
- Finally, restraint use is the same by gender, lower on weekends compared to weekdays, and the same across different months of the year.

2.0 Introduction

This report analyzes occupant protection in police-reported motor vehicle crashes on public roadways in Michigan from 2014 through 2018. Michigan traffic crashes are defined as taking place on public roadways in Michigan, involving at least one motor vehicle in transport, and resulting in death, injury, or property damage of $1,000 or more. Michigan police reports classify occupant restraint use according to the following categories:

- No belts available: no provision of belts that the occupant could use at the time of crash
- Shoulder belt only: the occupant was only using a shoulder belt at the time of the crash
- Lap belt only: the occupant was wearing only a lap belt at the time of the crash
- Lap and shoulder belt: the occupant was wearing both lap and shoulder belts at the time of the crash
- No belt used: the occupant was not wearing/using any form of belt restraint at the time of the crash, although a belt was available at the occupant's seating position
- Restraint failure: the restraint was used but failed
- Restraint use unknown: the reporting officer could not identify the type of restraint use

Child restraint use is classified before 2016 as either "child restraint used" or "child restraint not used, unavailable or improper use." Proper use of a child restraint was not captured, and for each occupant, only one restraint category could be checked. Thus, if a child occupant was using a lap-shoulder belt even if a child restraint is recommended, the officer would most likely code restraint as "lap-shoulder belt" rather than "No child restraint used." Starting in 2016, new levels were added, including "Child Restraint Used—Forward Facing," "Child Restraint Used—Rearward Facing," and "Child Restraint Used—Booster Seat."

To address the change in coding, analyses covering the full five-year time frame collapse the 2016-2018 categories into the old categories of "child restraint used" or "child restraint not used" to use the full five years of data. However, some analyses focus on the newer information that specifies proper or improper use, and these are restricted to the 2016-2018 crash years. These differences are specified in the text. This analysis is limited to passenger-vehicle occupants, defined as those with a vehicle type of Car, SUV, Van or Pickup. Finally, occupants age 11 years and older are treated as adults and occupants age 10 years and younger as children for the purpose of classifying seat belt and child restraint usage based on Michigan laws.

3.0 Trends

The distribution of restraint type used and not used are shown in Figure 1 and Figure 2 for children aged 0 to 10. Figure 3 and Figure 4 display belted and unbelted distributions for occupants aged 11 years and older. Restraint types are categorized as above, but child restraint categories are coded as unknown for adults and are not included in the graph. In Figure 1, the categories for "Child Restraint Used" and "Belted" are included due increased belt use as children age. The "Shoulder Belt Only," "Lap Belt Only," "Lap and Shoulder Belt," and "Restraint Failure" are included in the belted group. Restraint failure is included as restrained because a restraint was worn. Both "No Belts Available" and "No Belts Used"

indicate unbelted. In general, restraint use for crash-involved occupants has been increasing over the five years examined.

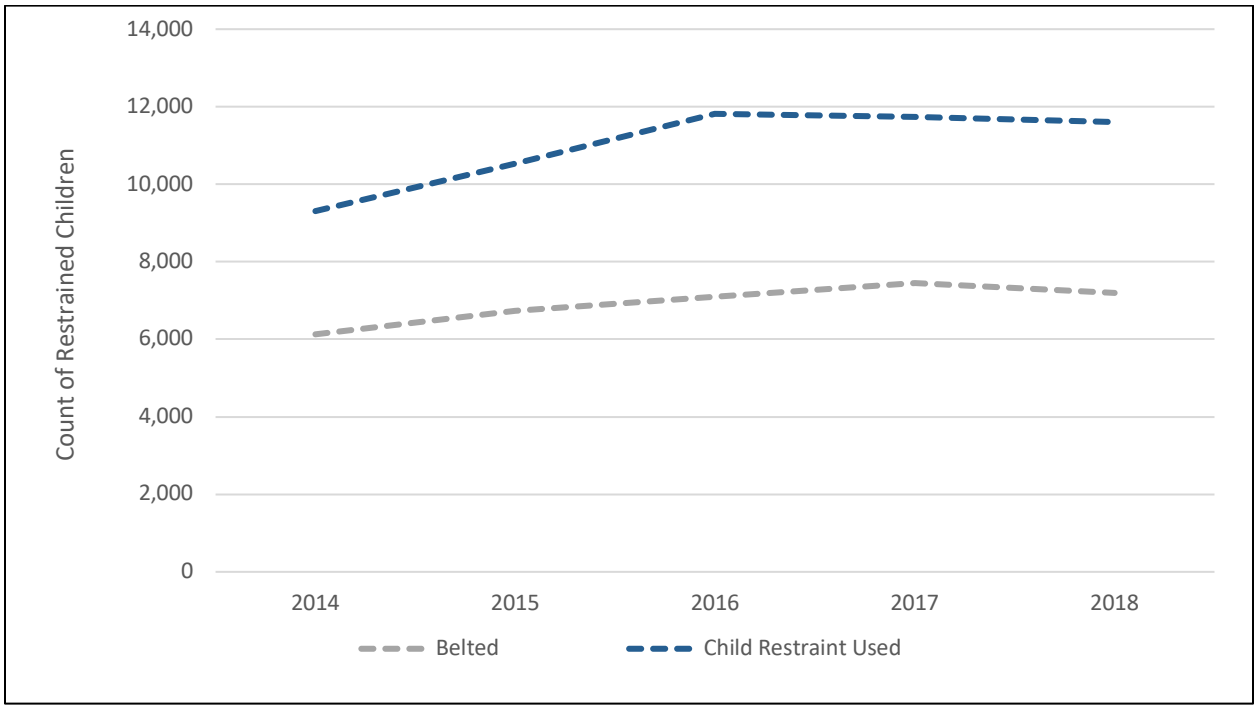

Figure 1 – Restrained Children Aged 0-10

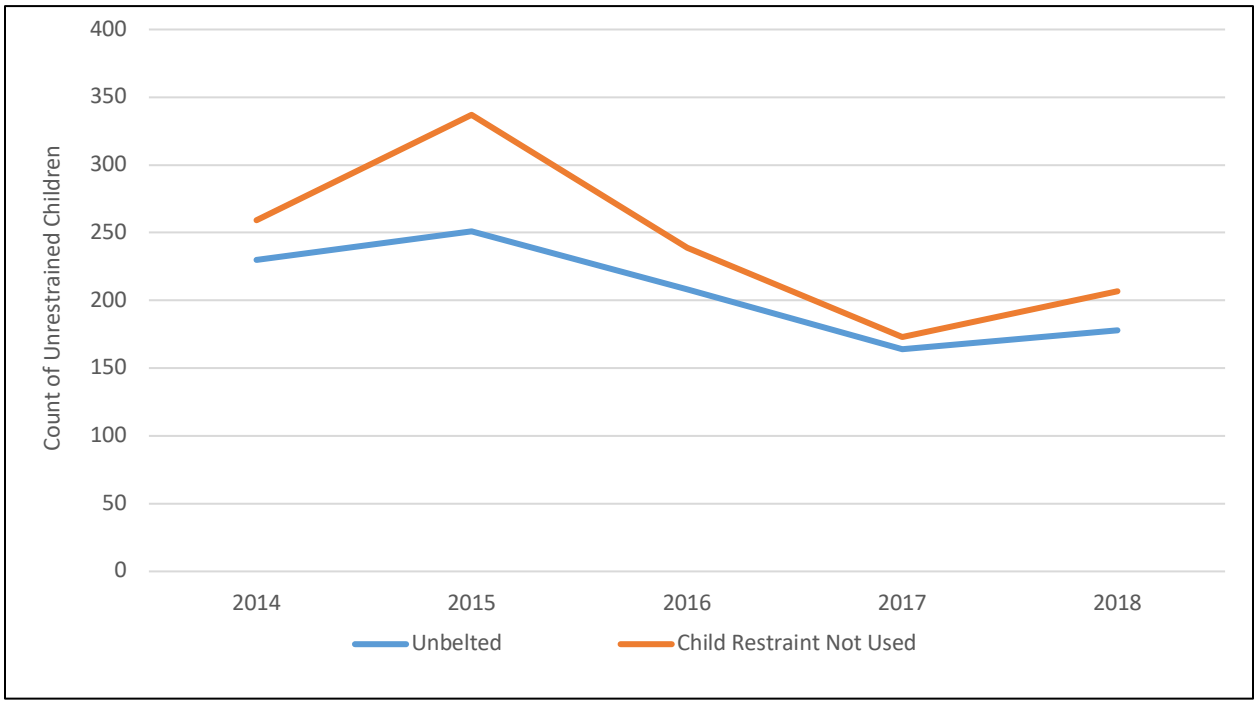

Figure 2 – Unrestrained Children Aged 0-10

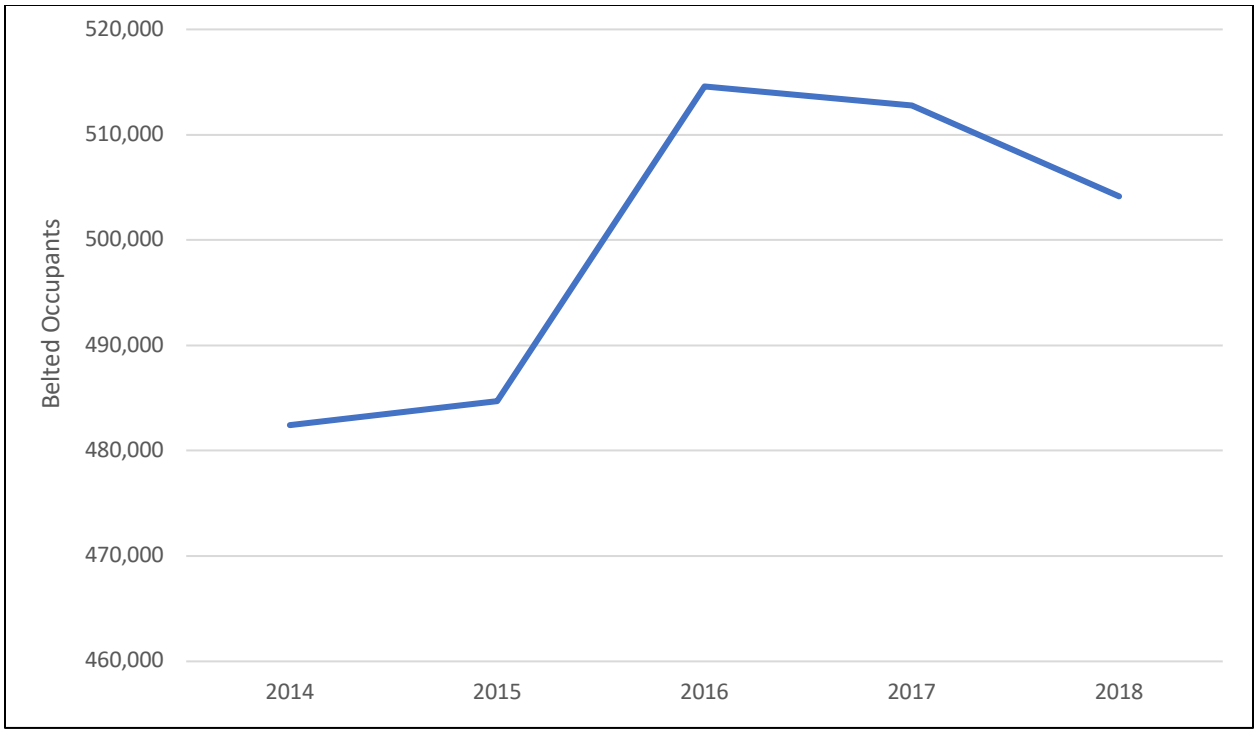

Figure 3 – Belted Occupants Aged 11+

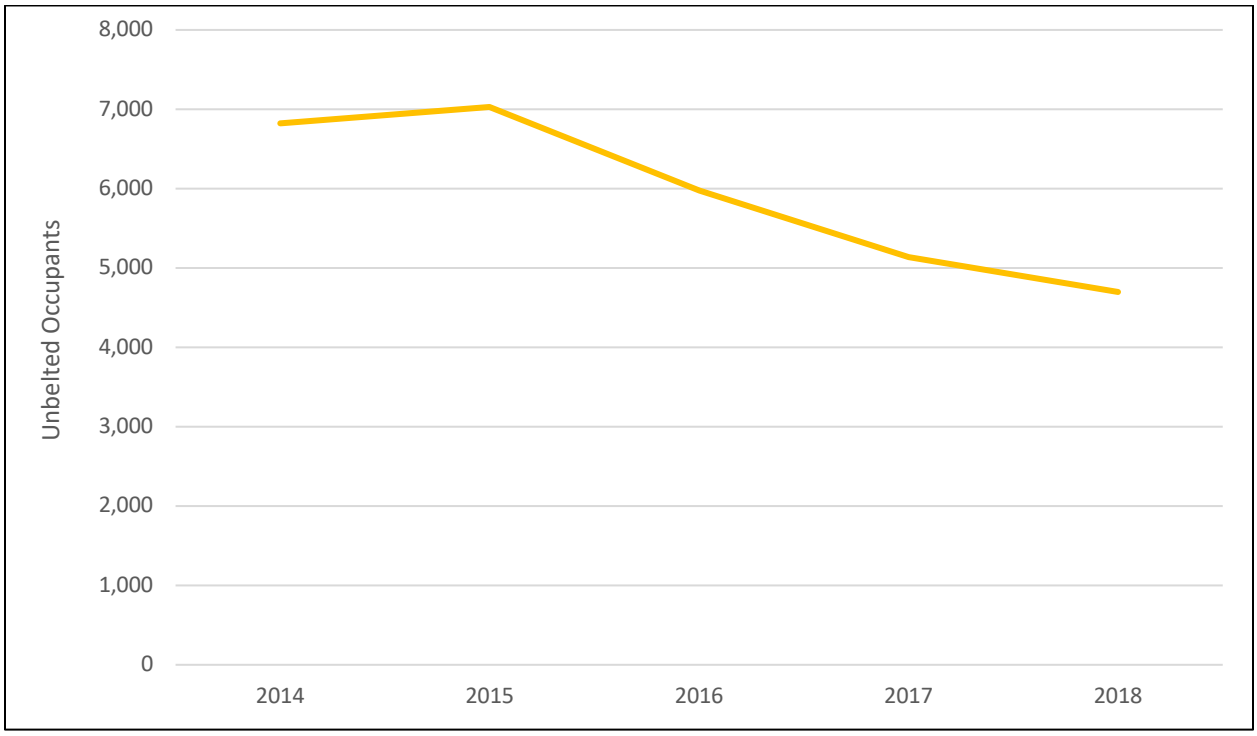

Figure 4 – Unbelted Occupants Aged 11+

In 2016, changes to the police crash report included more detailed coding of child restraint use to specify whether child seats were rear-facing, forward-facing or boosters. Combined with the child's age, it is possible to identify whether child-seat use was suboptimal or optimal. In Michigan, "proper" child seats are required through age 8. While "proper" is not defined in the law, NHTSA's current recommendations[1] include overlapping age ranges: rear-facing for ages 0-3, forward-facing for ages 1-7, and booster seats for ages 4-12. Based on these age ranges and prior practice (which tended to move children into subsequent seat types sooner), we selected the following age ranges and definitions of "optimal" vs. "suboptimal" restraints. These are defined in Table 1.

Table 1. Definitions of Optimal and Suboptimal Restraints by Age Group

Age Group	Optimal Restraints	Suboptimal Restraints
0-1	Rear-facing	Forward-facing, booster or seatbelt
2-4	Rear-facing or forward-facing	Booster or seatbelt
5-8	Forward-facing or booster	Rear-facing or seatbelt

Table 2 on the following page summarizes restraint use among crash-involved occupants. For occupants age 11 and older, "restrained" includes Lap Only, Shoulder Only, Lap and Shoulder, and Restraint Failure. For occupants age 10 and younger, the "restrained" category also includes any child-seat categories. "Optimal" restraints can only be categorized for 2016 through 2018, and the definition follows the guidelines above. "Suboptimal" restraint is any "restrained" category other than those considered optimal.

For adults, restraint use is very high and increased slightly to 99.1% in 2018. For children, restraint use of some kind is also very high, decreasing slightly from 98.3% in 2017 to 98.0% in 2018, but it is still lower than that of adults. That said, many children are suboptimally restrained, particularly 5-8-year-olds, who are likely to be in lap and shoulder belts rather than booster seats. Interestingly, a high percentage of 0-1-year-olds were coded as suboptimally restrained in front-facing child seats in 2016 (65.0%), but substantially fewer of them were coded as such in 2017 (38.8%). In 2018, the suboptimal percentage decreased again to 37.6%. NHTSA's recommendation to keep 1-year-olds in rear-facing seats until age 2 came out in 2011, and it may be that educational campaigns and car-seat clinics made a substantial difference in getting the message out to parents by 2017. However, it may also be that restraint coding has become more accurate over time as officers became more experienced at using the new codes. This is consistent with the fact that the proportional change from rear-facing restraints in 2016 to forward-facing restraints in 2017 was the same for children under 1 (for whom the rear-facing recommendation has been out for a long time) and children age 1.

[1] "Car Seat Recommendations for Children," National Highway Transportation Safety Administration, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/carseat-recommendations-for-children-by-age-size.pdf, (2019).

Table 2. Restraint Use by Age Group and Year

Age Group	Restraint Condition	2014	2015	2016	2017	2018
Adults (≥11)	Restrained	98.6%	98.6%	98.9%	99.0%	99.1%
	Unrestrained	1.4%	1.4%	1.1%	1.0%	0.9%
Children (≤10)	Restrained	96.9%	96.7%	97.7%	98.3%	98.0%
0-1	Optimal			33.2%	59.8%	60.8%
	Suboptimal			65.0%	38.8%	37.6%
2-4	Optimal			78.6%	73.6%	73.4%
	Suboptimal			18.8%	24.3%	24.3%
5-8	Optimal			48.5%	45.8%	46.5%
	Suboptimal			48.9%	52.4%	51.3%
Children (≤10)	Unrestrained	3.1%	3.3%	2.3%	1.7%	2.0%

4.0 Injury Severity Level

Table 3 shows the distribution of restraint use by injury for all crash-involved occupants of passenger vehicles. Figure 5 shows the distribution of injury for five groups: restrained adults, unrestrained adults, restrained children without a child seat, restrained children with a child seat and unrestrained children. The figure shows that a substantially greater proportion of unrestrained occupants are injured or killed. Among adults, 87.9% of restrained occupants had no injury whereas 56.4% of unrestrained occupants had no injury; less than 0.1% of restrained adults were killed, but more than 3.2% of unrestrained adults were killed. For children, 83.1% of the restrained occupants without a child seat and 88.4% of the restrained occupants with a child seat were uninjured. Of the unrestrained child occupants, 66.6% were uninjured. Fatality rates for all children were lower than adults, but the difference between restrained children (0.046% killed without a child seat, 0.038% killed with a child seat) and unrestrained children (0.58% killed) is still quite dramatic.

Table 3. Distribution of Injury Severity by Occupant Restraint Use for All Occupants

Person Restraint	Fatal Injury (K)	Suspected Serious Injury (A)	Suspected Minor Injury (B)	Possible Injury (C)	No Injury (O)	Unknown Injury	Total
No belt available	35	159	344	760	5,586	79	6,963
No restraint used	937	2,656	4,069	4,750	13,393	154	25,959
Lap and shoulder belt	1,616	14,637	68,052	219,961	2,206,658	1,928	2,512,852
Lap belt only	22	117	439	1,316	9,305	20	11,219
Shoulder belt only	10	133	356	1,261	9,270	17	11,047
Restraint failure	3	19	35	104	800	21	982
Child Restraint Used	21	191	1,180	5,188	49,575	139	56,294
Unknown/ Error	481	2,049	4,166	10,533	97,260	174,281	288,770
Total	3,125	19,961	78,641	243,873	2,391,847	176,639	2,914,086

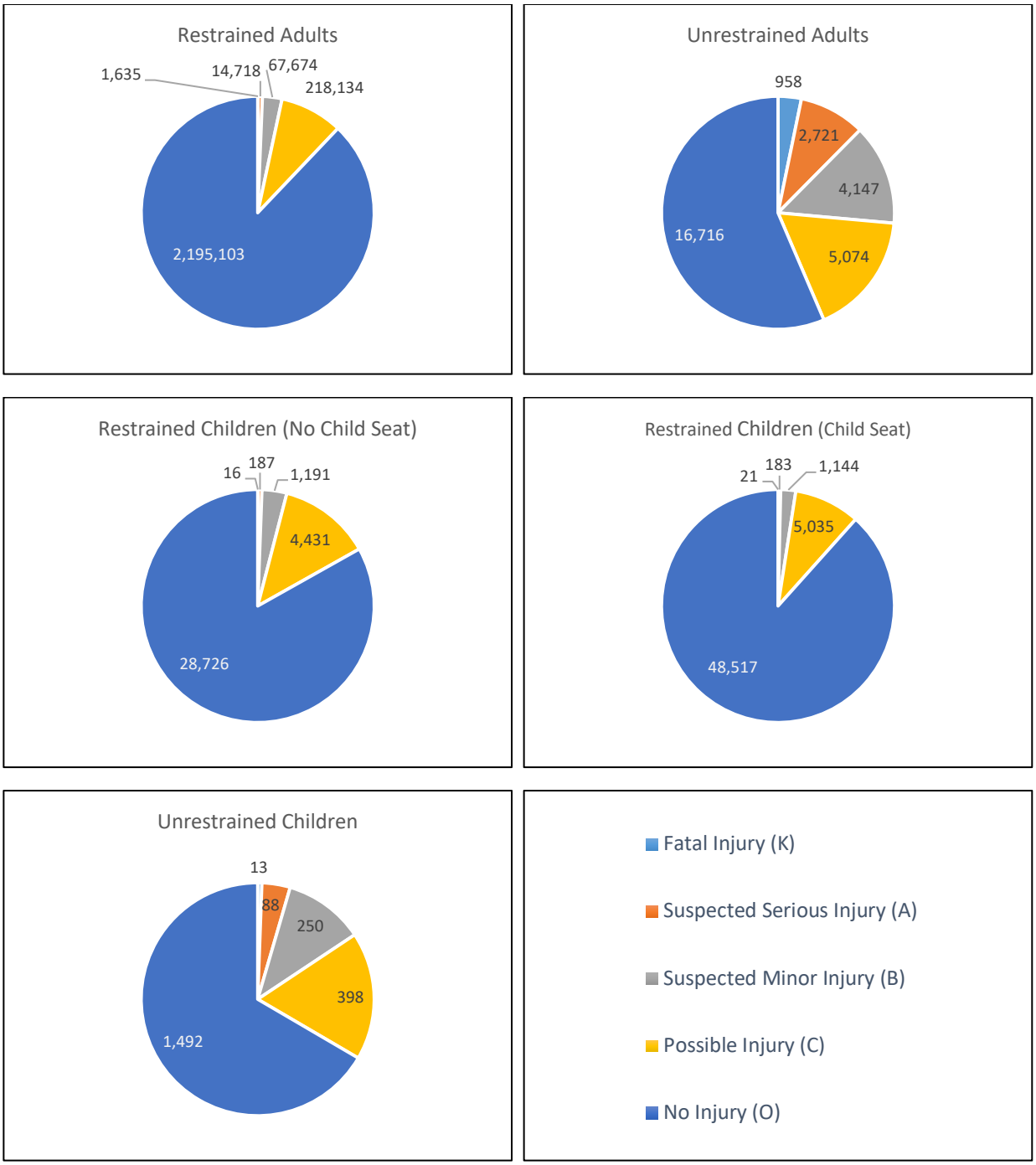

Figure 5 – Injury Severity Distribution Across Different Types of Restraint Use

5.0 Impaired Driving and Restraint Use

Table 4 shows the percentage of adult and child motor vehicle occupants using restraints by impairment status of the driver of that vehicle. All occupants are considered in this table. The general patterns are the same for adults and children, though children's restraint-use rates are generally below that of adults. When the driver is not impaired, restraint-use rates for both adults and child occupants are very high. However, when the driver is drinking, suspected of using drugs, or both, restraint use rates decrease in that order. This is true for children as well as adults. Lack of restraint use exacerbates the already high injury/fatality risk associated with impaired driving.

Table 4. Occupant Restraint Use Rates as Function of Driver Impairment

Occupant Group	No Alcohol or Drugs	Alcohol Only	Drugs Only	Alcohol and Drugs
Adults	99.0%	91.6%	90.1%	84.9%
Children	97.7%	87.4%	84.3%	72.7%

6.0 Occupant Position and Restraint Use

Table 5 on the following page shows the count of child occupants by age, restraint and seating row. Parents are advised not to place children under 12 in the front seat, but some vehicles (e.g., pickup trucks) have no second row or no second row with room for a car seat. About 6.4% of children age 0-1, 1.9% of children age 2-4, 6.5% of children age 5-8, and 22.9% of children age 9-10 are in the front row of seats. Among infants (age 0-1) in the front row, 77.5% are restrained without a child seat and 18.3% are restrained with a child seat. In contrast, when these children are in the second or third row, they are restrained without a child seat approximately 7% of the time and with a child seat approximately 91% of the time. The pattern for children age 2-4 is similar, but the child-seat-restraint rate for the front row (55.6%) is much higher than for infants and the child-seat-restraint rate in the second and third rows (about 84-87%) is slightly lower than for infants. Five-to-eight-year-olds follow similar patterns to infants in that they are restrained without a child restraint in the front row 81.3% of the time. However, these children are also restrained without child restraints almost 50% of the time in the second and third rows, suggesting that some parents are transitioning these children out of car seats in general. Finally, for 9-10-year-olds, just under 10% are restrained with child restraints in the second and third rows, and only 1.2% use a child restraint in the front row. These children's front-row restraint rate is similar to the restraint rate for adult passengers. Interestingly, in the second and third rows, about 9-10% of children age 9-10 are restrained with a child seat, with only about 1.7% unbelted, but for adult occupants, these numbers are reversed and about 10% of rear-seat occupants over age 10 are unbelted.

Table 5. Child Restraint Use by Occupant Position

		Count			Percent Restraint Category		
Age Group	**Restraint Category**	**Front Row**	**Second Row**	**Third Row**	**Front Row**	**Second Row**	**Third Row**
0-1	Restrained (no child seat)	903	904	201	77.5%	6.4%	7.0%
	Restrained (child seat)	213	13,079	2,601	18.3%	92.0%	90.8%
	Unrestrained	49	227	63	4.2%	1.6%	2.2%
2-4	Restrained (no child seat)	179	2,156	629	35.9%	10.2%	12.7%
	Restrained (child seat)	277	18,432	4,170	55.6%	87.3%	84.0%
	Unrestrained	42	523	166	8.4%	2.5%	3.3%
5-8	Restrained (no child seat)	1,639	10,532	3,346	81.3%	47.9%	48.9%
	Restrained (child seat)	291	10,897	3,337	14.4%	49.6%	48.8%
	Unrestrained	86	536	162	4.3%	2.4%	2.4%
9-10	Restrained (no child seat)	3,366	7,937	2,349	97.7%	88.7%	89.3%
	Restrained (child seat)	41	862	240	1.2%	9.6%	9.1%
	Unrestrained	40	148	42	1.2%	1.7%	1.6%
11+	Restrained (no child seat)	2,433,760	51,048	11,886	99.1%	89.9%	89.3%
	Restrained (child seat)	401	678	141	0.0%	1.2%	1.1%
	Unrestrained	21,617	5,077	1,290	0.9%	8.9%	9.7%

7.0 Restraint Use by Age

This section looks more closely at the relationship between age and restraint use. For children, only the 2016-2018 data, which is more detailed for child restraints, was used to identify the specific type of car seat and compare to recommendations. The distribution of restraint type for children aged 0-10 is shown in Figure 6. The percent unrestrained is dashed and plotted on the right axis. Percentages of different restraint types are solid and plotted on the left axis. The unrestrained rate is lowest for children age 10 years (1.4%) and highest for children aged 4-6 (2.6% each). However, a substantial fraction of children under age 1 are reported as restrained without a car seat (i.e., lap belt, shoulder belt or both). It is unclear whether this is a coding error (of age or restraint) or whether these infants are riding in laps or actually restrained without a car seat. Otherwise, patterns of car seat use generally mirror the age recommendations. For example, rear-facing child restraint use is highest for children under 1 (58.9%) and decreases to less than 5% by age 3. Front-facing child restraints are used by 46.8% of 1-year-olds, peak at 73.9% for 2-year-olds and decrease steadily through age 10. Finally, booster-seat use peaks at age 6 at 25.0%.

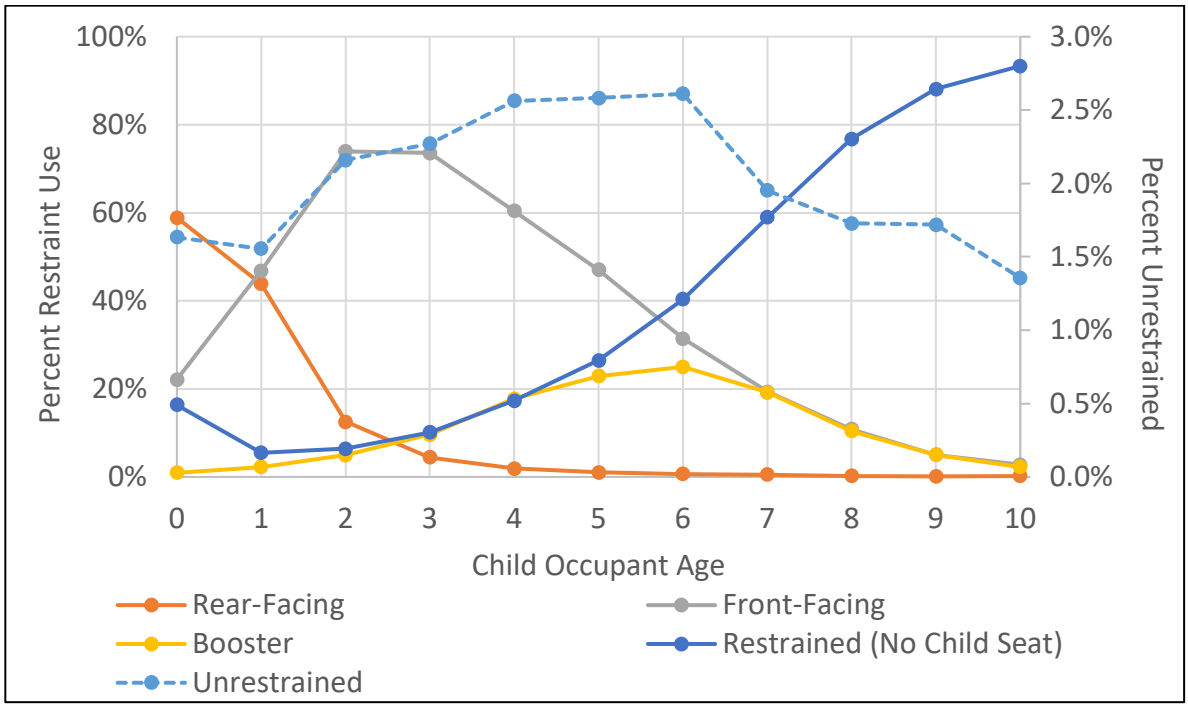

Figure 6 – Distribution of Restraint Type by Age for Children 0-10 Years Old

Table 6 shows the breakdown of restraint type by age groups for adults. Ages are grouped into young teens (11-14), older teens (15-20), young adults (21-24) and all others (25+). The table gives counts of passenger-vehicle occupants over the five-year period for each restraint and age category, as well as percentages out of all occupants (including unknown). The overall proportion of restraint use is also provided, calculated with unknown/error excluded. In general, restraint use is high for all groups, but does increase with age. Most importantly, optimal restraint use (lap and shoulder belt) increases with age. The 11-14 age group is much more likely to use lap belt only (almost four times as likely) or a shoulder belt only (more than twice as likely) compared to other age groups.

Table 6. Restraint Use by Age Group

	Age Group			
Restraint Category	**11-14**	**15-20**	**21-24**	**25+**
No belt available	124 (0.4%)	966 (0.3%)	759 (0.3%)	4,646 (0.2%)
No restraint	553 (1.6%)	4,617 (1.3%)	3,529 (1.2%)	14,473 (0.7%)
Lap and shoulder belt	30,054 (88.7%)	340,637 (93.7%)	267,796 (93.0%)	1,839,039 (94.4%)
Lap belt only	794 (2.3%)	2,097 (0.6%)	1,048 (0.4%)	5,862 (0.3%)
Shoulder belt only	357 (1.1%)	1,513 (0.4%)	1,192 (0.4%)	7,465 (0.4%)
Restraint failure	14 (0.0%)	116 (0.0%)	100 (0.0%)	564 (0.0%)
Unknown/Error	1,977 (5.8%)	13,622 (3.7%)	13,661 (4.7%)	75,745 (3.9%)
Total	33,873	363,568	288,085	1,947,794
Percent Restrained (excluding unknown)	97.9%	98.4%	98.4%	99.0%

8.0 Additional Variables

Table 7 shows restraint use rates broken down by three variables that could have an influence on restraint use. These variables are 1) gender, 2) day of the week (weekend vs. weekday), and 3) month of the year (Oct-Mar vs. Apr-Sep). There are no notable differences in the gender breakdown of restraint use for either children or adults. On weekends, adult restraint use is slightly lower, probably associated with the increased use of alcohol (and its relationship to restraint non-use; see Section 5.0). Children are more likely to be restrained without using a child seat on weekends, and their general unrestrained use rate is slightly higher on weekends. Finally, we might expect that child seat use would be lower during cold months when it is more difficult to secure children with bulky coats in car seats. However, no clear pattern appears to be present. Car seat use is slightly lower in warm months, and during those months, children are slightly more likely to be restrained without a car seat or unrestrained. For adults there is a negligible decrease in restraint use in warm months.

Table 7. Restraint Use for Children and Adults by Gender, Weekday/Weekend, and Cold/Warm Months

Occupant Group	Restraint Category	Male	Female	Weekday	Weekend	Cold Months (Oct-Mar)	Warm Months (Apr-Sep)
Children	Restrained (no child seat)	17,430 (37.6%)	17,055 (37.7%)	24,735 (36.5%)	9,877 (40.9%)	16,818 (36.9%)	17,794 (38.4%)
	Restrained (child seat)	27,767 (59.9%)	27,098 (60.0%)	41,367 (61.1%)	13,631 (56.5%)	27,715 (60.8%)	27,283 (58.9%)
	Unrestrained	1,183 (2.6%)	1,046 (2.3%)	1,621 (2.4%)	625 (2.6%)	1,015 (2.2%)	1,231 (2.7%)
Adults	Restrained	1,308,061 (98.7%)	1,190,140 (99.0%)	1,949,128 (99.0%)	549,520 (98.4%)	1,360,623 (98.9%)	1,138,025 (98.7%)
	Unrestrained	17,475 (1.3%)	12,154 (1.0%)	20,587 (1.0%)	9,080 (1.6%)	14,984 (1.1%)	14,683 (1.3%)

9.0 Conclusions

In this report, the relationship between restraint use and a variety of other crash and person characteristics was analyzed. This analysis focused on passenger-car occupants involved in crashes in 2014-2018, and generally separated analysis of occupants age 0-10, labeled “children,” and occupants age 11 and older, labeled “adults” for restraint-use purposes. The new UD-10 form allows us to identify specific types of car seats for crash years 2016-2018 but prior to that, only the use or nonuse of a car seat of any kind is coded.

Over the 5-year time frame, restraint use has been very high in Michigan and even slightly increasing. The highest rate for adults was 99.0% and for children was 98.3%, both in 2017. That said, many children are suboptimally restrained, particularly 5-8-year-olds, who are likely to be in lap and shoulder belts rather than booster seats. Interestingly, the percentage of 0-1-year-olds coded as suboptimally restrained in front-facing child seats decreased substantially between 2016 and 2017. NHTSA’s

recommendation to keep 1-year-olds in rear-facing seats until age 2 came out in 2011, and it may be that educational campaigns and car-seat clinics made a substantial difference in getting the message out to parents by 2017.

Restraint use is strongly associated with reduced levels of injury and fatality for adults and children, though children have generally lower rates of injury and fatality than adults. Less than 0.1% of restrained adults were killed, but more than 3.2% of unrestrained adults were killed. For children, the difference between restrained children (0.046% killed without a child seat, 0.038% killed with a child seat) and unrestrained children (0.58% killed) is still quite dramatic.

Adult and child occupants in vehicles with impaired drivers have lower restraint-use rates, with the lowest rates among those in vehicles with drivers impaired by both drugs and alcohol. Seat position also influences restraint rates and types, especially among children. For example, 7.9% of children under age 11 are riding in the front row. Among infants (age 0-1) in the front row, 77.5% are restrained without a child seat and 18.3% are restrained with a child seat. In contrast, when these children are in the second or third row, they are restrained without a child seat approximately 7% of the time and with a child seat approximately 91% of the time. Five-to-eight-year-olds are restrained without child restraints almost 50% of the time in the second and third rows, suggesting that some parents are transitioning these children out of car seats in general. Finally, for 9-10-year-olds, just under 10% are restrained with child restraints in the second and third rows, and only 1.2% use a child restraint in the front row. For adult occupants, about 10% of rear-seat occupants over age 10 are unbelted, a much higher rate than for front-seat adult occupants.

Restraint use rates change with age. The unrestrained rate was lowest for children age 10 years at 1.4% and highest for 6-year-olds at 2.6%. Among adults, restraint use increased with age, starting at 97.9% for young teens (11-14) and rising to 99.0% for those 25 and older. The newer child-restraint codes allow us to see patterns of use rates for specific car seat types (rear-facing, front-facing, and booster), which mirror the age recommendations from NHTSA. However, booster-seat use is still relatively low for ages 4-8, with 40.3% of 6-year-olds and 76.8% of 8-year-olds using vehicle restraints without any child restraint. Finally, restraint use is the same by gender, lower on weekends (compared to weekdays), and the same across different months of the year.