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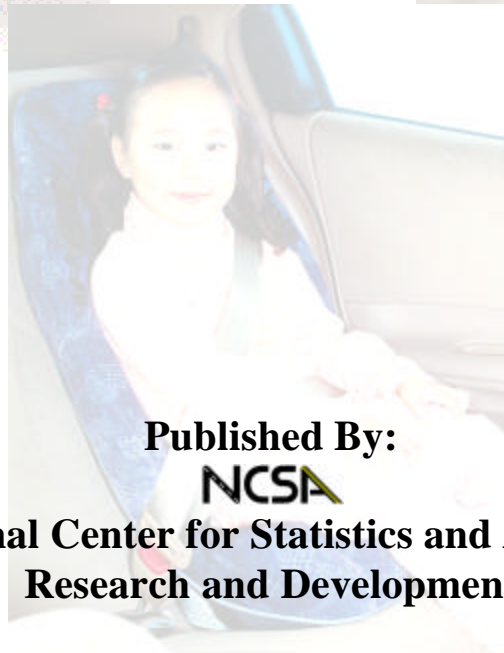
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Technical Report



# Fatalities and Injuries to 0-8 Year Old Passenger Vehicle Occupants based on Impact Attributes



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16. Abstract <p>The number of passenger vehicle occupant fatalities among children 0 to 8 years old has shifted relatively little from 923 in 1991 to 895 in 2000. During this time-period, the number of annual fatalities decreased 9 percent among children 0 to 3 years old, and rose 3 percent among children 4 to 8 years old. Among children 0 to 3 years old, the percentage of fatalities where the child was unrestrained dropped from 58 percent in 1991 to 34 percent in 2000, mainly due to the increased usage of child safety seats. This percentage dropped from 64 percent to 48 percent for the 4 to 8 year old age group, as lap and/or shoulder belt usage increased.</p> <p>Crashes involving frontal impacts accounted for more than 5 times as many fatalities as rear impacts, among children 0 to 8 years old. Sixty-one percent of side impact fatalities involved children seated adjacent to the impacted side, while only 20 percent involved children seated opposite the side of impact.</p> <p>The objective of this study by the National Center for Statistics and Analysis (NCSA) is to analyze passenger vehicle crashes involving children 0 to 8 years old. The NCSA's Fatality Analysis Reporting System (FARS), NCSA's National Automotive Sampling System (NASS) General Estimates System (GES), and NASS Crashworthiness Data System (CDS) were consulted to establish restraint usage trends over a ten-year period and contrasted with National Occupant Protection Use Survey (NOPUS) restraint usage rates in preparing this report. Fatality rates were calculated using population data from the U.S. Census Bureau and vehicle miles traveled (VMT) from the Federal Highway Administration (FHWA). The study is intended to provide a better understanding of where to focus future safety efforts designed to improve highway transportation for young children.</p>					
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## 1. EXECUTIVE SUMMARY

This report, published by National Highway Traffic Safety Administration's (NHTSA) National Center for Statistics and Analysis (NCSA), provides insight into fatalities and injuries to passenger vehicle occupants, age 0 through 8 years old, based on a variety of impact attributes. Variables examined include restraint use, seating position, principal vehicle impact point, injury severity, injured body region, and passenger age. The analysis was based on 1991-2000 data from several different databases: NCSA's Fatality Analysis Reporting System (FARS), a census of fatal motor vehicle crashes; NCSA's National Automotive Sampling System General Estimates System (GES) and Crashworthiness Data System (CDS), which collect data regarding injuries resulting from motor vehicle crashes; Federal Highway Administration (FHWA) data regarding vehicle miles traveled (VMT); and, the United States Census Bureau, general population data.

Passenger vehicle occupant fatalities for children age 0 through 8 years old remained relatively constant from 1991 through 2000, despite a significant increase in the annual number of passenger vehicle miles traveled. Key factors contributing to this improvement in child passenger safety include a reduction in the percentage of children traveling unrestrained, and an increase in the usage of child safety seats and lap and/or shoulder belts.

This report does not analyze all variables existing within the databases created by NCSA. Further analyses can be done which expand the understanding of fatality and injury risks facing young children traveling within passenger vehicles. NCSA plans to conduct these analyses and report the findings in the future.

### 1.1 Summary

Conclusions listed below are based on the following categorical specifications included within the FARS and NASS database systems.

**Vehicle Type :** Passenger vehicles (passenger cars and light trucks)

**Ages:** 0 through 8 years old

**Restraint Use:** Child safety seat, lap and/or shoulder belt, unrestrained, and other/unknown

**Seating Positions:** Front passenger seat (middle and right) and second seat (left, middle, and right)

**Principal Impact Points:** Front impact, rear impact, near side impact, and far side impact

**Injury Severity:** Abbreviated Injury Scale (AIS) ranging from AIS 1, minor through AIS 6, maximum (untreatable)

**Years:** 1991 – 2000.

## 1.2 Conclusions

The following conclusions are based on the analysis within this report. Based on these conclusions, NCSA will conduct further studies to gain more insight into the fatality and injury risks facing young children.

- Exposure data show that the number of annual vehicle miles traveled has increased nearly 25 percent between 1991 and 2000.
- For children within the age groups less than 1, 1 through 3, and 4 through 8, the fatality rates per vehicle miles traveled have declined, as the use of child safety seats and lap and/or shoulder belts have increased.
- The overall number of annual fatalities decreased 9 percent within the 0 through 3 year old age range, corresponding to 1996 implementation of the NHTSA Buckle Up America campaign and the National Safety Council's Airbag and Seatbelt Safety campaign.
- The overall number of annual fatalities increased 3 percent within the 4 through 8 year old age range.
- The number of fatalities where the occupant was unrestrained decreased 47 percent within the 0 through 3 year old age range and decreased 23 percent within the 4 through 8 year old age range.
- Concurrent with the 1996 traffic safety campaigns intended to improve child passenger safety, the seating position of many children shifted from the front seat to the second seat.
- Many more fatalities were attributable to frontal impacts versus rear impacts, despite the shifting of children to rear seats.
- Among side impact crashes, the number of near side fatalities is 2.6 times greater than the number of far side fatalities.
- Of the six injury severity levels ranging from minor to maximum, 92 percent of all injuries occur within the injury level of least severity, minor.
- Head injuries account for 57 percent of all injuries.

## 2. INTRODUCTION

More than 9,500 0 through 8 year old passenger vehicle occupants were killed and more than 1,430,000 0 through 8 year old passenger vehicle occupants were injured in motor vehicle crashes from 1991 through 2000. This report by NCSA examines 0 through 8 year old passenger vehicle occupant fatalities and injuries from 1991 through 2000.

The purpose of this report is to:

- Use FARS, GES and CDS data to analyze passenger vehicle crashes involving children age 0 through 8 years old
- Use exposure data including VMT from FHWA, and population size from the US Census Bureau
- Calculate fatality rates by combining exposure data with FARS data
- Gain a better understanding of where to focus future safety efforts designed to improve highway transportation for young children

This report analyzes the relationship between many variables pertaining to the safety of children in passenger vehicles. The focus of this report includes the impact of different methods of restraint use, including children in child safety seats, lap and/or shoulder belts, or traveling unrestrained. The report examines children less than one year old, 1 through 3 years old, 4 through 8 years old, and the combined age category of 0 through 8 years old.



### 3. ANALYTICAL APPROACH

The analytical approach for the report involved the following steps:

- Reviewing the data sources, FARS, GES, CDS, FHWA and US Census Bureau
- Formulating a methodology to determine the elements of interest
- Calculating percentages and rates to analyze 10 years of trend data within specific data elements
- Summarizing data that focus on the safety of children in passenger vehicles

#### 3.1 Data Sources

In compiling the data for child occupants ages 0 through 8 years old, five primary sources were consulted. These were:

- Fatality Analysis Reporting System (FARS) relating to fatal traffic crashes
- National Automotive Sampling System (NASS) – General Estimates System (GES) relating to injury crashes
- NASS - Crashworthiness Data System (CDS) relating to injury crashes
- *2000 Traffic Safety Facts* for Federal Highway Administration (FHWA) data for vehicle miles traveled
- U.S. Census Bureau for resident population

Descriptions of relevant data sources are included in the Appendix, Section 11.1.

#### 3.2 Methodology

The following sections provide an overview relative to the variables and statistics used within this report.

##### 3.2.1 Variables

**Vehicle Type** - The report examines fatalities and injuries to occupants of passenger vehicles. Passenger vehicles include the following body types: passenger cars, vans, pickup trucks, sport utility vehicles, and other light trucks.

**Age** - Children within the age range of 0 through 8 years old are included in this report. The data were frequently divided into three age groups: less than one year

old, 1 through 3 years old (1, 2, and 3 years old), and 4 through 8 years old (4, 5, 6, 7, and 8 years old). The age categories remain consistent throughout this report, as the phrases “4 through 8 years old”, “4 to 8 years old”, and “4 – 8 years old” are all equivalent, representing children of ages 4, 5, 6, 7, and 8 years old.

**Restraint Use** - Restraint use is divided into the following four categories: child safety seat, lap and/or shoulder belt, unrestrained, and other/unknown. In Sections 4.1, 4.2, and 11.1, child safety seat and lap and/or shoulder belt usage are combined to form the restrained category.

**Seating Position** - Children traveling in the front passenger seat and second seat were included in this report. The front passenger seat was divided into the front middle seat and the front right seat. The second seat was separated into three seating positions: right side, middle and left side. The driver’s seating position, the third and fourth rows of the vehicle, and other areas were excluded.

**Person Type** - The report was limited to people within passenger vehicles in transport. Pedestrians, bicyclists, and occupants of motor vehicles not in transport are excluded from this report.

**Impact Points** - This study examined the principal impact point of the crash limited only to planar crashes. Crashes where the principal impact point occurred on the top or undercarriage of the vehicle were excluded in this study. The direction of impact was categorized using the 12 clock points. These clock points were separated into the following four impact categories: front (11 o’clock, 12, and 1), rear (5, 6, and 7), left (8, 9, and 10) and right (2, 3, and 4).

**Injury Severity** - All charts and tables involving data collected from the FARS database provide information relating to fatal crashes. The charts in this report created using GES data aggregate all levels of injury severity from the GES database. These aggregated levels of injury severity are unique to the GES database. The categories of injury severity included within the CDS database are as follows: AIS 1 – Minor, AIS 2 – Moderate, AIS 3 – Serious, AIS 4 – Severe, AIS 5 – Critical, and AIS 6 – Maximum (untreatable).

**Body Region** - The CDS categories of injured body regions include: abdomen, chest, head, lower extremity, neck, and upper extremity. The lower extremity extends from the pelvic region to the foot. The area from the shoulder to the hand comprises the upper extremity.

**Years** - This report examines passenger vehicle fatalities and injuries over the years 1991 through 2000. Data gathered from FARS and GES databases include information on crashes throughout this time period. Injuries occurring in 1997, described in the CDS database, were omitted due to issues involving the electronic conversion of this database.

### 3.2.2 Statistical Qualifiers

From 1991 through 2000, there has been an increase in child safety seat usage and lap and/or shoulder belt usage among children in passenger vehicles. During this time period, the number of fatalities involving children restrained in these devices has risen. This rise can be largely attributable to the increase in restraint usage that occurred over this time period.

The passenger vehicle occupant fatality rates per U.S. population are presented in Section 6.1. These rates are not calculated based upon restraint usage estimates within each age category. For example, the fatality rates for passengers restrained by child safety seats, within each age category, are calculated by dividing the number of fatalities where the passengers were restrained by a child safety seat by the total population size of that age category.

The passenger vehicle occupant fatality rates per vehicle miles traveled (VMT) are presented in Section 6.2. The VMT used in the calculations is an estimate of the annual number of miles traveled by all passenger vehicles during the years 1991 through 2000. Given that these figures are estimates of the number of miles traveled by passengers of all ages, they are not equal to the number of miles traveled by children age 0 through 8. It is assumed, however, that the two separate VMT totals for these two age categories are strongly correlated, given the diverse age distribution of the drivers of these children.

## **4. PASSENGER VEHICLE OCCUPANT FATALITY AND INJURY DATA**

This chapter presents findings based on restraint use for all ages and the 0-8 year old age group. The restraint use in this section has been categorized as restraint used (both child safety seat and lap and/or shoulder belt), none used and unknown in order to make a comparison between the two age groups. While Sections 4.1 and 4.2 have a restraint use category listed as “unknown”, the final restraint use category of Section 4.3 is defined as “other/unknown” owing to the precision of additional restraint use data within the CDS database.

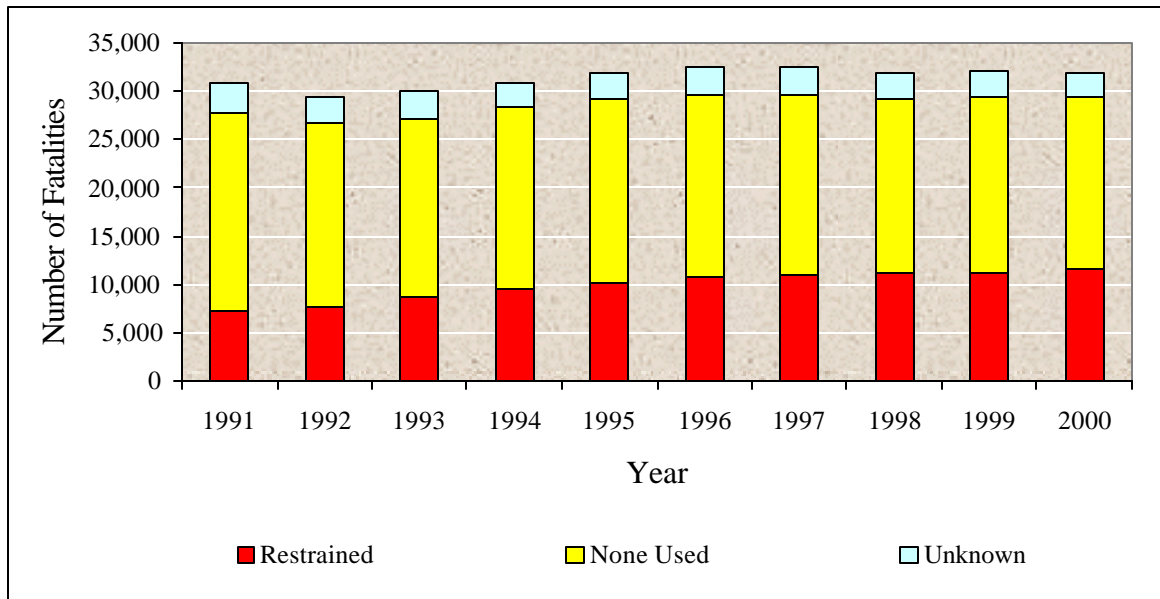
### **4.1 Passenger Vehicle Occupants Killed, by Restraint Use (FARS Data)**

Table 1 shows the number of passenger vehicle occupant fatalities, for all ages, broken down by restraint use. The number of fatalities increased from 30,776 in 1991 to 31,910 in 2000, a rise of 4 percent. The percentage of fatalities where the occupant was restrained by a lap and/or shoulder belt or child safety seat increased from 24 percent in 1991 to 37 percent in 2000, an increase of 13 percentage points. The percentage of fatalities where the passenger was unrestrained, falling under the “None Used” category, decreased from 67 percent to 55 percent during this time period. The “Unknown” category of restraint use declined only slightly, from 10 percent to 8 percent, for fatally injured occupants over the ten year period. In fact, the percentage of fatally injured occupants that were restrained increased each year since 1991. However, still more than half (55 percent) of the fatally injured occupants were unrestrained in 2000.

The number of fatalities in the 0-8 year old age range dropped from 923 in 1991 to 895 in 2000, a decrease of 3 percent. Table 2 shows the number of passenger vehicle occupant fatalities, for children in the 0 through 8 year old age range, categorized by restraint use. The percentage of fatalities where the passenger was restrained by a lap and/or shoulder belt or child safety seat increased from 32 percent in 1991 to 53 percent in 2000, an increase of 21 percentage points. The percentage of fatalities where the passenger was unrestrained decreased by 20 percentage points from 61 percent in 1991 to 41 percent in 2000. Still over 40 percent of the 0-8 year old fatally injured occupants were unrestrained in 2000.

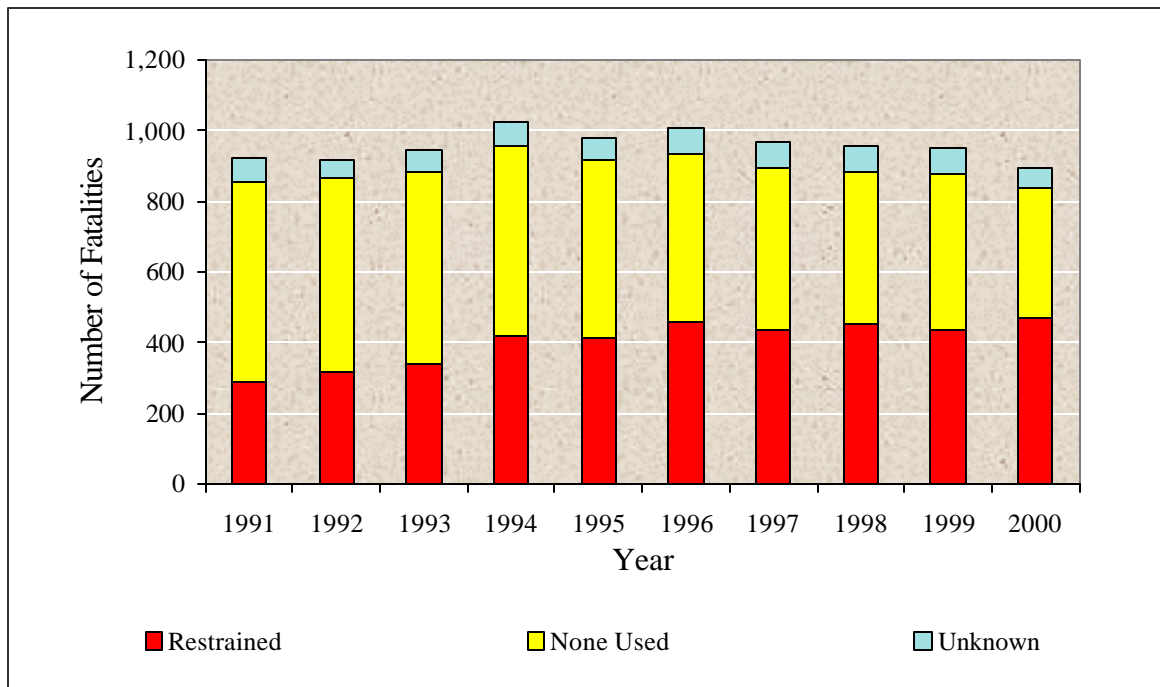
A comparison between Table 1 and Table 2 shows that the proportion of fatalities involving people who were unrestrained was higher among occupants of all ages compared to children 0 through 8 years old. The number of fatalities among all ages shows a small increase from 1991 to 2000, and a small decrease within the 0-8 year old age group despite the large increase in restraint use that occurred during this time period. The fact that these numbers of fatalities have risen from 1991 to 2000 is mostly attributable to the increase in vehicle miles traveled.

Chart 1: Passenger Vehicle Occupant Fatalities, All Ages, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

Chart 2: Passenger Vehicle Occupant Fatalities, 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

<b>Table 1</b>							
<b>Passenger Vehicle Occupant Fatalities, All Ages, by Year and Restraint Use</b>							
<b>Year</b>	<b>Restraint Use</b>						<b>Total</b>
	<b>Restrained</b>		<b>None Used</b>		<b>Unknown</b>		
1991	7,331	24%	20,488	67%	2,957	10%	30,776
1992	7,698	26%	19,053	65%	2,734	9%	29,485
1993	8,677	29%	18,553	62%	2,847	9%	30,077
1994	9,641	31%	18,636	60%	2,624	8%	30,901
1995	10,152	32%	19,123	60%	2,716	8%	31,991
1996	10,713	33%	18,848	58%	2,876	9%	32,437
1997	10,995	34%	18,642	57%	2,811	9%	32,448
1998	11,213	35%	18,022	56%	2,664	8%	31,899
1999	11,174	35%	18,316	57%	2,637	8%	32,127
2000	11,676	37%	17,618	55%	2,616	8%	31,910

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

<b>Table 2</b>							
<b>Passenger Vehicle Occupant Fatalities, Age 0 - 8 Years Old, by Year and Restraint Use</b>							
<b>Year</b>	<b>Restraint Use</b>						<b>Total</b>
	<b>Restrained</b>		<b>None Used</b>		<b>Unknown</b>		
1991	292	32%	564	61%	67	7%	923
1992	320	35%	546	59%	53	6%	919
1993	338	36%	543	57%	67	7%	948
1994	419	41%	537	52%	72	7%	1028
1995	417	42%	500	51%	66	7%	983
1996	457	45%	477	47%	76	8%	1010
1997	434	45%	460	48%	73	8%	967
1998	454	48%	432	45%	69	7%	955
1999	436	46%	440	46%	76	8%	952
2000	470	53%	367	41%	58	6%	895

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

## 4.2 Passenger Vehicle Occupants Injured, by Restraint Use (GES Data)

Table 3 shows the number of passenger vehicle occupants injured, for all ages, broken down by restraint use. The number of occupants injured increased from 2,797,000 in 1991 to 2,938,000 in 2000, an increase of 5 percent. The percentage of occupants injured where the passenger was restrained by a lap and/or shoulder belt or child safety seat increased from 63 percent in 1991 to 80 percent in 2000, an increase of 17 percentage points. The percentage of occupants injured where the passenger was unrestrained, falling under the “None Used” category, decreased from 27 percent in 1991 to 12 percent in 2000. The percentage of injured occupants who were restrained has increased each year from 1991 to 2000.

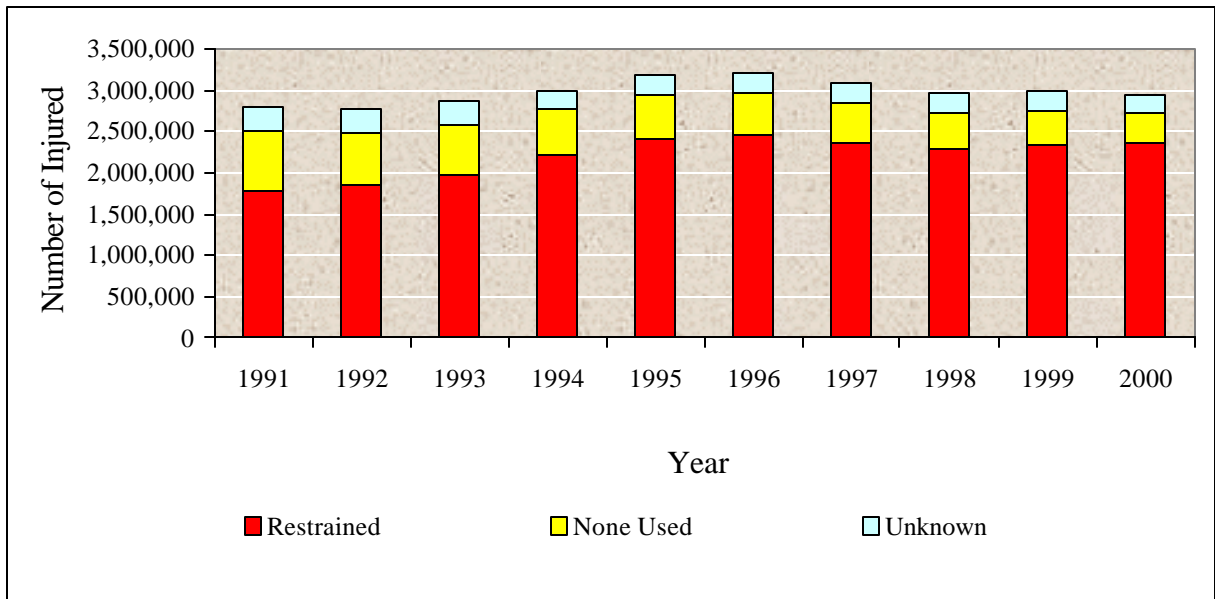
The number of injured occupants in the 0-8 year old age range declined from 141,000 in 1991 to 132,000 in 2000, a decrease of 6 percent. Table 4 shows the number of passenger vehicle occupants injured, for children in the 0 through 8 year old age range, categorized by restraint use. The percentage of injured occupants where the passenger was restrained by a lap and/or shoulder belt or child safety seat increased from 61 percent in 1991 to 83 percent in 2000, an increase of 22 percentage points. The percentage of occupants injured where the passenger was unrestrained, falling under the “None Used” category, decreased from 31 percent in 1991 to 12 percent in 2000.

Comparing the data from 1991 through 2000, the increase in the percentage of restrained occupants injured and the decrease in the percentage of unrestrained occupants injured were nearly identical for both children 0 through 8 years old and for all ages combined.

The number of injured occupants for all ages showed a small increase from 1991 to 2000, despite the large increase in restraint use that occurred during this time period. The fact that the number of injured occupants for all ages has risen from 1991 to 2000 is mostly attributable to the increase in the number of vehicle miles traveled.

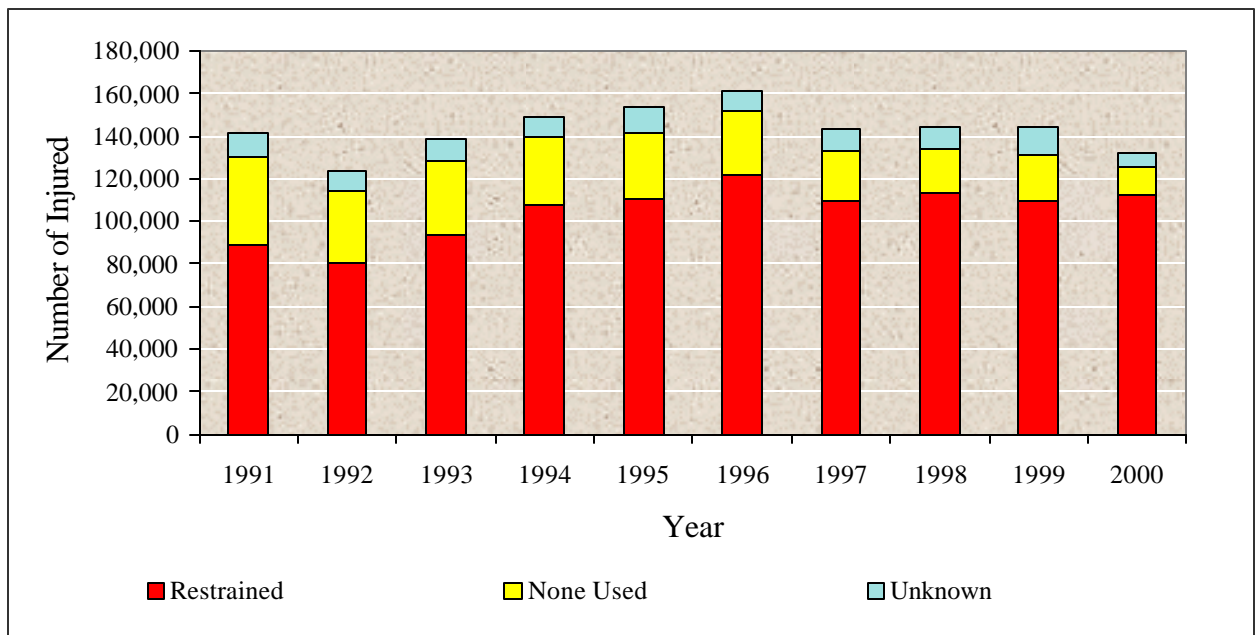
Restraint use in GES is determined by police and may be overreported for survivors. GES estimates are rounded to the nearest thousand.

Chart 3: Passenger Vehicle Occupants Injured, All Ages, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

Chart 4: Passenger Vehicle Occupants Injured, Age 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000



<b>Table 3</b>							
<b>Passenger Vehicle Occupants Injured, All Ages, by Year and Restraint Use</b>							
<b>Year</b>	<b>Restraint Use</b>						<b>Total</b>
	<b>Restrained</b>		<b>None Used</b>		<b>Unknown</b>		
1991	1,780,000	63%	725,000	27%	292,000	10%	2,797,000
1992	1,854,000	67%	622,000	23%	300,000	10%	2,776,000
1993	1,983,000	69%	589,000	21%	294,000	10%	2,866,000
1994	2,208,000	73%	564,000	20%	223,000	7%	2,995,000
1995	2,415,000	74%	536,000	18%	241,000	8%	3,192,000
1996	2,468,000	76%	509,000	17%	242,000	7%	3,220,000
1997	2,369,000	76%	469,000	16%	258,000	8%	3,095,000
1998	2,297,000	78%	427,000	14%	239,000	8%	2,964,000
1999	2,327,000	78%	412,000	14%	245,000	8%	2,984,000
2000	2,368,000	80%	359,000	12%	211,000	7%	2,938,000

Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

<b>Table 4</b>							
<b>Passenger Vehicle Occupants Injured, Age 0 - 8 Years Old, by Year and Restraint Use</b>							
<b>Year</b>	<b>Restraint Use</b>						<b>Total</b>
	<b>Restrained</b>		<b>None Used</b>		<b>Unknown</b>		
1991	89,000	61%	41,000	31%	12,000	8%	141,000
1992	80,000	64%	34,000	28%	10,000	8%	122,000
1993	94,000	68%	34,000	25%	11,000	8%	139,000
1994	108,000	72%	32,000	22%	9,000	6%	150,000
1995	111,000	72%	31,000	21%	12,000	7%	153,000
1996	122,000	74%	30,000	20%	9,000	6%	162,000
1997	110,000	74%	23,000	18%	10,000	8%	143,000
1998	113,000	77%	21,000	16%	10,000	7%	144,000
1999	110,000	78%	21,000	14%	13,000	8%	144,000
2000	112,000	83%	14,000	12%	6,000	5%	132,000

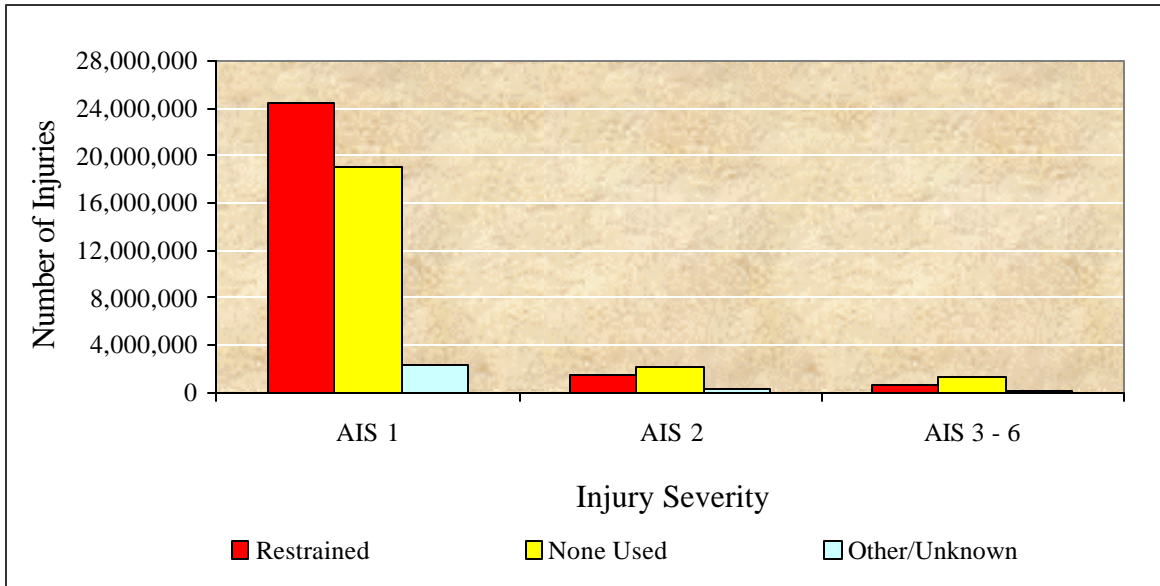
Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

### 4.3 Passenger Vehicle Occupant Injuries, by Injury Severity, Injured Body Region and Restraint Use (CDS Data)

The number of passenger vehicle occupant injuries for all ages, categorized by restraint use and injury severity, from 1991–1996 and 1998–2000, is shown in Table 5. Injury severity is defined using the Abbreviated Injury Scale (AIS), where the injury severity ranges from AIS 1, minor, up through AIS 6, maximum (untreatable). For a description of the categories of injury severity (AIS 1 through AIS 6), refer to Section 11.1. Within Table 5, it is seen that 88 percent of all injuries are AIS 1 injuries, while 8 percent are AIS 2 and 4 percent are among the four categories of AIS 3 – AIS 6. The proportion of injuries where the passenger was unrestrained rises as the severity of the injuries increases. Forty-two percent of AIS 1 injuries were sustained by an unrestrained passenger. This percentage of unrestrained injuries rose to 55 percent among AIS 2 injuries, and 62 percent among AIS 3 through AIS 6 injuries.

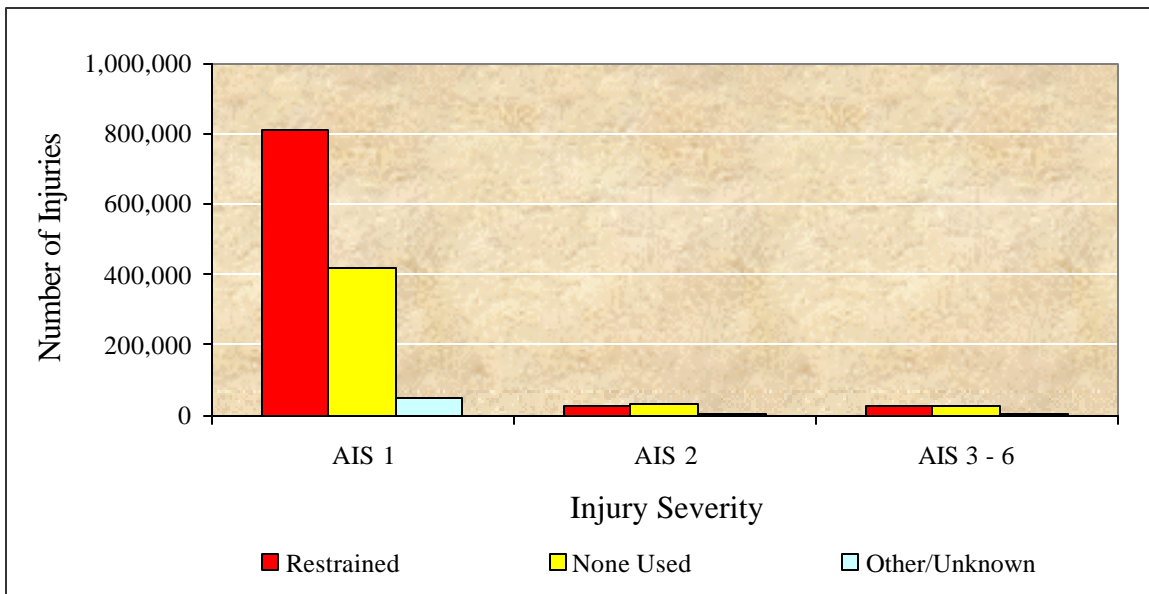
Table 6 shows the number of passenger vehicle occupant injuries for children in the 0 through 8 year old age range, categorized by restraint use and injury severity, from 1991–1996 and 1998–2000. Within this age group, 91 percent of all injuries are AIS 1 injuries, while 5 percent are AIS 2 and 4 percent are among the four categories of AIS 3 – AIS 6. A comparison of Tables 5 and 6 shows that children in the 0 through 8 year old age range have a slightly lower percentage of injuries of severity higher than AIS 1 (9 percent) than does the overall population (12 percent), suggesting that children are better restrained than adults. As seen within the overall age range, the proportion of injuries among the 0 through 8 year old passengers where the passenger was unrestrained rises as the severity of the injuries increases. Only 33 percent of AIS 1 injuries were sustained by an unrestrained passenger. This percentage of unrestrained injuries rises to 49 percent among AIS 2 injuries, and 52 percent among AIS 3 through AIS 6 injuries.

Chart 5: Passenger Vehicle Occupant Injuries, All Ages, by Injury Severity and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Chart 6: Passenger Vehicle Occupant Injuries, Age 0 – 8 Years Old, by Injury Severity and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

<b>Table 5</b>							
<b>Passenger Vehicle Occupant Injuries, All Ages, by Restraint Use and Injury Severity</b>							
<b>Restraint Use</b>	<b>Injury Severity</b>						<b>Total</b>
	<b>AIS 1</b>		<b>AIS 2</b>		<b>AIS 3-6</b>		
Restrained	24,374,144	92%	1,597,752	6%	607,447	2%	26,579,343
None Used	19,070,469	84%	2,279,149	10%	1,266,722	6%	22,616,340
Other/Unknown	2,305,533	83%	295,002	11%	173,030	6%	2,773,565
Total	45,750,146	88%	4,171,902	8%	2,047,198	4%	51,969,247
<b>Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000</b>							

<b>Table 6</b>							
<b>Passenger Vehicle Occupant Injuries, Age 0 - 8 Years Old, by Restraint Use and Injury Severity</b>							
<b>Restraint Use</b>	<b>Injury Severity</b>						<b>Total</b>
	<b>AIS 1</b>		<b>AIS 2</b>		<b>AIS 3-6</b>		
Restrained	811,972	94%	29,008	3%	23,452	3%	864,431
None Used	417,193	87%	31,652	7%	29,325	6%	478,169
Other/Unknown	50,057	88%	3,581	6%	3,464	6%	57,102
Total	1,279,222	91%	64,241	5%	56,241	4%	1,399,703
<b>Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000</b>							

## **5. PASSENGER VEHICLE OCCUPANTS KILLED OR INJURED, BY RESTRAINT USE**

Data regarding passenger vehicle occupants 0-8 years old, killed and injured, are presented based on restraint use. The categories of restraint use in this section and the remainder of this report are: child safety seat, lap and/or shoulder belt, unrestrained, and other/unknown.

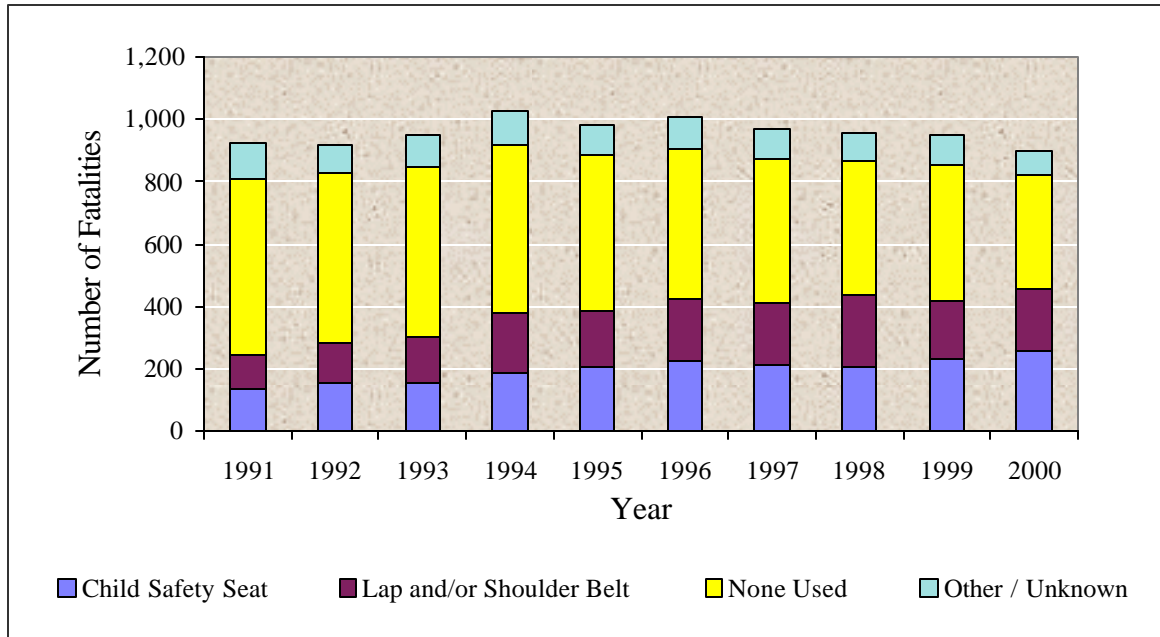
### **5.1 Passenger Vehicle Occupants Killed, by Age Group, Year and Restraint Use**

This section discusses passenger vehicle occupant fatalities, broken down by restraint use and age group, from 1991 through 2000. The age group categories include 0-8, <1, 1-3, and 4-8 years old.

#### **5.1.1 Passenger Vehicle Occupants Killed, by Year and Restraint Use, Age 0 – 8**

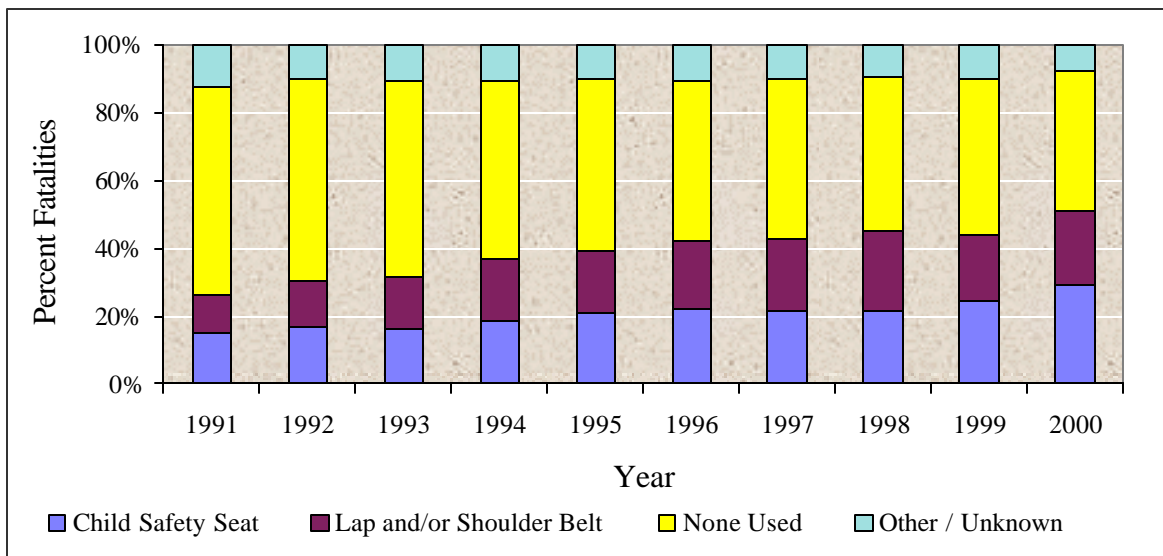
Table 7 refers to passenger vehicle occupant fatalities, for children in the 0 through 8 year old age range, categorized by restraint use. The overall number of fatalities dropped slightly from 923 in 1991 to 895 in 2000. The number of fatalities where the passenger was unrestrained dropped from 564 in 1991 to 367 in 2000. As displayed in Table 7, the percentage of fatalities where the passenger was unrestrained fell from 61 percent in 1991 to 41 percent in 2000, a reduction of 20 percentage points. Given the large increase in lap and/or shoulder belt usage during the 1990's, the number of fatalities where passengers were restrained by lap and/or shoulder belts rose from 106 in 1991 to 197 in 2000. As child safety seat usage climbed significantly during this time-period, the number of fatalities where passengers were restrained by a child safety seat rose from 138 to 261.

Chart 7: Passenger Vehicle Occupants Killed, Age 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

Chart 8: Percent of Passenger Vehicle Occupants Killed, Age 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 7**  
**Passenger Vehicle Occupants Killed, Age 0 - 8 Years Old,**  
**by Year and Restraint Use**

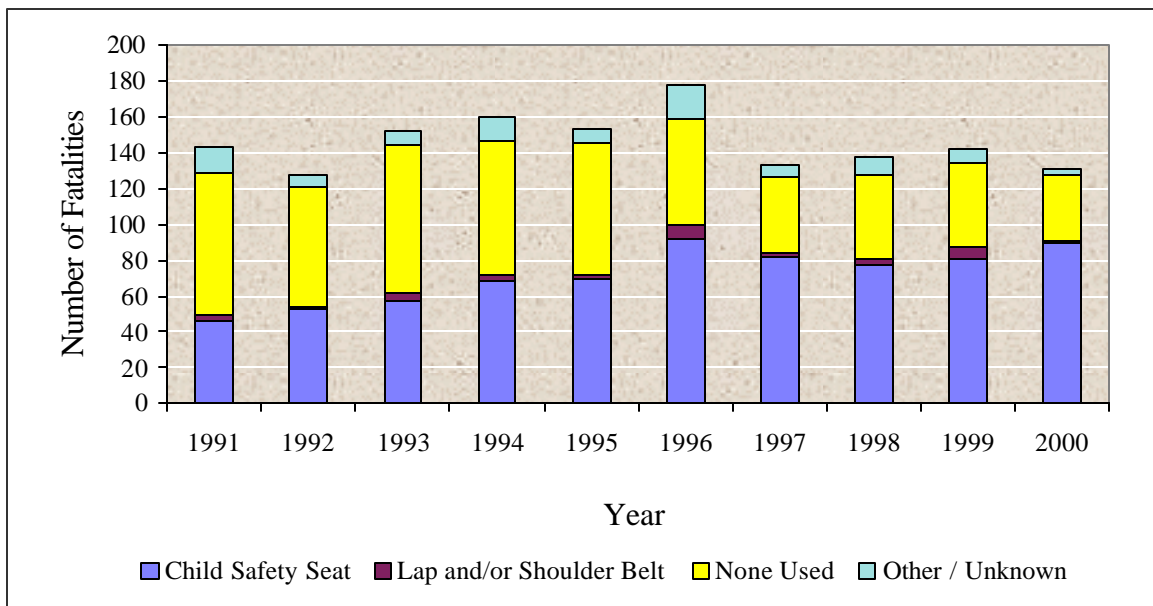
Year	Restraint Use								Total
	Child Safety Seat		Lap and/or Shoulder Belt		None Used		Other/Unknown		
1991	138	15%	106	11%	564	61%	115	12%	923
1992	156	17%	125	14%	546	59%	92	10%	919
1993	155	16%	147	16%	543	57%	103	11%	948
1994	188	18%	192	19%	537	52%	111	11%	1,028
1995	207	21%	178	18%	500	51%	98	10%	983
1996	223	22%	204	20%	477	47%	106	10%	1,010
1997	211	22%	202	21%	460	48%	94	10%	967
1998	207	22%	227	24%	432	45%	89	9%	955
1999	234	25%	182	19%	440	47%	96	10%	952
2000	261	29%	197	22%	367	41%	70	8%	895

**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

### 5.1.2 Passenger Vehicle Occupants Killed, by Year and Restraint Use, Age < 1

Due to the significant increase in child safety seat usage among children less than one year old, the number of unrestrained fatalities fell 55 percent (80 in 1991 to 36 in 2000). The increase seen from 1991 to 1996 in the number of fatalities was reversed with a sharp decline in the number of fatalities in 1997, which may be attributable to the 1996 traffic safety campaigns advocating the movement of children from the front seat to the second seat. Table 8 refers to passenger vehicle occupant fatalities, for children less than one year old, categorized by restraint use. The 55 percent reduction in the number of unrestrained fatalities among children less than one year old is far larger than the 35 percent decline seen in the number of unrestrained fatalities among children age 0 through 8 (564 in 1991 to 367 in 2000) and the 14 percent decline seen in the number of unrestrained fatalities among all ages (20,488 in 1991 to 17,618 in 2000). The increase in child safety seat usage during this time-period caused the percentage of fatally injured children below one year old restrained by a child safety seat to climb from 32 percent to 68 percent. The number of fatalities under the age of one has not shown any significant increase between 1997 and 2000.

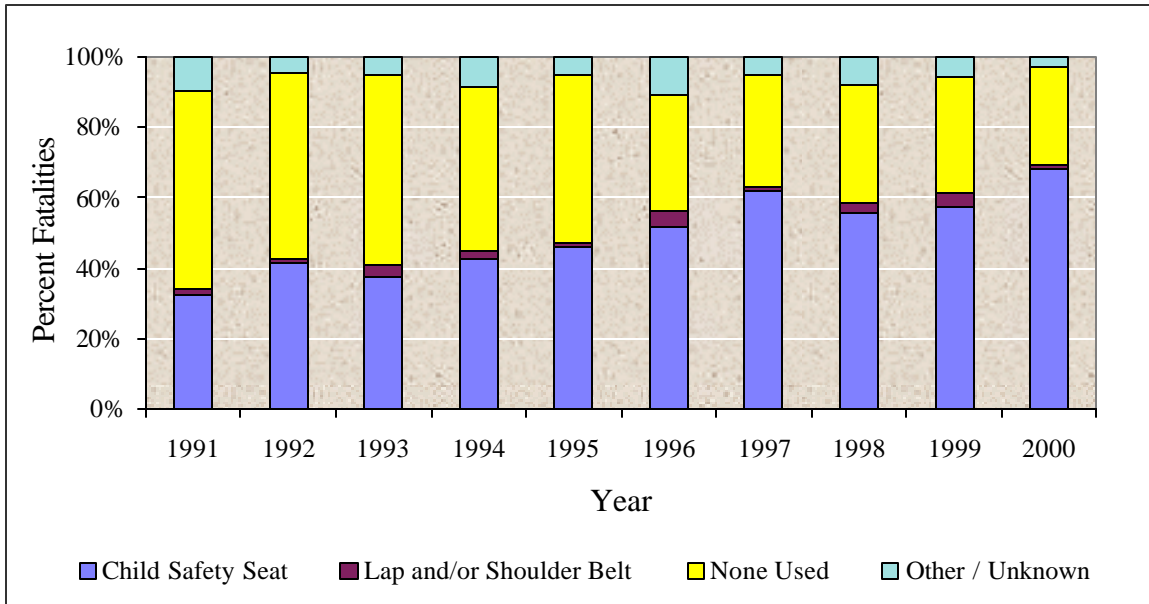
Chart 9: Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000



Chart 10: Percent of Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

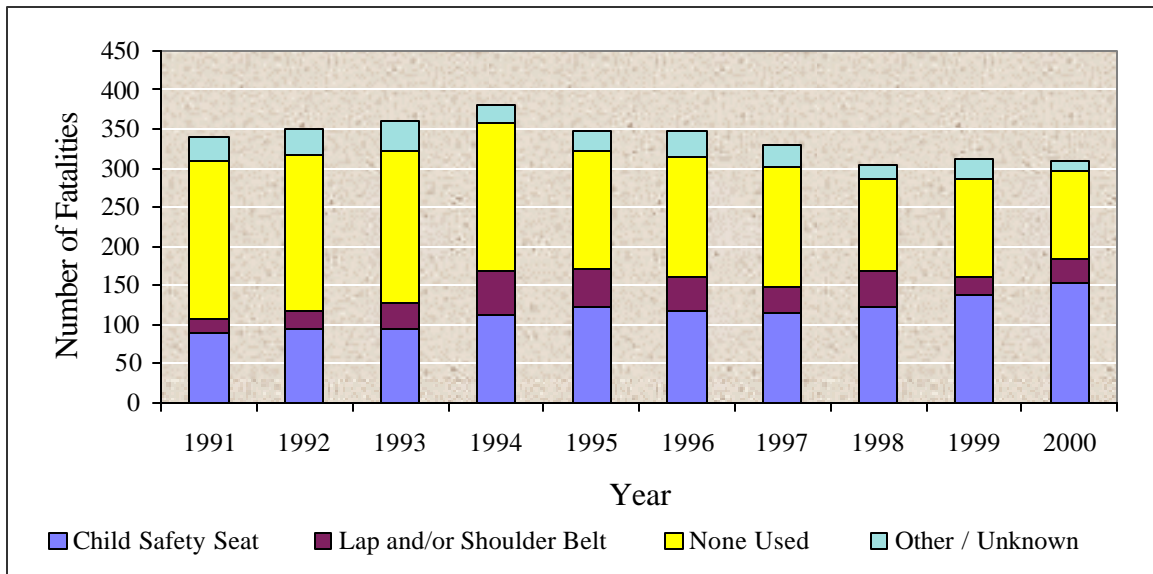
Year	Restraint Use								Total
	Child Safety Seat		Lap and/or Shoulder Belt		None Used		Other / Unknown		
1991	46	32%	3	2%	80	56%	14	10%	143
1992	53	42%	1	1%	67	53%	6	5%	127
1993	57	38%	5	3%	82	54%	8	5%	152
1994	68	43%	4	3%	74	46%	14	9%	160
1995	70	46%	2	1%	73	48%	8	5%	153
1996	92	52%	8	4%	59	33%	19	11%	178
1997	82	62%	2	2%	42	32%	7	5%	133
1998	77	56%	4	3%	46	33%	11	8%	138
1999	81	57%	6	4%	47	33%	8	6%	142
2000	89	68%	2	2%	36	27%	4	3%	131

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

### 5.1.3 Passenger Vehicle Occupants Killed, by Year and Restraint Use, Age 1 – 3

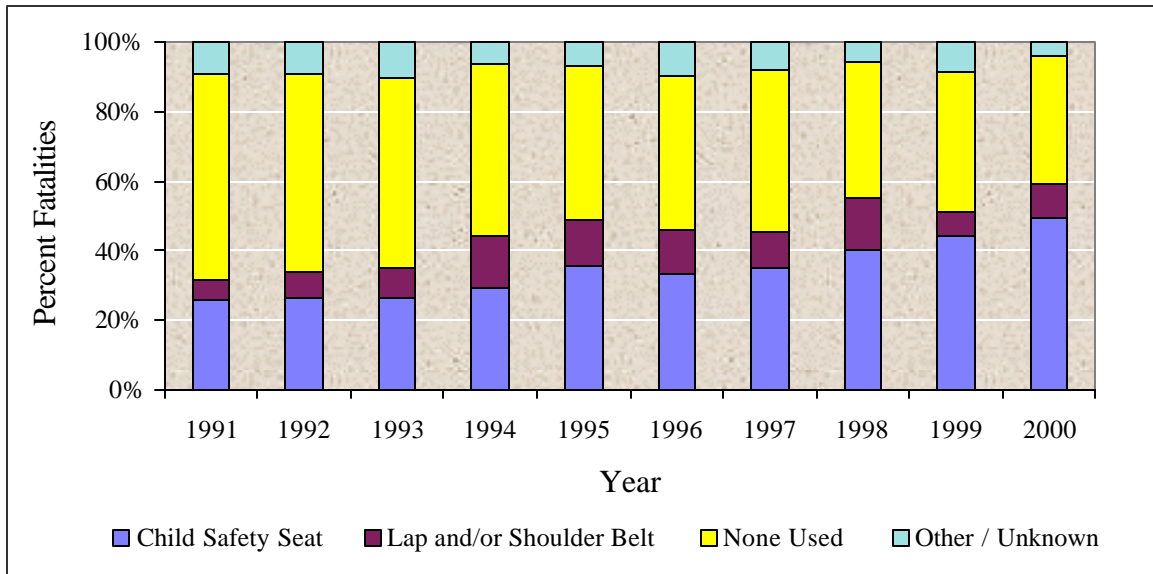
Table 9 shows the number and percent of passenger vehicle occupant fatalities, for children 1 through 3 years old, categorized by restraint use. Among the three age groups (<1, 1 – 3, and 4 – 8), the less than 1 year olds and the 1 through 3 year olds were the age categories where the number of fatalities clearly dropped from 1996 to 2000, each showing a reduction of 26 percent and 11 percent, respectively. The number of fatalities where the passenger was unrestrained declined from 201 in 1991 to 114 in 2000, a decrease of 43 percent. As child safety seat usage increased significantly during this time-period, the number of fatalities where passengers were restrained by a child safety seat increased from 88 to 153. The percent of fatalities where the child was restrained in a lap and/or shoulder belt ranged from 6 percent to 15 percent between 1991 and 2000. In comparison, this percentage remained below 5 percent for children less than one year old. The percent of fatally injured children restrained in a child safety seat has increased each year from 33 percent in 1996 to 49 percent in 2000. In 2000, only 37 percent of the fatalities among 1 through 3 year olds involved children who were unrestrained.

Chart 11: Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

Chart 12: Percent of Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

Year	Restraint Use								Total
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other / Unknown	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other / Unknown	
1991	88	26%	19	6%	201	59%	32	9%	340
1992	93	27%	25	7%	198	57%	33	9%	349
1993	95	26%	32	9%	196	54%	38	11%	361
1994	111	29%	57	15%	190	50%	23	6%	381
1995	123	35%	47	14%	153	44%	24	7%	347
1996	116	33%	44	13%	154	44%	33	10%	347
1997	115	35%	34	10%	153	47%	27	8%	329
1998	122	40%	47	15%	118	39%	18	6%	305
1999	138	44%	22	7%	125	40%	26	8%	311
2000	153	49%	30	10%	114	37%	13	4%	310

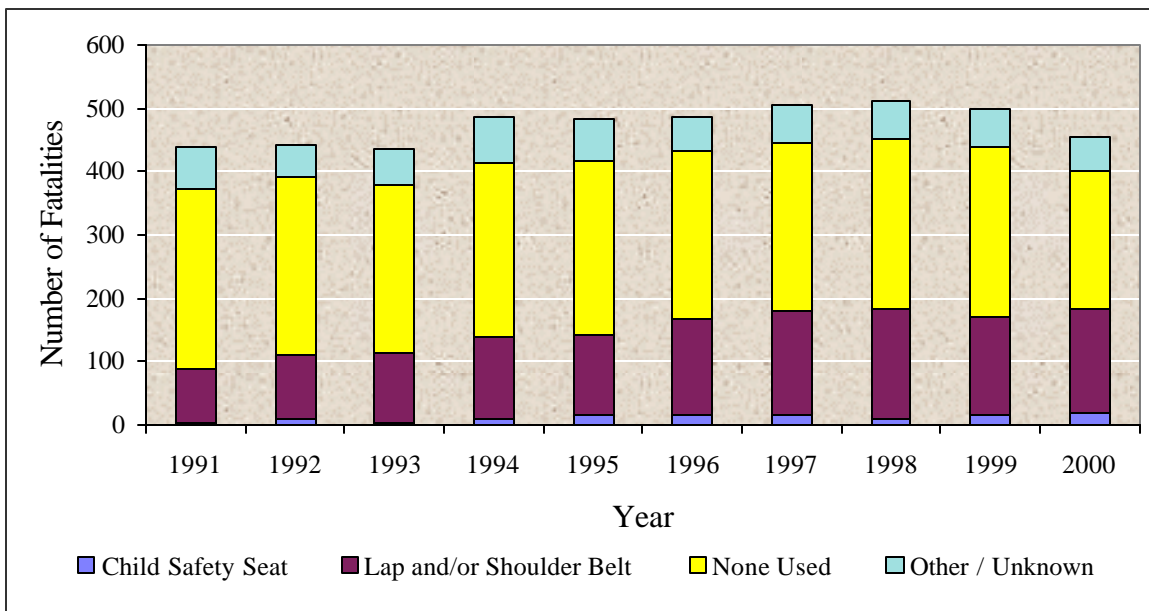
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

#### 5.1.4 Passenger Vehicle Occupants Killed, by Year and Restraint Use, Age 4 – 8

The overall number of fatalities in the 4-8 year old age group increased from 440 in 1991 to 454 in 2000, an increase of 3 percent. Table 10 displays passenger vehicle occupant fatalities, for children 4 through 8 years old, categorized by restraint use. This increase shows a reverse trend as compared to the 9 percent decline in annual fatalities among children less than four years old. The number of fatalities among children 4 through 8 years old where the passenger was unrestrained dropped from 283 in 1991 to 217 in 2000, a reduction of 23 percent. This reduction is minimal compared to the 47 percent decline among unrestrained children less than four years old. As lap and/or shoulder belt usage increased significantly during this time-period, the percentage of annual fatalities among children 4 through 8 years old where the child was restrained by a lap and/or shoulder belt increased from 19 percent to 36 percent. Fatalities for children 4 through 8 years old increased 14 percent over the period 1991 through 1998, while an 11 percent reduction in fatalities for this age group was evident from 1998 through 2000.

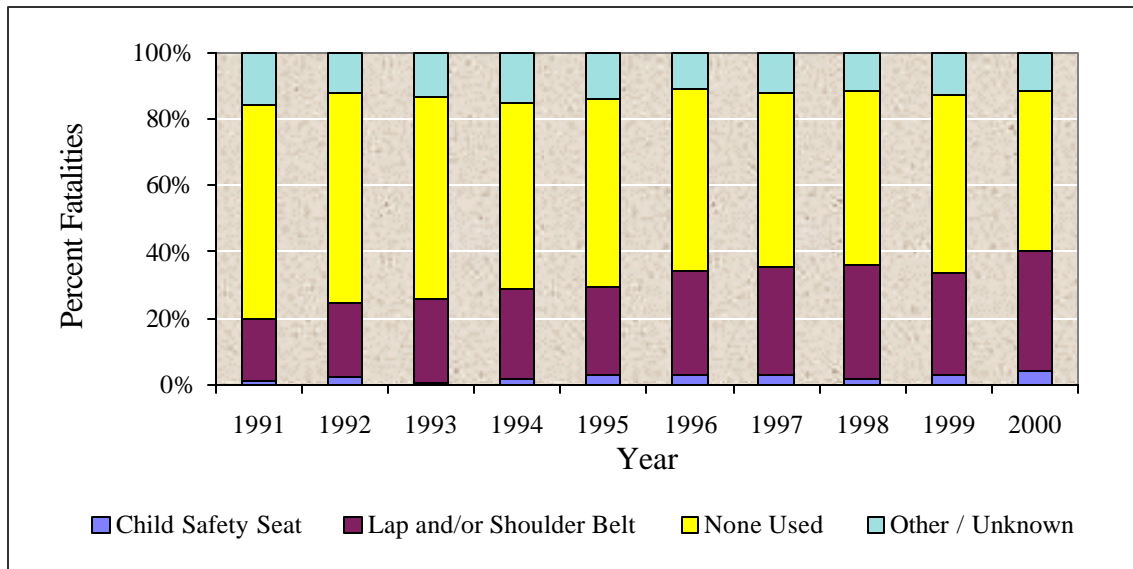
Upon comparing Tables 8, 9 and 10, it is clear that children 4 through 8 years old had a higher percentage of annual fatalities where the passenger was unrestrained than children within the two younger age groups. This percentage among children 4 through 8 years old ranged from 64 percent in 1991 to 48 percent in 2000. Comparatively, children 1 through 3 years old (a drop from 59 percent to 37 percent) and less than one year old (56 percent to 27 percent) had a much smaller proportion of fatalities where the passenger was unrestrained.

Chart 13: Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

Chart 14: Percent of Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 10**  
Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Year and Restraint Use

Year	Restraint Use								Total
	Child Safety Seat		Lap and/or Shoulder Belt		None Used		Other / Unknown		
1991	4	1%	84	19%	283	64%	69	16%	440
1992	10	2%	99	22%	281	63%	53	12%	443
1993	3	1%	110	25%	265	61%	57	13%	435
1994	9	2%	131	27%	273	56%	74	15%	487
1995	14	3%	129	27%	274	57%	66	14%	483
1996	15	3%	152	31%	264	54%	54	11%	485
1997	14	3%	166	33%	265	52%	60	12%	505
1998	8	2%	176	34%	268	52%	60	12%	512
1999	15	3%	154	31%	268	54%	62	12%	499
2000	19	4%	165	36%	217	48%	53	12%	454

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

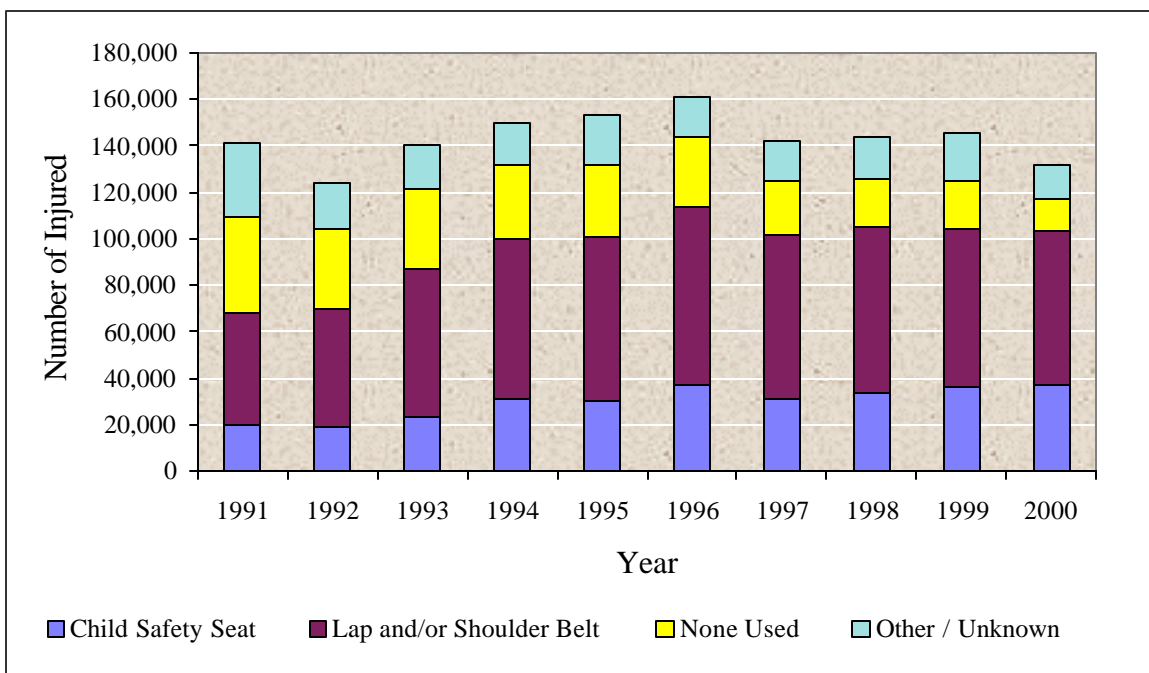
## 5.2 Passenger Vehicle Occupants Injured, by Restraint Use

Table 11 shows the number and percent of passenger vehicle occupants injured, for children in the 0 through 8 year old age range, categorized by restraint use, from 1991 through 2000. During this time period, the number of children injured where the passenger was unrestrained dropped more than 60 percent, from 41,000 to 14,000. Given the large increase in lap and/or shoulder belt usage during the 1990's, the percentage of children injured where the child was restrained by a lap and/or shoulder belt increased from 33 percent in 1991 to 48 percent in 2000. As child safety seat usage increased significantly during this time-period, the percentage of children injured where the child was restrained by a child safety seat increased from 15 percent to 28 percent.

The percentage of children injured while traveling unrestrained decreased from 31 percent in 1991 to 12 percent in 2000. Comparatively, the percentage shift of fatalities among children 0-8 years old where the passenger was unrestrained went from 61 percent in 1991 to 41 percent in 2000, as seen in Table 2. Although fatalities and injuries were both reduced during this time period, traveling unrestrained clearly leads to a much larger percentage of fatalities than injuries, suggesting that restraint use is saving a tremendous number of lives.

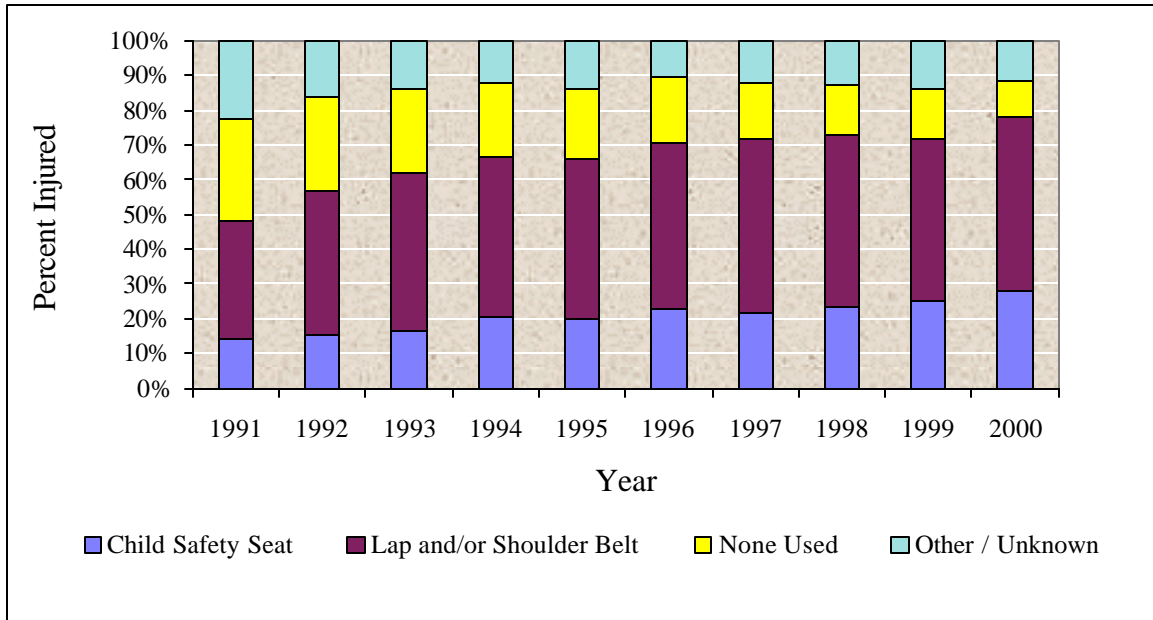
Restraint use in GES is determined by police and may be overreported for survivors. GES estimates are rounded to the nearest thousand.

Chart 15: Passenger Vehicle Occupants Injured, Age 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

Chart 16: Percent of Passenger Vehicle Occupants Injured, Age 0 - 8 Years Old, by Year and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

**Table 11**  
**Passenger Vehicle Occupants Injured, Age 0 - 8 Years Old,**  
**by Year and Restraint Use**

Year	Restraint Use								Total
	Child Safety Seat		Lap and/or Shoulder Belt		None Used		Other / Unknown		
1991	20,000	15%	48,000	33%	41,000	31%	32,000	21%	141,000
1992	19,000	17%	51,000	39%	34,000	28%	20,000	16%	122,000
1993	23,000	18%	64,000	43%	34,000	25%	19,000	14%	139,000
1994	31,000	19%	69,000	45%	32,000	22%	18,000	14%	150,000
1995	30,000	20%	71,000	46%	31,000	21%	21,000	14%	153,000
1996	37,000	23%	77,000	44%	30,000	20%	17,000	13%	162,000
1997	31,000	21%	71,000	47%	23,000	18%	17,000	14%	143,000
1998	34,000	24%	71,000	47%	21,000	16%	18,000	13%	144,000
1999	36,000	24%	68,000	49%	21,000	14%	20,000	13%	144,000
2000	37,000	28%	66,000	48%	14,000	12%	15,000	12%	132,000

Source: National Center for Statistics and Analysis, NHTSA, NASS GES 1991-2000

## **6. PASSENGER VEHICLE OCCUPANT FATALITY RATES, BY AGE**

This chapter discusses data relating to passenger vehicle occupant fatality rates based on United States resident population and passenger vehicle miles traveled. The definitions of these two types of rates appear in the introduction to their respective sections.

### **6.1 Passenger Vehicle Occupant Fatality Rates per 100,000 Population, by Age**

Section 6.1 shows one table and four charts of passenger vehicle occupant fatality rates, per 100,000 population. These rates are categorized into four age groups (<1, 1 – 3, 4 – 8, and 0 – 8) during the period from 1991 through 2000, and are calculated using total U.S. population sizes for each age category. The population figures used to calculate these rates were collected from the U.S. Census Bureau (Section 11.4, Table 45).

Table 12 shows that the 0 through 8 year old rate of fatalities decreased by 5 percent from 1991 to 2000 (2.74 to 2.60). During this time period, the rate ranged from a low of 2.60 in 2000 to a high of 2.97 in 1994.

Among the three age categories (<1, 1 – 3, and 4 – 8) which are comprised of children within the 0 through 8 year old age range, the fatality rates for the children less than one year old were the highest every year from 1991 through 2000. The rate for 4 through 8 year olds remained the lowest for each of these ten years.

In 2000, the fatality rate for children 1 through 3 years old was 17 percent higher than the rate for children 4 through 8 years old, while children less than one year old had a fatality rate 46 percent higher than the 4 through 8 year old age group. These fatality rate ratios for 2000 are very similar to the aggregated rate ratios for the period from 1991 through 2000. From a biomechanics perspective, these findings imply that younger children are more at risk for a fatality due to their developing skeletal structure and soft tissue vulnerability.

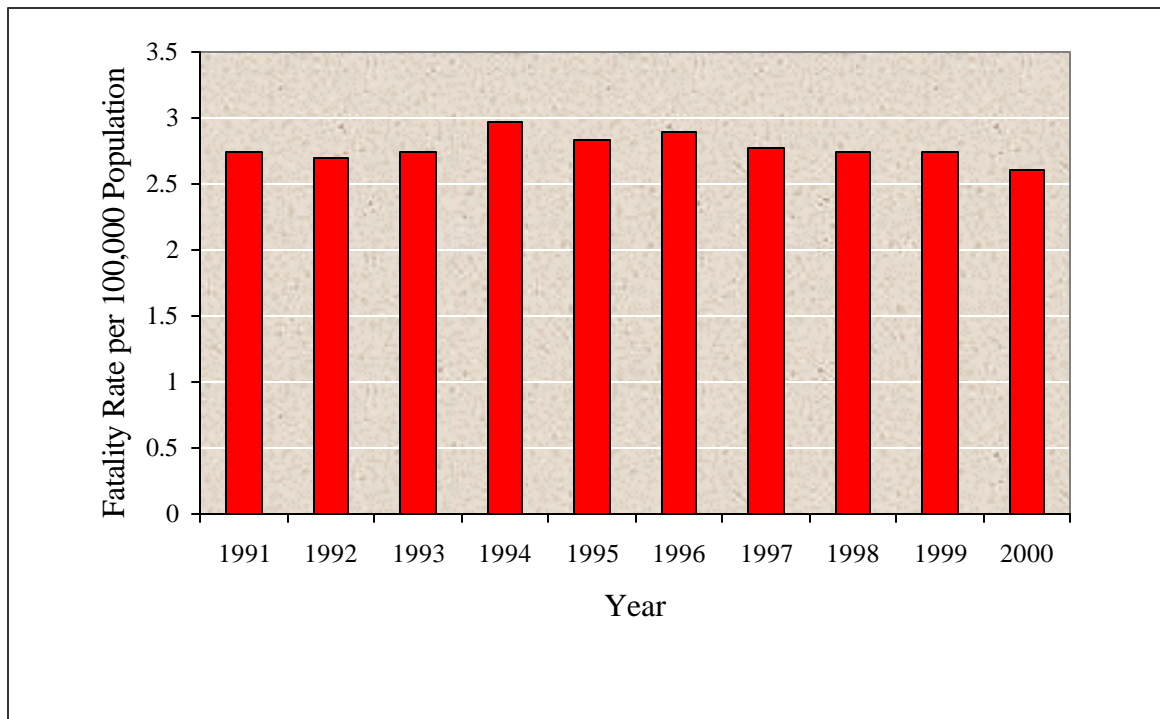


**Table 12**  
**Passenger Vehicle Occupant Fatality Rates per 100,000 Population,**  
**by Year and Age Group**

Year	Age Group			
	Less than 1 Year Old	1 – 3 Years Old	4 – 8 Years Old	0 – 8 Years Old
1991	3.57	2.96	2.42	2.74
1992	3.19	2.97	2.42	2.70
1993	3.89	3.03	2.34	2.75
1994	4.15	3.22	2.57	2.97
1995	4.01	2.97	2.50	2.83
1996	4.72	3.02	2.47	2.90
1997	3.52	2.89	2.55	2.77
1998	3.64	2.70	2.58	2.74
1999	3.72	2.76	2.54	2.74
2000	3.43	2.74	2.35	2.60

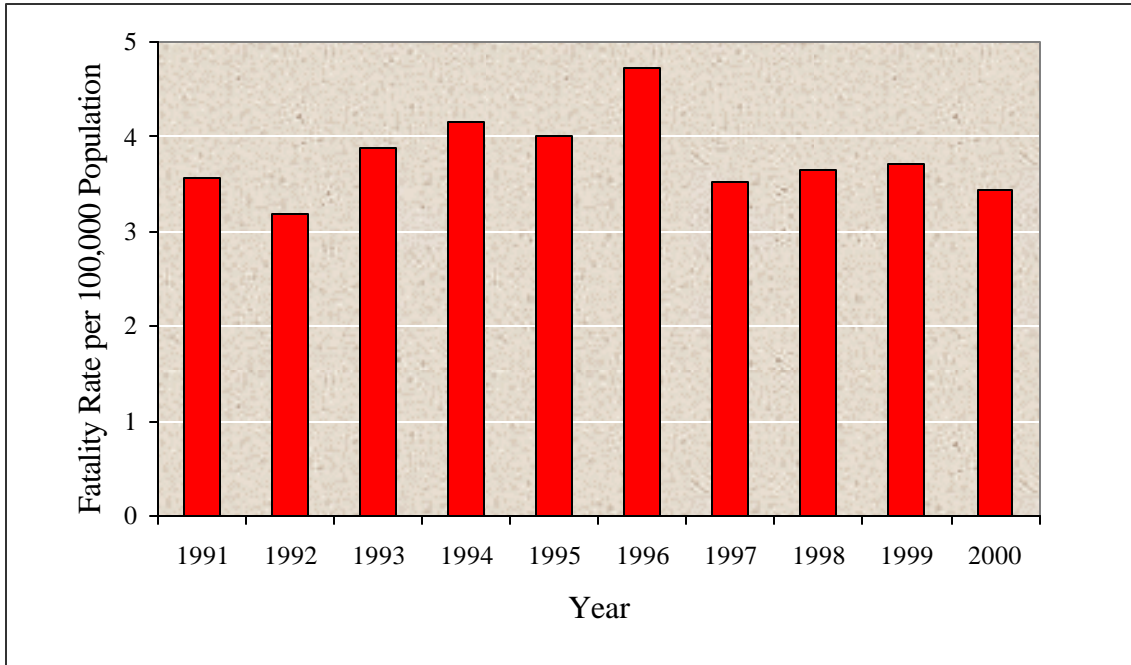
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000 and Census Bureau

Chart 17: Passenger Vehicle Occupant Fatality Rates per 100,000 Population,  
 Age 0 - 8 Years Old, by Year



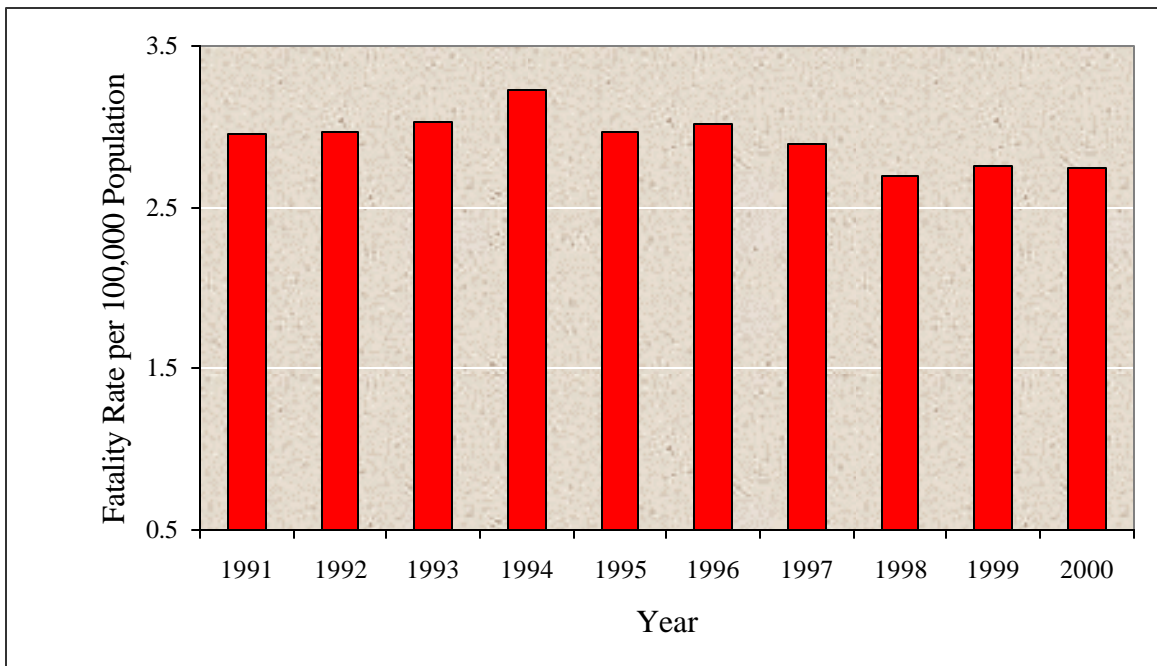
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000 and Census Bureau

Chart 18: Passenger Vehicle Occupant Fatality Rates per 100,000 Population, Age Less than One Year Old, by Year



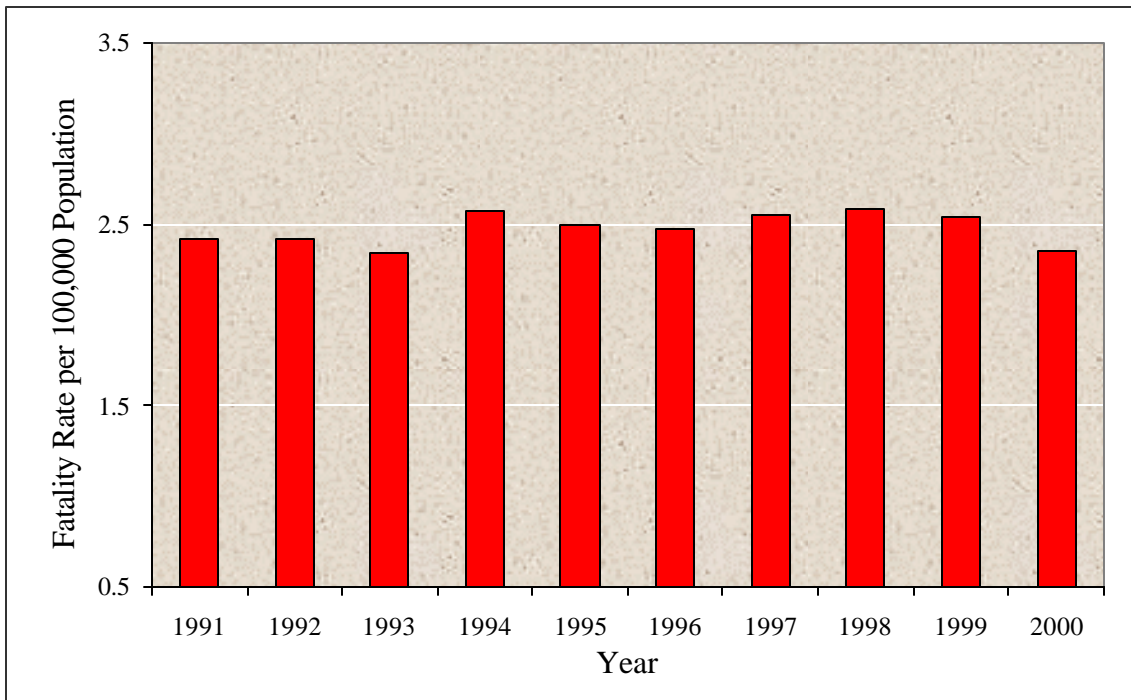
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000 and Census Bureau

Chart 19: Passenger Vehicle Occupant Fatality Rates per 100,000 Population, Age 1 - 3 Years Old, by Year



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000 and Census Bureau

Chart 20: Passenger Vehicle Occupant Fatality Rates per 100,000 Population, Age 4 - 8 Years Old, by Year



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000 and Census Bureau

## 6.2 Passenger Vehicle Occupant Fatality Rates per 100 Billion Vehicle Miles Traveled, by Age

Section 6.2 shows one table and four charts of passenger vehicle occupant fatality rates per vehicle miles traveled (VMT). The rates are categorized into four age groups during the period from 1991 through 2000. The age categories are 0-8, <1, 1-3, and 4-8 years old.

The VMT used in the calculations is an estimate of the annual number of miles traveled by passenger vehicles during the years 1991 through 2000. As these estimates show a rise in VMT of approximately 25 percent from 1991 to 2000, a decline is seen among fatality rates that were not seen previously in table and charts displaying numbers of fatalities.

Given that these figures are estimates of the number of miles traveled by passengers of all ages, they are not equal to the number of miles traveled by children age 0 through 8. It is assumed, however, that the two separate VMT totals for these two age categories are strongly correlated, given the diverse age distribution of the drivers and passengers of the involved vehicles.

It must be noted that the data within Section 6.2 do not allow for the fatality rates per VMT of the four different sized age categories to be compared, given the VMT used to

calculate each of these rates represent the entire US population. While the temporal rate ratios within each age category provide valuable information, a comparison of fatality rates between the four age categories of differing width is not possible.

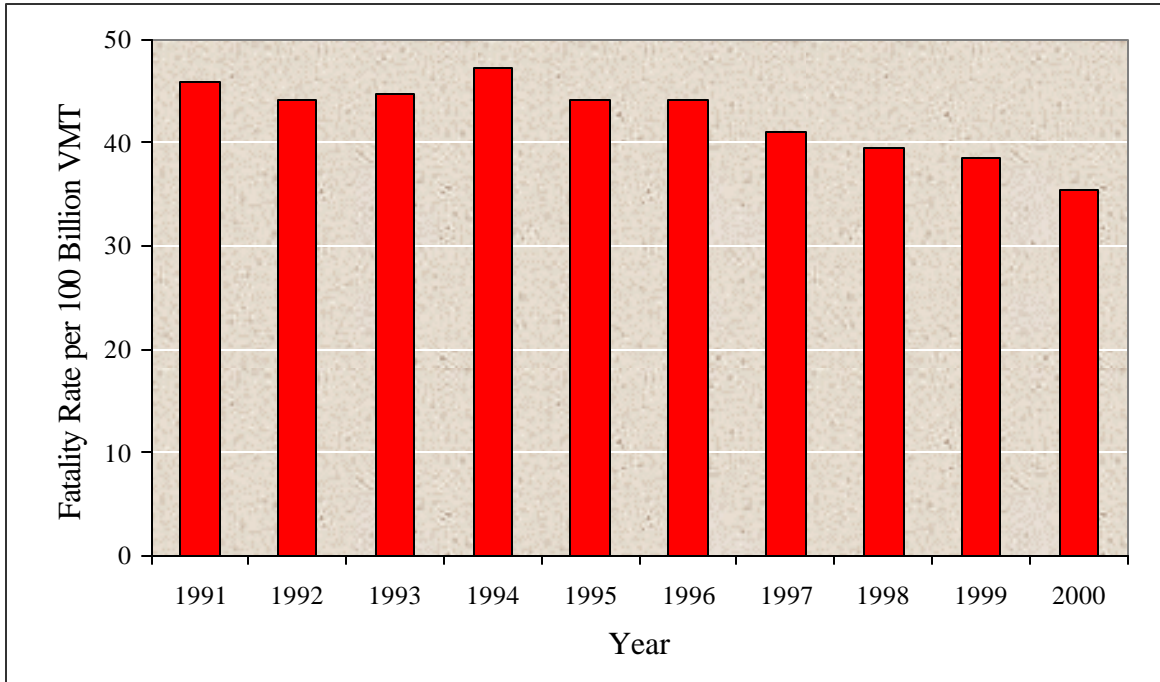
Table 13 shows the rates of passenger vehicle occupant fatalities, per 100 billion VMT. Upon comparing the ratios of 2000 versus 1991 fatality rates per VMT with the ratios of 2000 to 1991 fatality numbers, it is seen that these fatality rate ratios are significantly lower than the corresponding fatality number ratios, for each age category. Among children 0 through 8 years old, the fatality rate per VMT dropped 23 percent over this time period (45.98 per 100 billion VMT to 35.43). This significant decline is far greater than the 3 percent decline from 1991 to 2000 in the number of fatalities (923 to 895). This difference is due to the large increase in VMT during the 1990's.

From 1991 to 2000, fatality rates per VMT dropped 27 percent among children less than one year old (7.12 per 100 billion VMT to 5.19), 28 percent among children 1 through 3 years old (16.94 to 12.27), and 18 percent among children 4 through 8 years old (21.92 to 17.97). These improvements in fatality rates suggest that restraint use is saving many lives.

<b>Table 13</b>				
<b>Passenger Vehicle Occupant Fatality Rates per 100 Billion VMT, by Year and Age Group</b>				
<b>Year</b>	<b>Age Group</b>			
	<b>Less than 1 Year Old</b>	<b>1 – 3 Years Old</b>	<b>4 – 8 Years Old</b>	<b>0 – 8 Years Old</b>
1991	7.12	16.94	21.92	45.98
1992	6.11	16.79	21.31	44.22
1993	7.17	17.02	20.51	44.71
1994	7.37	17.55	22.43	47.36
1995	6.87	15.57	21.68	44.11
1996	7.79	15.18	21.21	44.17
1997	5.65	13.98	21.46	41.09
1998	5.71	12.61	21.18	39.50
1999	5.75	12.59	20.20	38.54
2000	5.19	12.27	17.97	35.43

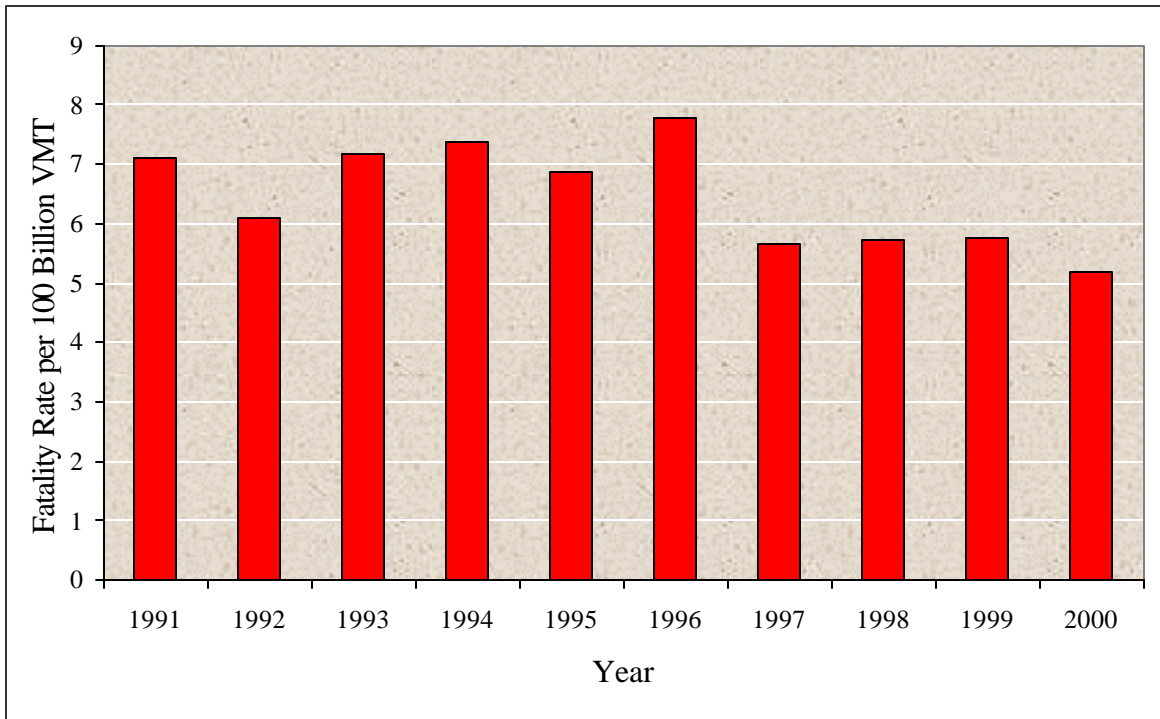
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000, and FHWA**

Chart 21: Passenger Vehicle Occupant Fatality Rates per 100 Billion VMT, Age 0 - 8 Years Old, by Year



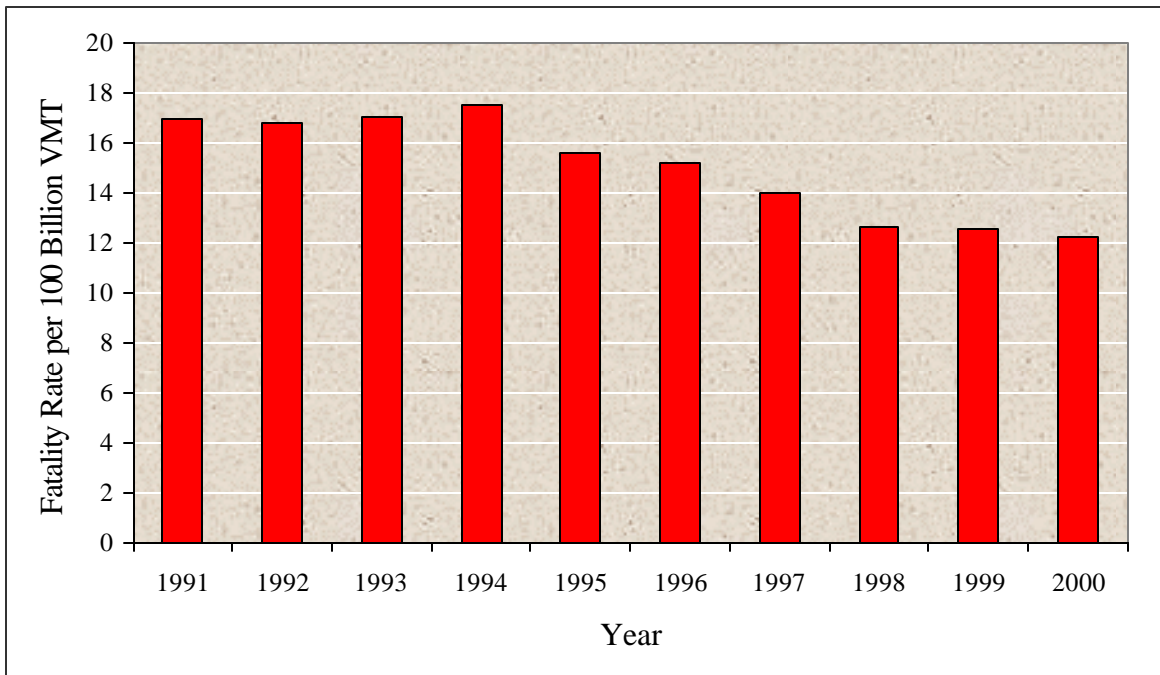
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000, and FHWA

Chart 22: Passenger Vehicle Occupant Fatality Rates per 100 Billion VMT, Age Less than One Year Old, by Year



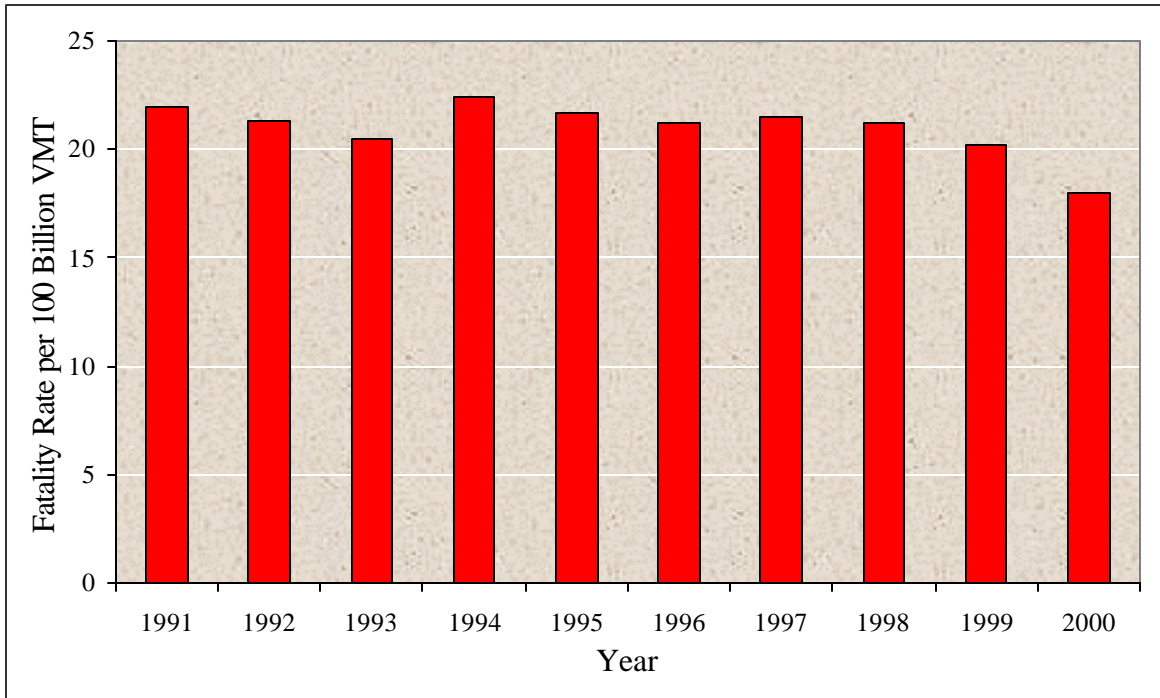
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000, and FHWA

Chart 23: Passenger Vehicle Fatality Rates per 100 Billion VMT, Age 1 - 3 Years Old, by Year



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000, and FHWA

Chart 24: Passenger Vehicle Occupant Fatality Rates per 100 Billion VMT, Age 4 - 8 Years Old, by Year



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000, and FHWA

## **7. PASSENGER VEHICLE OCCUPANTS KILLED, BY RESTRAINT USE, SEATING POSITION, AND AGE**

This chapter discusses passenger vehicle occupant fatalities, broken down by restraint use, seating position, and age, from 1991 through 2000. The age categories include 0-8, <1, 1-3, and 4-8. The seating positions are subdivided into front passenger seat (front middle and front right) and second seat (second seat left, second seat middle, second seat right).

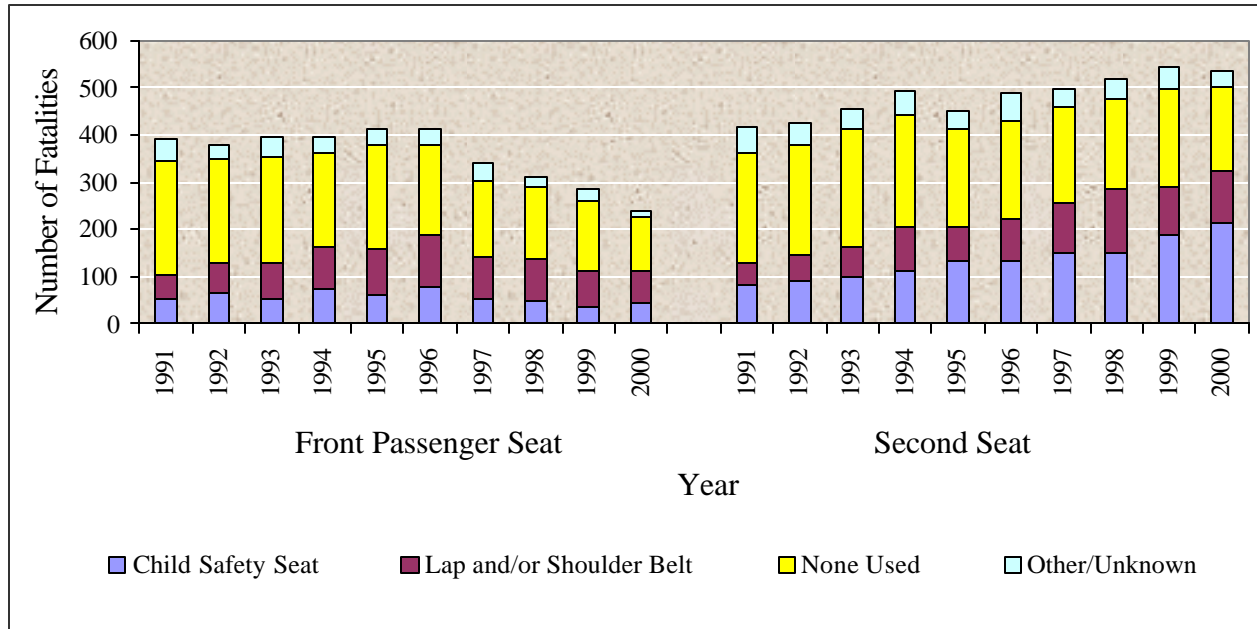
### **7.1 Passenger Vehicle Occupants Killed, by Year, Restraint Use and Seating Position, Age 0 - 8**

The number of passenger vehicle occupant fatalities for children in the 0 through 8 year old age range, categorized by restraint use and seating position, is shown in Table 14. While the number of fatalities in the front passenger seat declined from 392 in 1991 to 239 in 2000, a drop of 39 percent, the number of fatalities in the second seat rose from 416 in 1991 to 538 in 2000, an increase of 29 percent.

A steep decline in front seat fatalities occurred from 411 in 1995 to 239 in 2000, a decrease of 42 percent. The decline was greatly attributable to the 1996 traffic safety campaigns, which advocated the movement of children from the front seat to the second seat. Following these campaigns, the number of fatalities in the front seat where the passenger was unrestrained declined from 220 in 1995 to 112 in 2000, a decrease of 49 percent. During this same time period, the number of fatalities in the second seat where the passenger was unrestrained decreased by 15 percent. By 2000, 47 percent of front seat fatalities involved passengers who were unrestrained, as compared to 33 percent within the second seat.

Another significant change, which coincided with the 1996 campaigns, was the shift in child safety seat usage from the front seat to the second seat. Fatalities in the front seat, where a child safety seat restrained the passenger, declined from 62 in 1995 to 42 in 2000, a reduction of 32 percent. The number of fatally injured passengers in the second seat, restrained by a child safety seat, climbed from 133 in 1995 to 213 in 2000, an increase of 60 percent. Similar trends in the second seat were also seen in the use of lap and/or shoulder belts, though the increase was slightly less (56 percent) as compared to child safety seats.

Chart 25: Passenger Vehicle Occupants Killed, Age 0 - 8 Years Old, by Year, Seating Position, and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 14**  
**Passenger Vehicle Occupants Killed, Age 0 - 8 Years Old,**  
**by Year, Seating Position, and Restraint Use**

Year	Seating Position									
	Front Passenger Seat					Second Seat				
	Restraint Use					Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total
1991	52	52	241	47	392	81	48	234	53	416
1992	65	64	219	31	379	89	56	233	46	424
1993	54	77	221	44	396	98	65	248	44	455
1994	72	90	201	34	397	111	94	239	49	493
1995	62	96	220	33	411	133	71	207	41	452
1996	79	109	193	34	415	135	89	208	56	488
1997	54	87	162	40	343	149	108	202	39	498
1998	48	88	154	22	312	151	134	191	41	517
1999	36	75	151	26	288	190	100	209	46	545
2000	42	72	112	13	239	213	111	176	38	538

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000



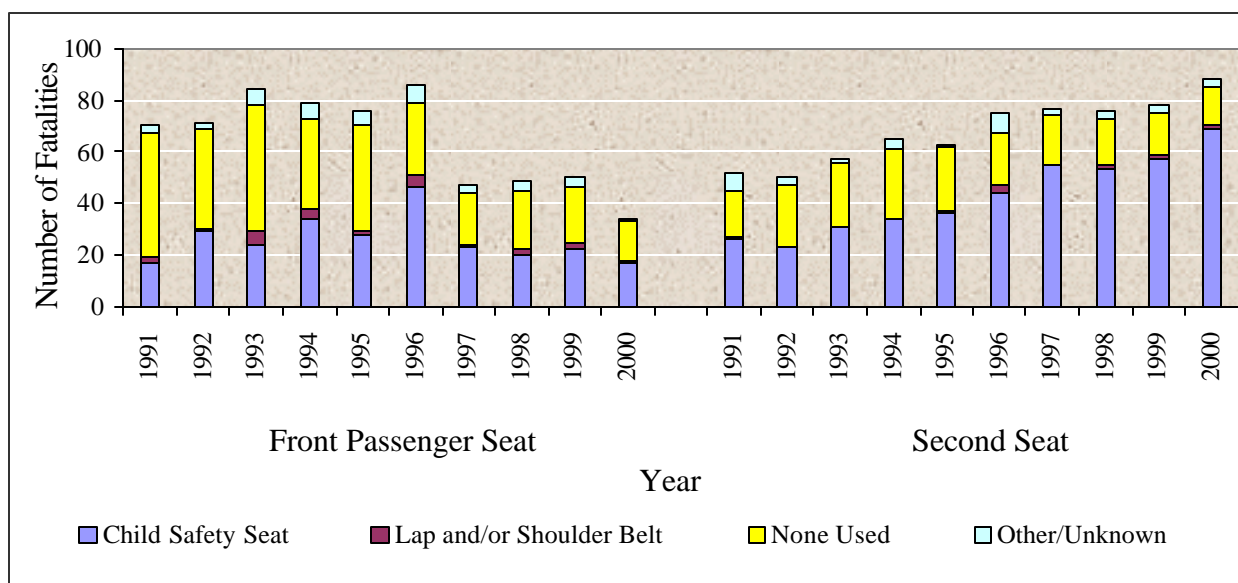
## 7.2 Passenger Vehicle Occupants Killed, by Year, Restraint Use and Seating Position, Age < 1

The number of passenger vehicle occupant fatalities for children less than one year old, categorized by restraint use and seating position, is shown in Table 15. The number of fatalities in the front passenger seat dropped from 70 in 1991 to 34 in 2000, a decrease of 51 percent. The number of fatalities in the second seat rose from 52 in 1991 to 88 in 2000, an increase of 69 percent. The percent of fatalities occurring in the front seat dropped from 57 percent in 1991 to 28 percent in 2000. The general trend in the front seat was an increase in fatalities between 1991 and 1996, followed by a large drop seen from 1997 through 2000. However, the trend in the number of fatalities in the second seat has been a steady increase from 1991 through 2000.

A steep decline in front seat fatalities occurred from 76 in 1995 to 34 in 2000, a decrease of 55 percent. The decline was attributable to the 1996 traffic safety campaigns, which advocated the movement of children from the front seat to the second seat. Following these campaigns, the number of fatalities in the front seat where the passenger was unrestrained declined from 41 in 1995 to 15 in 2000, a decrease of 63 percent. Despite this improvement, children who were unrestrained accounted for 44 percent of fatalities in the front passenger seat, as compared with only 17 percent in the second seat

As child safety seat usage shifted from the front seat to the second seat, the number of front seat fatalities where the child was restrained by a child safety seat dropped from 46 in 1996 to 17 in 2000, while fatalities in the second seat rose from 44 in 1996 to 69 in 2000.

Chart 26: Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Seating Position, Year, and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 15**  
**Passenger Vehicle Occupants Killed, Age Less than One Year Old,**  
**by Year, Seating Position, and Restraint Use**

Year	Seating Position									
	Front Passenger Seat					Second Seat				
	Restraint Use					Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total
1991	17	2	48	3	70	26	1	18	7	52
1992	29	1	39	2	71	23	0	24	3	50
1993	24	5	49	6	84	31	0	25	1	57
1994	34	4	35	6	79	34	0	27	4	65
1995	28	1	41	6	76	36	1	25	1	63
1996	46	5	28	7	86	44	3	20	8	75
1997	23	1	20	3	47	55	0	19	3	77
1998	20	2	23	4	49	53	2	18	3	76
1999	22	3	21	4	50	57	2	16	3	78
2000	17	1	15	1	34	69	1	15	3	88

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

### 7.3 Passenger Vehicle Occupants Killed, by Year, Restraint Use and Seating Position, Age 1 – 3

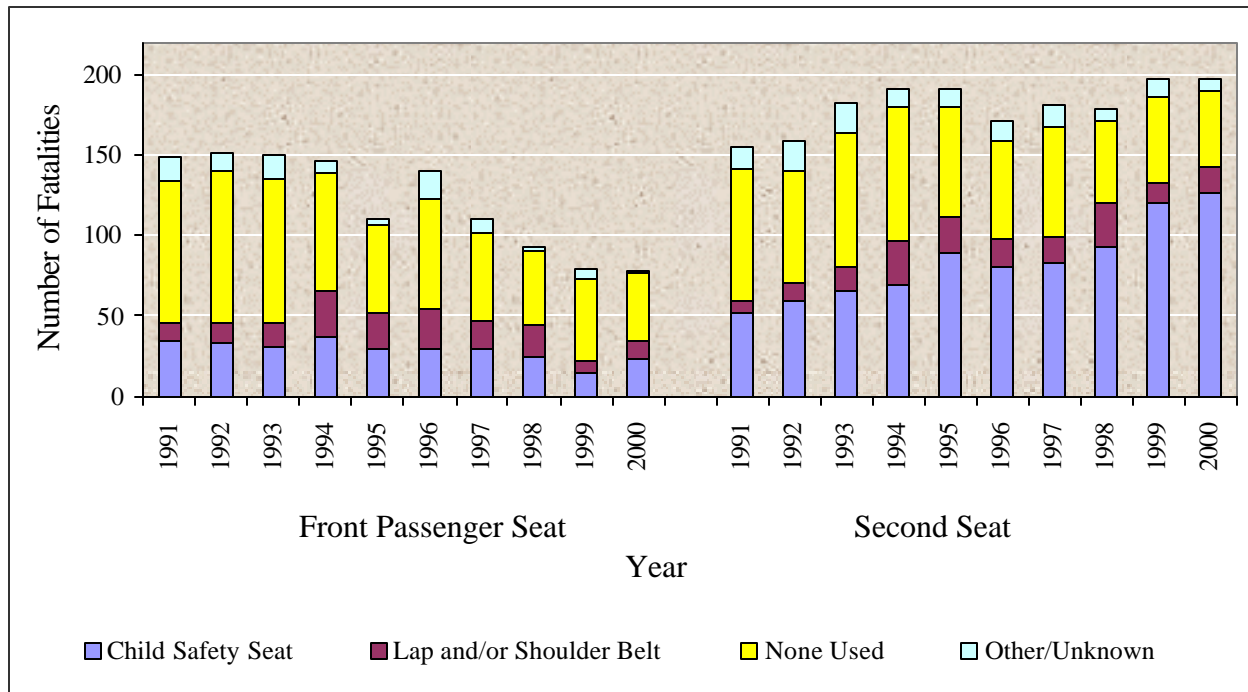
Table 16 shows the number of passenger vehicle occupant fatalities, for children in the 1 through 3 year old age range, categorized by restraint use and seating position. The number of fatalities in the front passenger seat declined from 149 in 1991 to 78 in 2000, a decrease of 48 percent, while the number of overall fatalities in the second seat increased from 155 in 1991 to 197 in 2000, an increase of 27 percent. This shift in fatalities from the front passenger seat to the second seat was similar to the shift seen among children less than one year old. The percent of fatalities among children age 1 through 3 years old occurring in the front passenger seat dropped from 49 percent in 1991 to 28 percent in 2000.

The strongest shift in fatalities from the front passenger seat to the second seat occurred from 1996 to 2000. The number of front passenger seat fatalities dropped from 140 in 1996 to 78 in 2000, a decrease of 44 percent. This reduction was attributable to the 1996 traffic safety campaigns, which advocated the movement of children from the front seat to the second seat. During this same time period, the number of second seat fatalities rose from 171 to 197, an increase of 15 percent.

Another change that coincided with the 1996 campaigns was the shift in child safety seat usage from the front passenger seat to the second seat. Fatalities in the front passenger seat where the passenger was restrained by a child safety seat declined 21 percent from 1996 to 2000. During this same time period, fatalities in the second seat where the passenger was restrained by a child safety seat increased 59 percent.

This shift in restraint use from the front passenger seat to the second seat is also seen through examining the location of fatalities among children who are unrestrained. In 2000, 55 percent of front passenger seat fatalities involved children who were unrestrained, as compared with only 24 percent in the second seat.

Chart 27: Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Seating Position, Year, and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 16**  
**Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Year, Seating Position and Restraint Use**

Year	Seating Position									
	Front Passenger Seat					Second Seat				
	Restraint Use					Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total
1991	34	11	89	15	149	52	7	83	13	155
1992	33	13	94	11	151	59	12	69	19	159
1993	30	16	89	15	150	65	15	84	19	183
1994	37	28	74	7	146	69	28	83	11	191
1995	29	23	55	3	110	89	22	69	12	192
1996	29	25	69	17	140	80	18	61	12	171
1997	29	18	55	8	110	83	16	69	13	181
1998	25	19	46	3	93	93	27	51	8	179
1999	14	8	51	6	79	120	13	54	11	198
2000	23	11	43	1	78	127	16	47	7	197

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

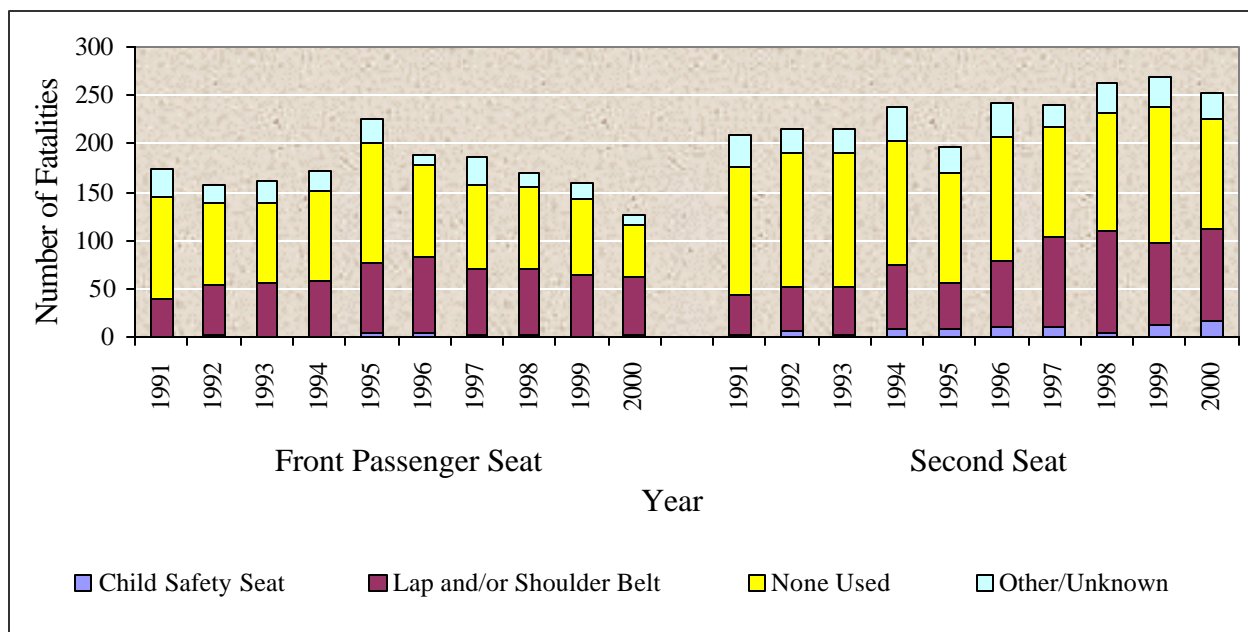
## 7.4 Passenger Vehicle Occupants Killed, by Year, Restraint Use and Seating Position, Age 4 – 8

Table 17 shows the number of passenger vehicle occupant fatalities, for children in the 4 through 8 year old age range, categorized by restraint use and seating position. Among children 4 through 8 years old, the number of fatalities in the front passenger seat declined from 173 in 1991 to 127 in 2000, a decrease of 27 percent. In comparison the number of overall fatalities in the second seat climbed from 209 in 1991 to 253 in 2000, an increase of 21 percent.

A shift that coincided with the 1996 traffic safety campaigns was the shift in lap and/or shoulder belt usage from the front seat to the second seat. Fatalities in the front seat where the passenger was restrained by a lap and/or shoulder belt dropped from 72 in 1995 to 60 in 2000, a decline of 17 percent, while fatalities in the second seat where passengers were restrained by a lap and/or shoulder belt rose from 48 in 1995 to 94 in 2000, a large increase of 96 percent.

A comparison of the three age groups (<1, 1-3, and 4-8) shows that the shift of restraint use from the front seat to the second seat was more significant among children 0 through 3 years old than children 4 through 8 years old. This lack of restraint use in the second seat among 4 through 8 year olds led to a large number of fatalities involving children who were unrestrained. Within the second seat in 2000, 45 percent of fatalities among children 4 through 8 years old occurred when the child was unrestrained, as compared to 24 percent of 1 through 3 year olds and only 17 percent of children less than one year old.

Chart 28: Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Seating Position, Year, and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 17**  
**Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,**  
**by Year, Seating Position, and Restraint Use**

Year	Seating Position									
	Front Passenger Seat					Second Seat				
	Restraint Use					Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	Total
1991	1	39	104	29	173	3	40	133	33	209
1992	3	50	86	18	157	7	44	140	24	215
1993	0	56	83	23	162	2	50	139	24	215
1994	1	58	92	21	172	8	66	129	34	237
1995	5	72	124	24	225	8	48	113	28	197
1996	4	79	96	10	189	11	68	127	36	242
1997	2	68	87	29	186	11	92	114	23	240
1998	3	67	85	15	170	5	105	122	30	262
1999	0	64	79	16	159	13	85	139	32	269
2000	2	60	54	11	127	17	94	114	28	253

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

## **8. PASSENGER VEHICLE OCCUPANTS KILLED, BY RESTRAINT USE, PRINCIPAL IMPACT POINT, SEATING POSITION, AND AGE**

Chapter 8 shows the analysis of passenger vehicle occupant fatalities aggregated from 1991 through 2000 based on the following:

- Restraint use – child safety seat, lap and/or shoulder belt, unrestrained (none used) and other/unknown
- Seating position – front seat (excluding driver’s seat) and second seat
- Age groups – less than one year old, one through three years old, and four through eight years old
- Principal Impact point – front impact, rear impact, near side impact, and far side impact.
- Chapter 8 is limited to planar crashes. Crashes where the principal impact point occurred on the top or undercarriage of the vehicle were excluded within this section.

The FARS data from 1991 through 2000 that comprise this chapter are aggregated in order to provide the most accurate presentation of the aforementioned variables. This aggregation is necessary given the categorization, stratification, and sample size of the data throughout this time period.

### **8.1 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position, Front/Rear Impact and Age**

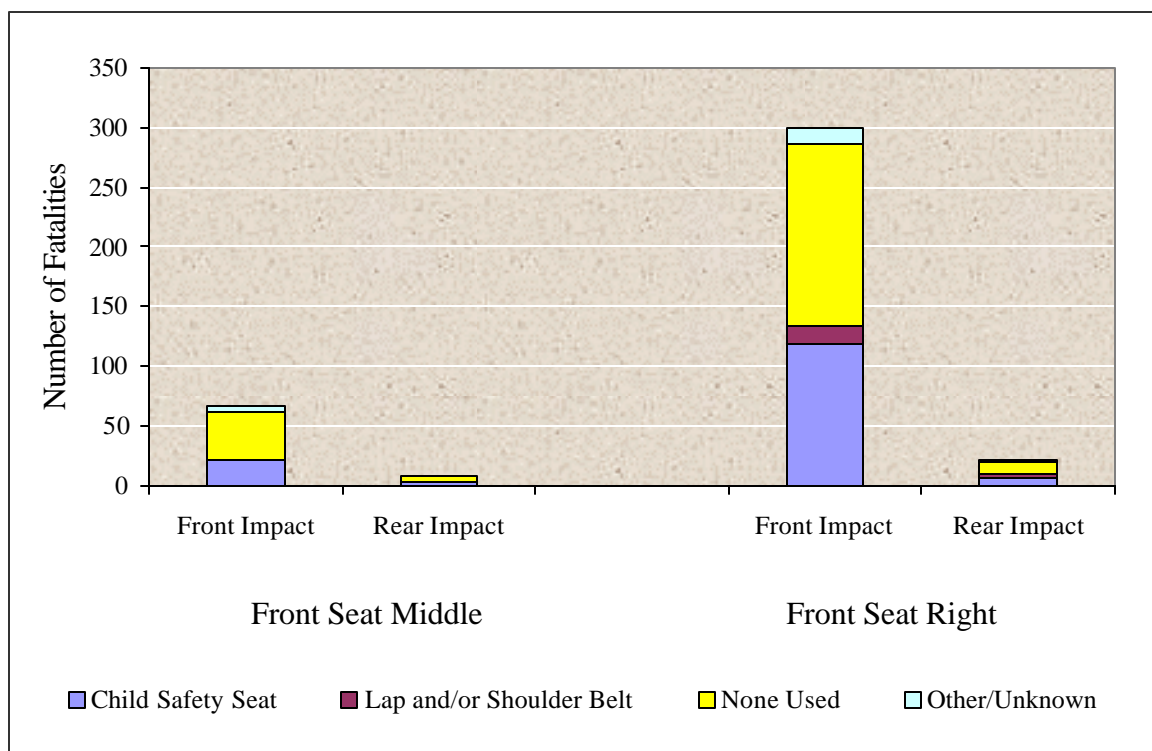
This section provides analysis relating to front impacts and rear impacts, as defined in Section 3.2.1. Sections 8.1.1 – 8.1.3 apply to occupants in the front seat. Sections 8.1.4 – 8.1.6 apply to occupants in the second seat.

#### **8.1.1 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Front Seat, Age <1**

Table 18 shows the number of passenger vehicle occupant fatalities, for children less than one year old, categorized by restraint use, impact point, and seating position, aggregated over ten years. Within the front seat, the number of front impact fatalities was 12.7 times greater than the number of rear impact fatalities. In the front middle seat, 67 front impact fatalities and 8 rear impact fatalities occurred from 1991 through 2000. In the front right seat, 300 front impact fatalities and 21 rear impact fatalities occurred from 1991 through 2000. Upon combining the front middle seat and front right seat, 53 percent of all front impact fatalities involved children who were unrestrained. Front impacts accounted for 94 percent of the fatally injured occupants in the front right seat in child safety seats. Overall front impact accounted for 93 percent of all fatally injured occupants in the front seat.



Chart 29: Front Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

<b>Table 18</b>					
<b>Front Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Restraint Use and Longitudinal Impact Point</b>					
<b>Restraint Use</b>	<b>Seating Position</b>				<b>Total</b>
	<b>Front Seat Middle</b>		<b>Front Seat Right</b>		
	<b>Impact Point</b>		<b>Impact Point</b>		
	<b>Front Impact</b>	<b>Rear Impact</b>	<b>Front Impact</b>	<b>Rear Impact</b>	
Child Safety Seat	21	3	118	7	149
Lap and/or Shoulder Belt	1	0	15	2	18
None Used	40	5	153	11	209
Other/Unknown	5	0	14	1	20
<b>Total</b>	<b>67</b>	<b>8</b>	<b>300</b>	<b>21</b>	<b>396</b>

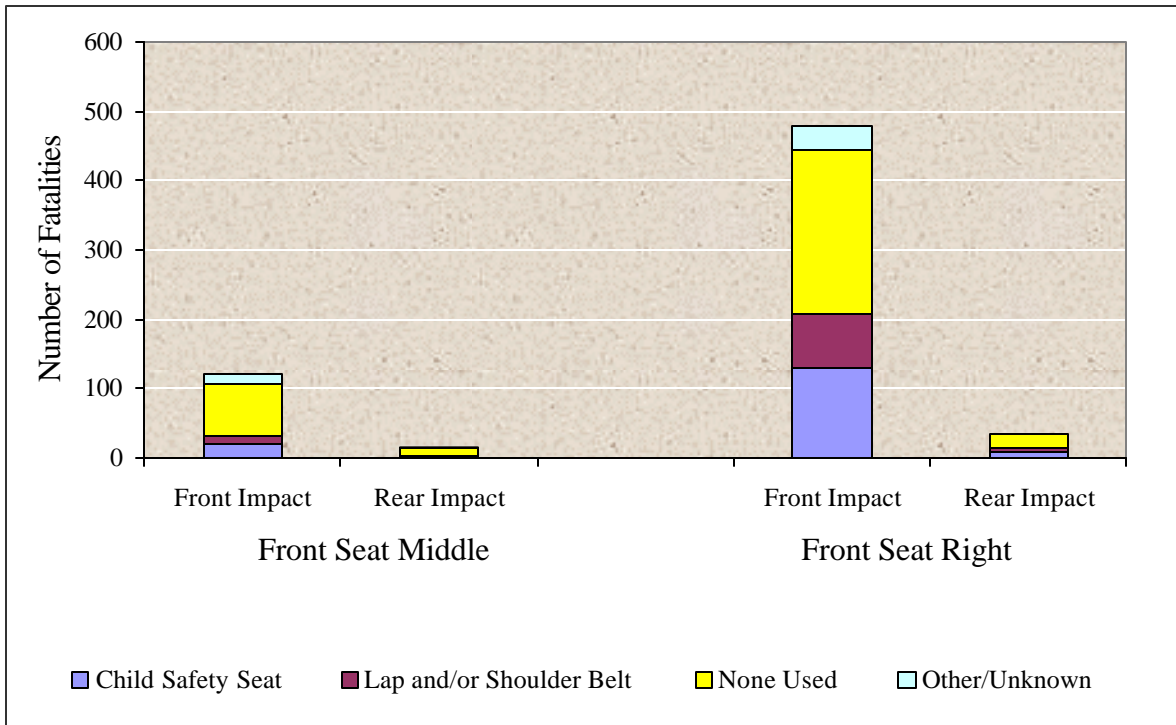
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

8.1.2 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Front Seat, Age 1 – 3

The number of passenger vehicle occupant fatalities, for children 1 through 3 years old, categorized by restraint use, impact point, and seating position is shown in Table 19, aggregated over a ten year period. Similar to front seat occupants of age less than one year old, the number of front impact fatalities was 12.3 times greater than the number of rear impact fatalities. In the front middle seat, 124 front impact fatalities and 14 rear impact fatalities occurred from 1991 through 2000. In the front right seat, 480 front impact fatalities and 35 rear impact fatalities occurred during this time period.

Upon combining the front middle seat and front right seat, 51 percent of all front impact fatalities involved children who were unrestrained, a percentage nearly equal to that of children less than one year old. Among children 1 through 3 years old, 61 percent of front middle seat fatalities involved children who were unrestrained, while only 50 percent of front right seat fatalities involved children who were unrestrained. This variation suggests that children age 1 through 3 years old are more likely to be unrestrained if they travel in the front middle seat.

Chart 30: Front Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 19**  
**Front Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Restraint Use and Longitudinal Impact Point**

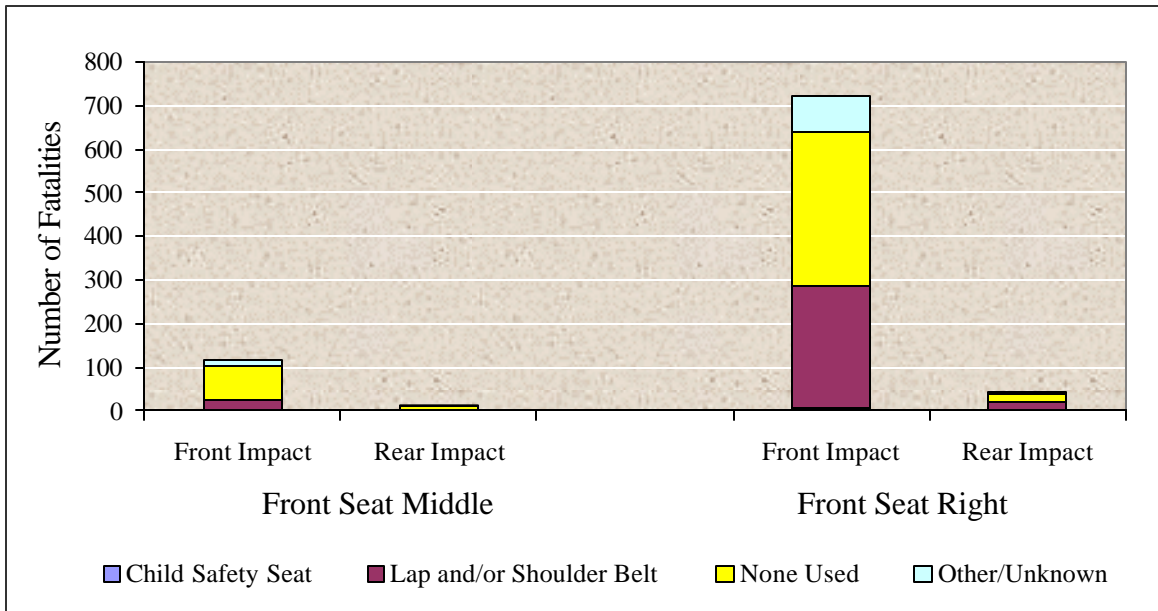
Restraint Use	Seating Position				Total
	Front Seat Middle		Front Seat Right		
	Impact Point		Impact Point		
	Front Impact	Rear Impact	Front Impact	Rear Impact	
Child Safety Seat	19	2	128	7	156
Lap and/or Shoulder Belt	11	0	80	6	97
None Used	79	11	235	22	347
Other/Unknown	15	1	37	0	53
<b>Total</b>	<b>124</b>	<b>14</b>	<b>480</b>	<b>35</b>	<b>653</b>

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

8.1.3 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Front Seat, Age 4 - 8

The number of passenger vehicle occupant fatalities, for children 4 through 8 years old, categorized by restraint use, impact point, and seating position, aggregated from 1991 through 2000, is shown in Table 20. Within the front seat, the number of front impact fatalities was 15.9 times greater than the number of rear impact fatalities, a ratio 27 percent larger than among children less than four years old. In the front middle seat, 119 front impact fatalities and 11 rear impact fatalities occurred from 1991 through 2000. In the front right seat, 722 front impact fatalities and 42 rear impact fatalities occurred from 1991 through 2000. In the front middle seat, 68 percent of all longitudinal impacts involved fatally injured children who were unrestrained, as compared with 48 percent in the front right seat. Overall 51 percent of all fatally injured occupants in the front seat (middle and right) were unrestrained.

Chart 31: Front Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 20**  
**Front Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,**  
**by Restraint Use and Longitudinal Impact Point**

Restraint Use	Seating Position				Total
	Front Seat Middle		Front Seat Right		
	Impact Point		Impact Point		
	Front Impact	Rear Impact	Front Impact	Rear Impact	
Child Safety Seat	0	0	9	1	10
Lap and/or Shoulder Belt	26	0	278	22	326
None Used	79	10	350	16	455
Other/Unknown	14	1	85	3	103
<b>Total</b>	<b>119</b>	<b>11</b>	<b>722</b>	<b>42</b>	<b>894</b>

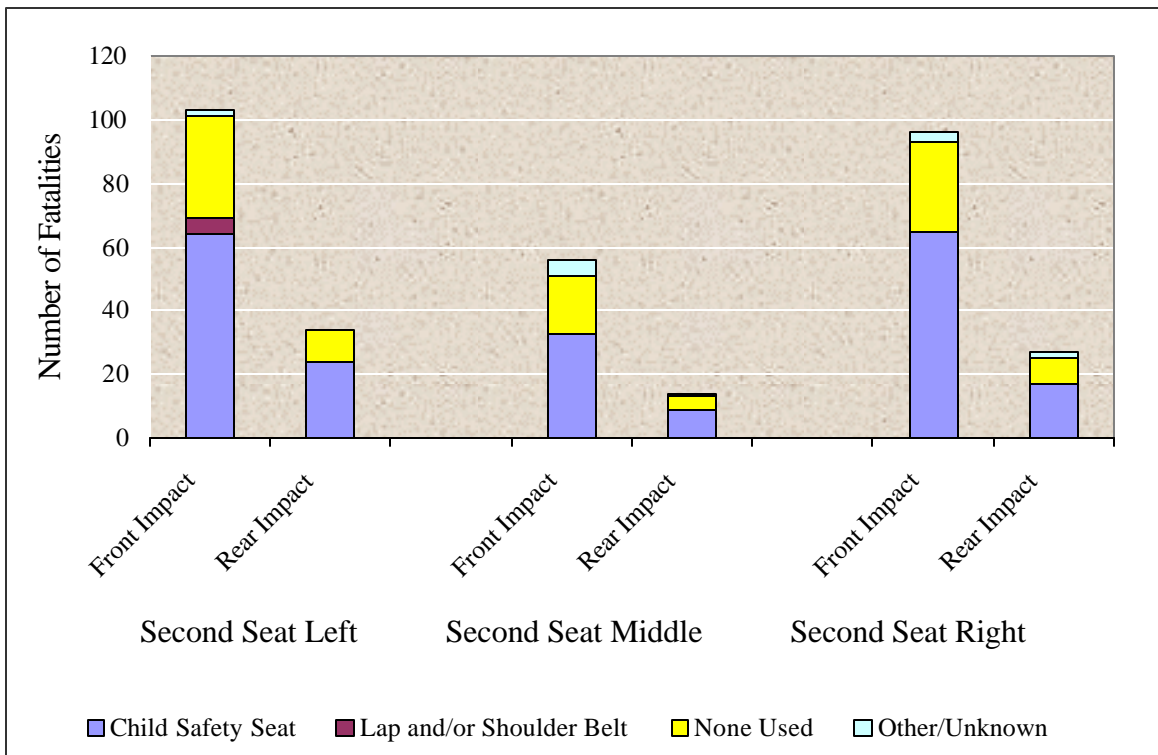
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.1.4 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Second Seat, Age <1

Table 21 shows the number of passenger vehicle occupant fatalities in the second seat, for children less than one year old, categorized by restraint use, impact point, and seating position. Within the second seat, the number of front impact fatalities (77 percent) was far greater than the number of rear impact fatalities (23 percent). While a similar trend occurred among children sitting in the front seat, the ratio of front impact fatalities to rear impact fatalities for children less than one year old was 12.7 in the front seat as compared to 3.4 in the second seat.

Among children seated in the left side of the second seat, 103 front impact fatalities and 34 rear impact fatalities occurred from 1991 through 2000. Throughout this same time period, there were 56 front impact fatalities and 14 rear impact fatalities within the second middle seat, and 96 front impact fatalities and 27 rear impact fatalities for children seated in the right side of the second seat. Upon combining all seating positions within the second seat, only 31 percent of all front impact fatalities within the second seat involved children who were unrestrained, as compared to 53 percent of children within the front seat who were less than one year old.

Chart 32: Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 21  
Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One  
Year Old, by Restraint Use and Longitudinal Impact Point**

Restraint Use	Seating Position						Total
	Second Left		Second Middle		Second Right		
	Impact Point		Impact Point		Impact Point		
	Front Impact	Rear Impact	Front Impact	Rear Impact	Front Impact	Rear Impact	
Child Safety Seat	64	24	33	9	65	17	212
Lap and/or Shoulder Belt	5	0	0	0	0	0	5
None Used	32	10	18	4	28	8	100
Other/Unknown	2	0	5	1	3	2	13
<b>Total</b>	<b>103</b>	<b>34</b>	<b>56</b>	<b>14</b>	<b>96</b>	<b>27</b>	<b>330</b>

Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

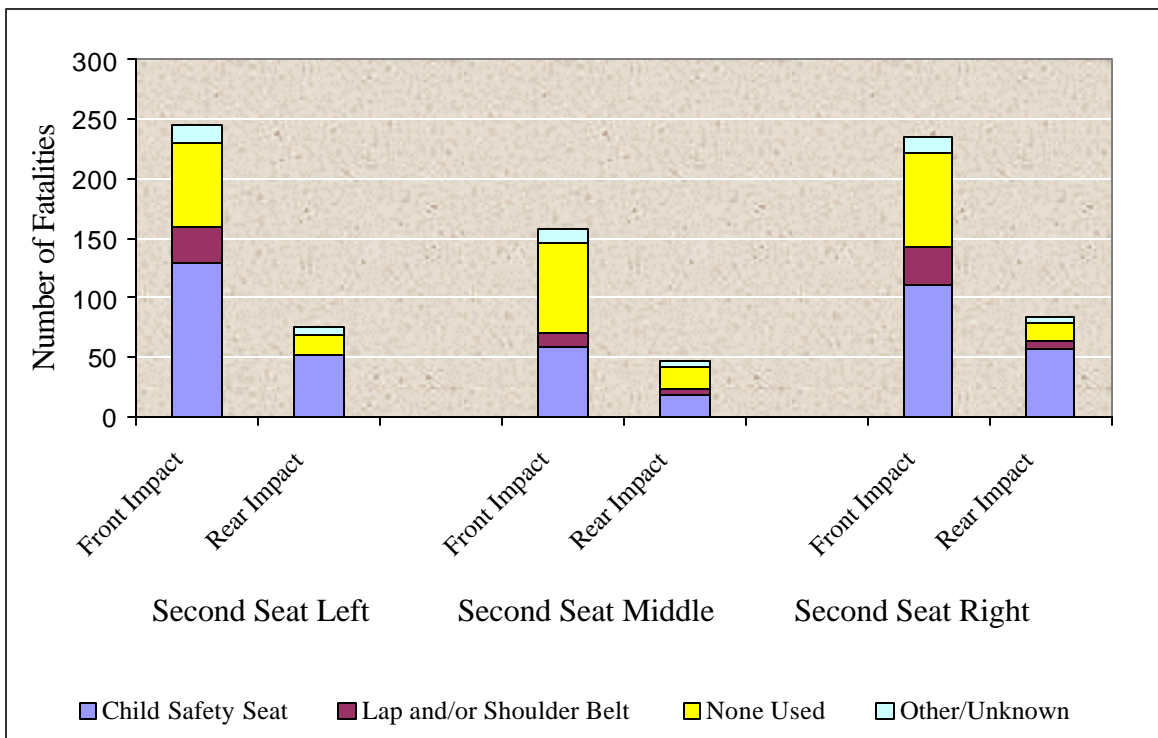
8.1.5 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Second Seat, Age 1 – 3

Table 22 shows the number of passenger vehicle occupant fatalities in the second seat, for children 1 through 3 years old, categorized by restraint use, impact point, and seating position, aggregated over a ten-year period. Within the second seat, the number of front impact fatalities (637) was far greater than the number of rear impact fatalities (206). The ratio of front impact fatalities to rear impact fatalities for children 1 through 3 years old was 12.3 in the front seat, compared to 3.1 in the second seat, similar to the pattern seen among children less than one year old.

Among children seated in the left side of the second seat, 245 front impact fatalities and 75 rear impact fatalities occurred from 1991 through 2000. During this same time period, there were 157 front impact fatalities and 47 rear impact fatalities within the second middle seat, and 235 front impact fatalities and 84 rear impact fatalities for children seated in the right side of the second seat.

Among children 1 through 3 years old, only 35 percent of all front impact fatalities within the second seat involved children who were unrestrained, as compared to 51 percent within the front seat. These percentages are almost equal to those seen among children less than one year old.

Chart 33: Second Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000



**Table 22**  
**Second Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Restraint Use and Longitudinal Impact Point**

Restraint Use	Seating Position						Total
	Second Left		Second Middle		Second Right		
	Impact Point		Impact Point		Impact Point		
	Front Impact	Rear Impact	Front Impact	Rear Impact	Front Impact	Rear Impact	
Child Safety Seat	129	51	59	18	110	57	424
Lap and/or Shoulder Belt	30	1	12	5	32	6	86
None Used	71	17	75	19	80	16	278
Other/Unknown	15	6	11	5	13	5	55
<b>Total</b>	<b>245</b>	<b>75</b>	<b>157</b>	<b>47</b>	<b>235</b>	<b>84</b>	<b>843</b>

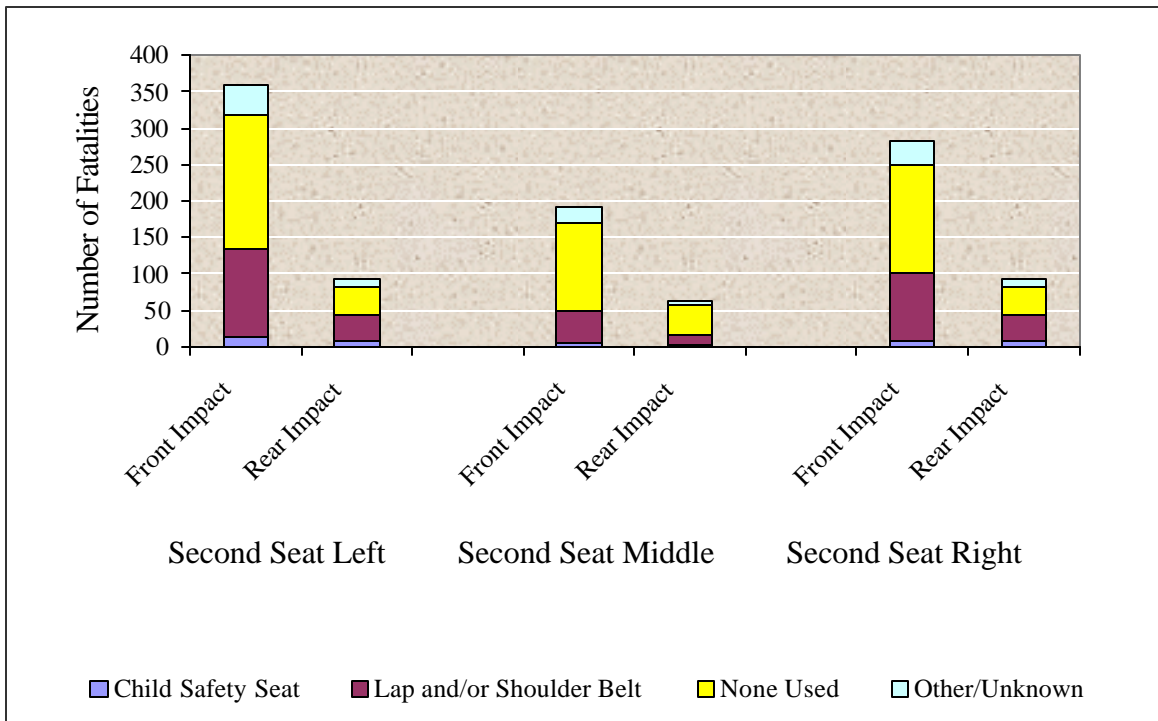
Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

8.1.6 Passenger Vehicle Occupants Killed, by Restraint Use, Front/Rear Impact, Second Seat, Age 4 - 8

The number of passenger vehicle occupant fatalities in the second seat, for children 4 through 8 years old, categorized by restraint use, impact point, and seating position, aggregated from 1991 through 2000, is shown in Table 23. Within the second seat, the overall number of front impact fatalities was far greater than the overall number of rear impact fatalities. While a similar trend occurred among children sitting in the front seat, the ratio of front impact fatalities to rear impact fatalities for children 4 through 8 years old was 15.9 in the front seat, as compared to 3.3 in the second seat.

Among children seated in the left side of the second seat, 358 front impact fatalities and 92 rear impact fatalities occurred from 1991 through 2000. Throughout this same time period, there were 193 front impact fatalities and 64 rear impact fatalities within the second middle seat, and 281 front impact fatalities and 94 rear impact fatalities for children seated in the right side of the second seat. Among children 4 through 8 years old, 55 percent of all front impact fatalities within the second seat involved children who were unrestrained, compared with 34 percent of children less than 4 years old.

Chart 34: Second Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Longitudinal Impact Point and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 23  
Second Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,  
by Restraint Use and Longitudinal Impact Point**

Restraint Use	Seating Position						Total
	Second Left		Second Middle		Second Right		
	Impact Point		Impact Point		Impact Point		
	Front Impact	Rear Impact	Front Impact	Rear Impact	Front Impact	Rear Impact	
Child Safety Seat	14	8	5	3	9	7	46
Lap and/or Shoulder Belt	119	36	43	14	92	36	340
None Used	186	38	123	40	148	39	574
Other/Unknown	39	10	22	7	32	12	122
<b>Total</b>	<b>358</b>	<b>92</b>	<b>193</b>	<b>64</b>	<b>281</b>	<b>94</b>	<b>1,082</b>

**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

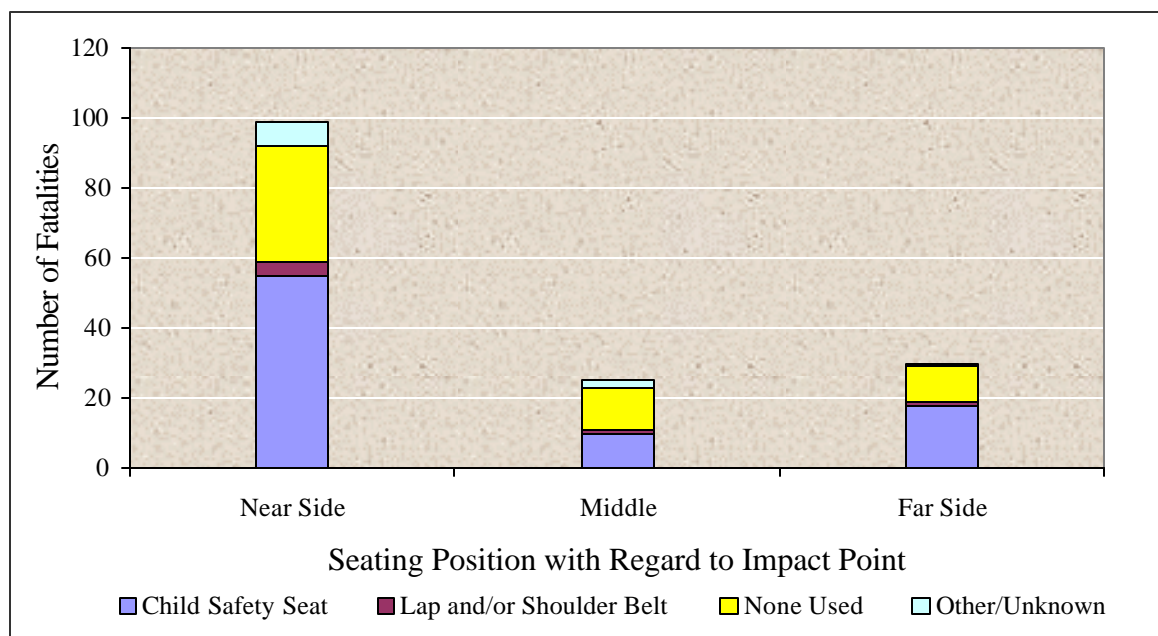
## 8.2 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact

This section refers to side impact fatalities occurring in the front and second seats. Seating position is broken down into three mutually exclusive categories. For occupants sitting on the side of the vehicle closest to the side impact, their seating position is defined as near side. For occupants sitting on the side of the vehicle furthest from the side impact, their seating position is defined as far side. Occupants seated in the middle seat comprise the third seating position category.

### 8.2.1 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Front Seat, Age <1

Table 24 shows the number of passenger vehicle occupant fatalities, for children less than one year old, categorized by restraint use, impact point, and seating position. Within the front seat, 99 side impact fatalities were near sided, equaling 64 percent of all front seat side impact fatalities, while 30 were far sided (19 percent) and 25 occurred in the middle seat (16 percent). Fifty four percent of side impact fatalities involved children restrained in a child safety seat. Children who were unrestrained accounted for 48 percent of fatalities occurring in the middle seat, versus 33 percent of fatalities in the near or far side.

Chart 35: Front Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 24**  
**Front Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Restraint Use and Seating Position Relative to Side Impact Point**

Restraint Use	Seating Position Relative to Impact Point			Total
	Near Side	Middle	Far Side	
Child Safety Seat	55	10	18	83
Lap and/or Shoulder Belt	4	1	1	6
None Used	33	12	10	55
Other/Unknown	7	2	1	10
<b>Total</b>	<b>99</b>	<b>25</b>	<b>30</b>	<b>154</b>

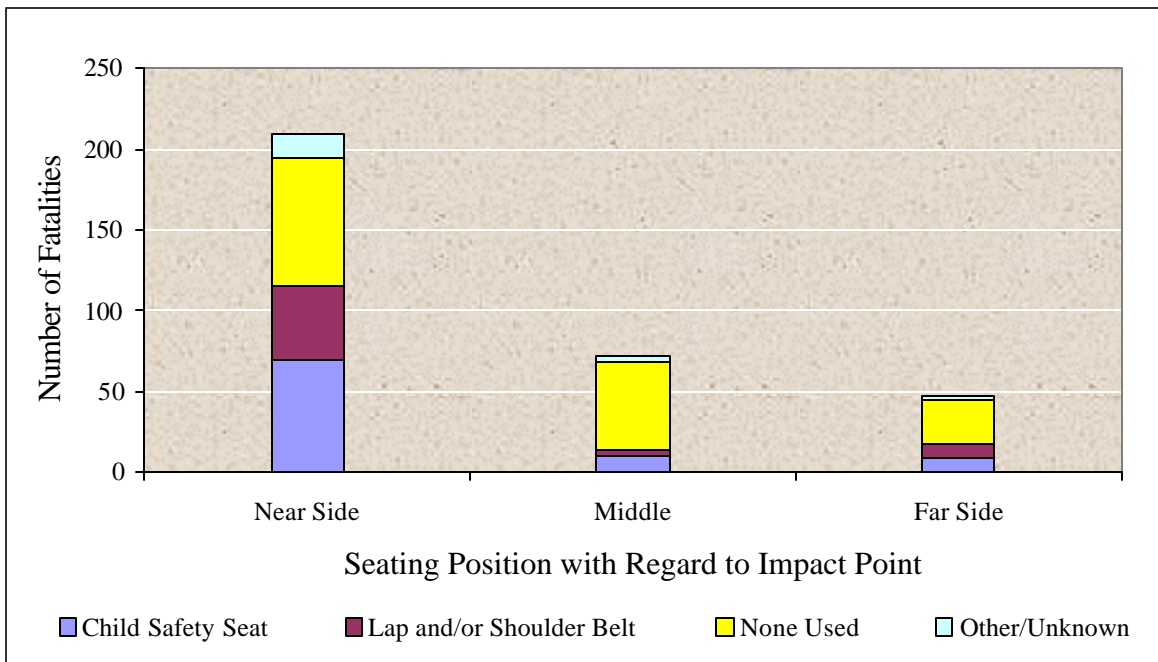
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.2 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Front Seat, Age 1 – 3

The number of passenger vehicle occupant fatalities in the front seat, for children 1 through 3 years old, categorized by restraint use, impact point, and seating position is shown in Table 25. Within the front seat, 209 side impact fatalities were near sided, equaling 64 percent of all front seat side impact fatalities, while 47 were far sided (14 percent) and 72 occurred in the middle seat (22 percent).

Among children 1 through 3 years old in the front seat, near side impacts accounted for 79 percent of side impact fatalities involving children in child safety seats or lap/and or shoulder belts. Comparatively, only 49 percent of fatalities involving children who were unrestrained were due to near side impacts, suggesting that restraint use is most effective among children not seated at the point of impact of the crash. Children who were unrestrained accounted for 76 percent of fatalities occurring in the middle seat, versus 57 percent of fatalities in the far side and 38 percent in the near side.

Chart 36: Front Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 25**  
**Front Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Restraint Use and Seating Position Relative to Side Impact Point**

Restraint Use	Seating Position Relative to Impact Point			Total
	Near Side	Middle	Far Side	
Child Safety Seat	69	10	9	88
Lap and/or Shoulder Belt	46	3	8	57
None Used	80	55	27	162
Other/Unknown	14	4	3	21
<b>Total</b>	209	72	47	328

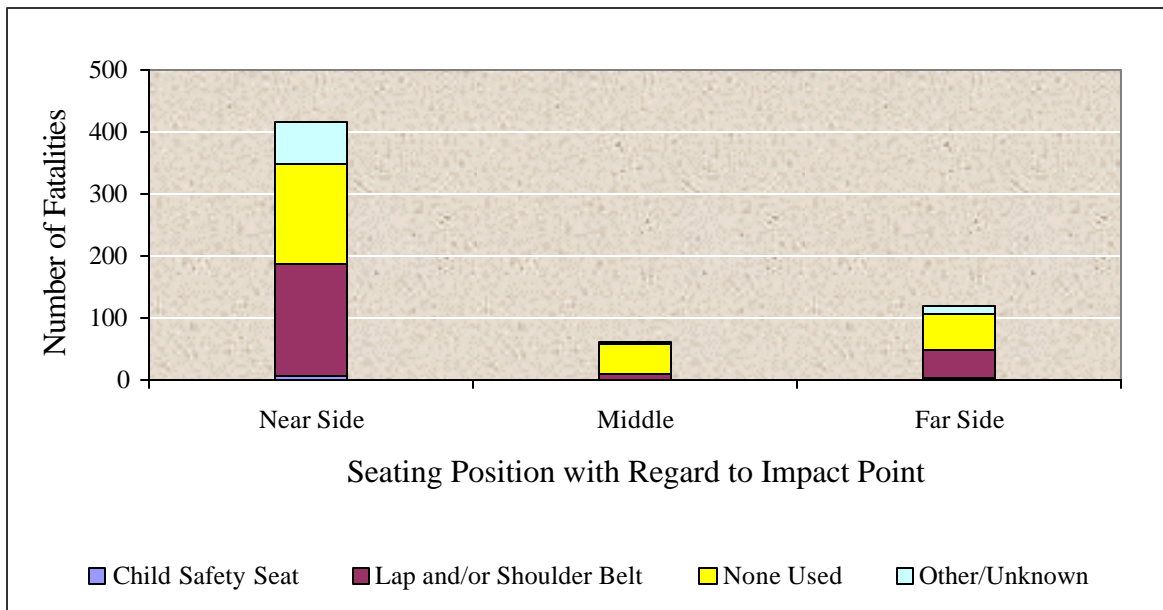
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.3 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Front Seat, Age 4 – 8

Table 26 shows the number of passenger vehicle occupant fatalities, for children 4 through 8 years old, categorized by restraint use, impact point, and seating position. Within the front seat, 415 side impact fatalities were near sided, equaling 70 percent of all front seat side impact fatalities. Of the front seat side impact fatalities, 117 were far sided (20 percent) and 61 occurred in the middle seat (10 percent).

Eighty percent of children 4 through 8 years old killed in side impact crashes while riding in the front middle seat were unrestrained. Similarly, for the 1 through 3 year olds, 76 percent of these children were unrestrained. Children restrained in lap and/or shoulder belts accounted for 40 percent of front seat side impact fatalities among 4 through 8 year olds, compared to 35 percent of all front seat passenger vehicle fatalities among 4 through 8 years olds from 1991 through 2000.

Chart 37: Front Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000



**Table 26**  
**Front Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,**  
**by Restraint Use and Seating Position Relative to Side Impact Point**

Restraint Use	Seating Position Relative to Impact Point			Total
	Near Side	Middle	Far Side	
Child Safety Seat	5	0	2	7
Lap and/or Shoulder Belt	182	8	45	235
None Used	162	49	60	271
Other/Unknown	66	4	10	80
<b>Total</b>	<b>415</b>	<b>61</b>	<b>117</b>	<b>593</b>

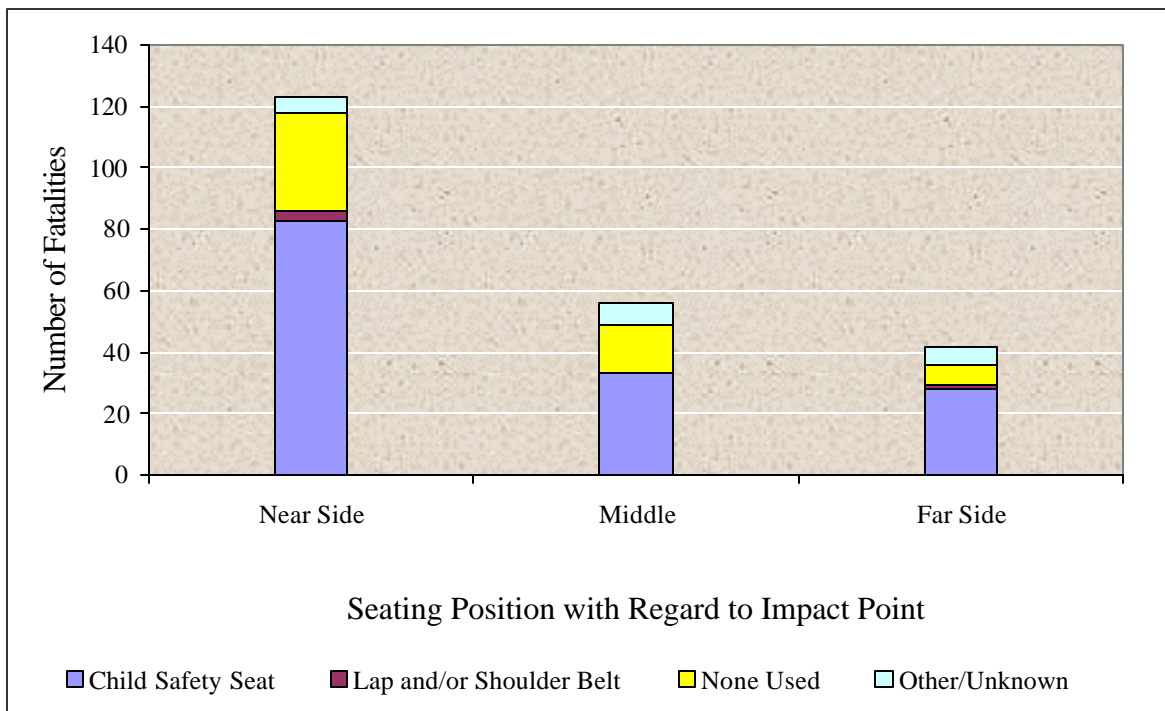
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.4 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Second Seat, Age <1

Within the second seat, 123 side impact fatalities were near sided, equaling 56 percent of all second seat side impact fatalities. Of the second seat side impact fatalities, 42 were far sided (19 percent) and 56 occurred in the middle seat (25 percent). Table 27 shows the number of passenger vehicle occupant fatalities, for children less than one year old, categorized by restraint use, impact point, and seating position.

Among children less than one year old, 65 percent of second seat side impact fatalities were children restrained in a child safety seat. Children who were unrestrained accounted for 25 percent of side impact fatalities throughout the second seat, versus 36 percent of front seat side impact fatalities.

Chart 38: Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

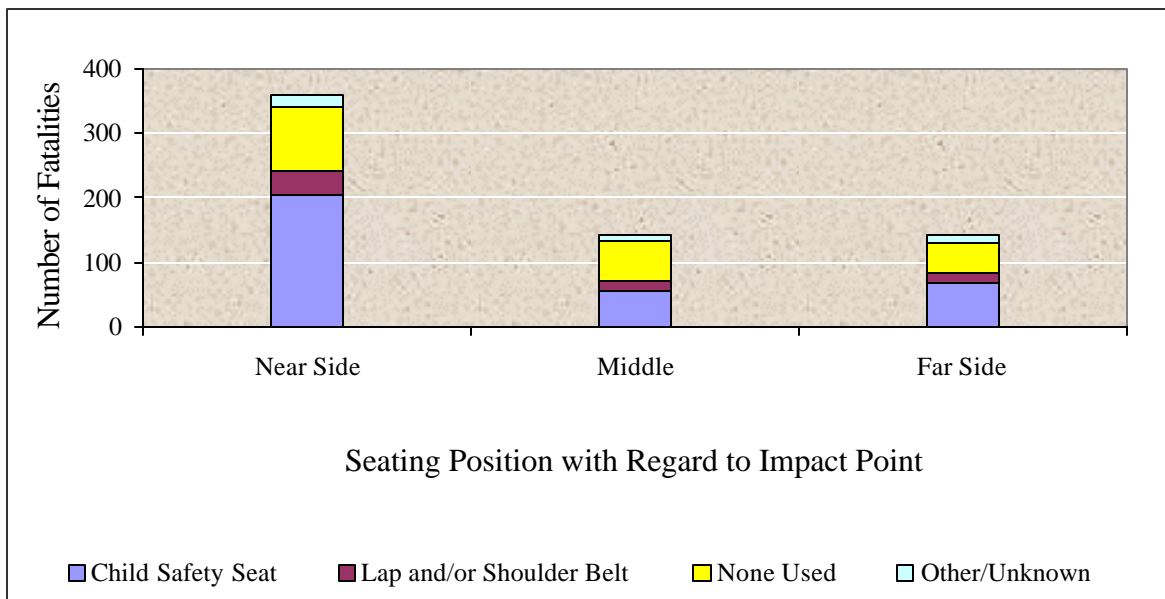
<b>Table 27</b>				
<b>Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Restraint Use and Seating Position Relative to Side Impact Point</b>				
<b>Restraint Use</b>	<b>Seating Position Relative to Impact Point</b>			<b>Total</b>
	<b>Near Side</b>	<b>Middle</b>	<b>Far Side</b>	
Child Safety Seat	83	33	28	144
Lap and/or Shoulder Belt	3	0	1	4
None Used	32	16	7	55
Other/Unknown	5	7	6	18
<b>Total</b>	<b>123</b>	<b>56</b>	<b>42</b>	<b>221</b>
<b>Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000</b>				

8.2.5 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Second Seat, Age 1 – 3

Table 28 shows the number of passenger vehicle occupant fatalities, for children 1 through 3 years old, categorized by restraint use, impact point, and seating position. Within the second seat, 358 side impact fatalities were near sided, equaling 56 percent of all second seat side impact fatalities, while 141 were far sided (22 percent) and 143 occurred in the middle seat (22 percent).

Among children 1 through 3 years old in the second seat, near side impacts accounted for 61 percent of side impact fatalities involving children in child safety seats or lap/and or shoulder belts. Comparatively, far side impacts accounted for only 21 percent of side impact fatalities involving children who were restrained, suggesting that restraint use is most effective among children not seated at the point of impact of the crash. Children who were unrestrained accounted for 43 percent of fatalities occurring in the middle seat, versus 27 percent in the near side and 33 percent of fatalities in the far side.

Chart 39: Second Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 28**  
**Second Seating Position Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Restraint Use and Seating Position Relative to Side Impact Point**

Restraint Use	Seating Position Relative to Impact Point			Total
	Near Side	Middle	Far Side	
Child Safety Seat	206	58	69	333
Lap and/or Shoulder Belt	36	13	14	63
None Used	97	62	47	206
Other/Unknown	19	10	11	40
<b>Total</b>	<b>358</b>	<b>143</b>	<b>141</b>	<b>642</b>

**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

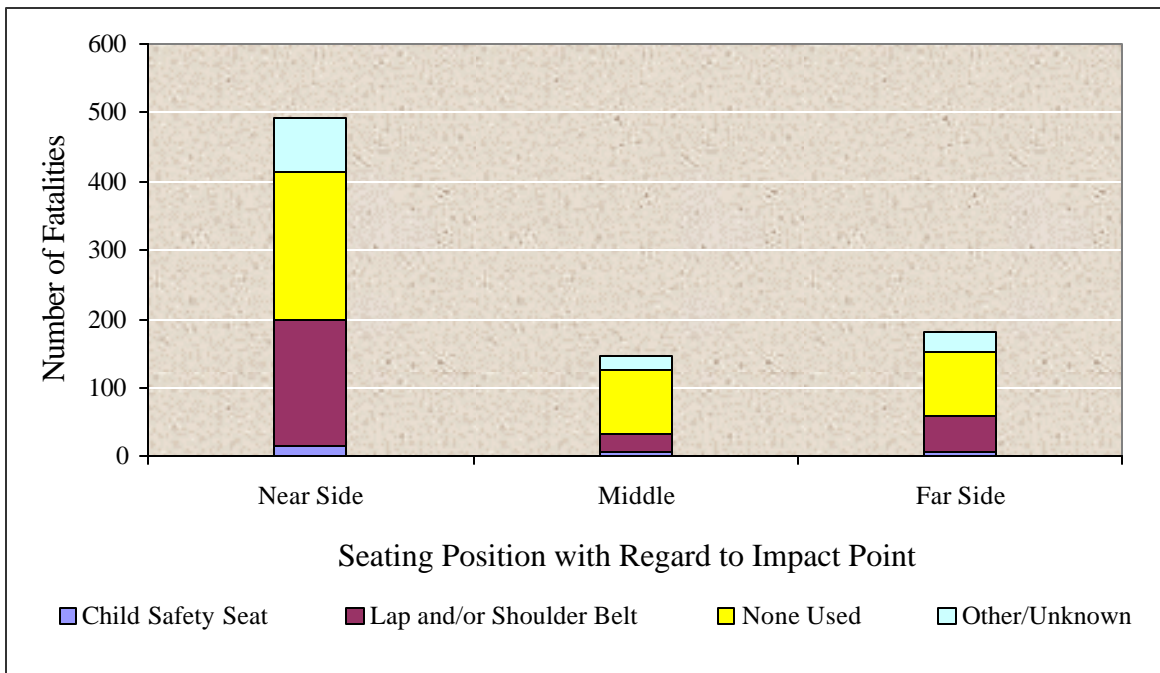
8.2.6 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Side Impact, Second Seat, Age 4 – 8

The number of passenger vehicle occupant fatalities in the second seat aggregated over a ten-year period, for children 4 through 8 years old, categorized by restraint use, impact point, and seating position is shown in Table 29. Within the second seat, 492 side impact fatalities were near sided, equaling 60 percent of all second seat side impact fatalities, while 182 were far sided (22 percent) and 147 occurred in the middle seat (18 percent).

Sixty-three percent of 4 through 8 year olds killed in side impact crashes while riding in the second middle seat were unrestrained, compared to only 29 percent of children less than 1 year old and 43 percent of children 1 through 3 years old.

Among children 4 through 8 years old in the second seat, near side impacts accounted for 68 percent of side impact fatalities involving children in child safety seats or lap/and or shoulder belts. Comparatively, far side impacts accounted for only 20 percent of side impact fatalities involving children who were restrained, suggesting that restraint use is most effective among children not seated at the point of impact of the crash.

Chart 40: Second Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Side Impact Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 29**  
**Second Seating Position Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,**  
**by Restraint Use and Seating Position Relative to Side Impact Point**

Restraint Use	Seating Position Relative to Impact Point			Total
	Near Side	Middle	Far Side	
Child Safety Seat	16	5	6	27
Lap and/or Shoulder Belt	183	29	52	264
None Used	216	93	95	404
Other/Unknown	77	20	29	126
Total	492	147	182	821

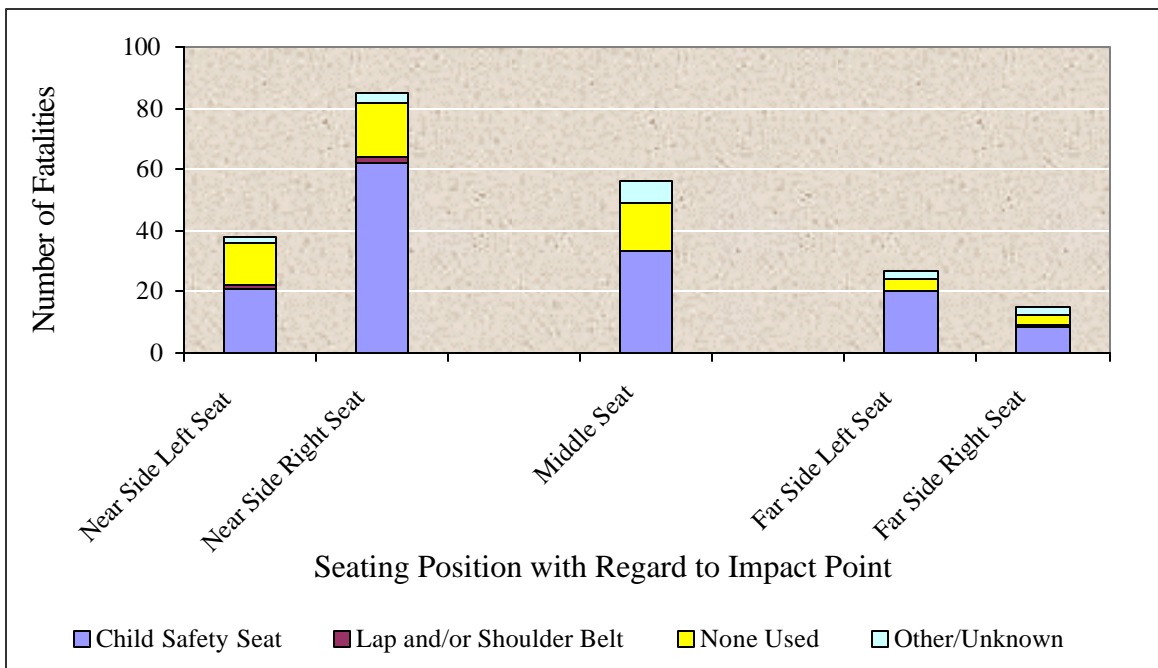
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.7 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Point of Side Impact, Second Seat, Age <1

Table 30 shows the number of passenger vehicle occupant fatalities, for children less than one year old, categorized by restraint use, impact point, and seating position. Within the second seat, 69 percent of children killed in near side crashes were seated on the right side, and 64 percent of children killed in far side crashes were seated on the left side.

After combining all side impact crashes where the passenger was seated in the near side or far side, it is seen that 68 percent of these crashes occurred when the vehicle was hit from the right side, while 32 percent of these crashes occurred when the vehicle was hit from the left side. This pattern suggests that drivers are more likely to place children less than one year old in a seating position that is convenient to their range of vision.

Chart 41: Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Lateral Impact Point Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000



**Table 30**  
**Second Seating Position Passenger Vehicle Occupants Killed, Age Less than One Year Old, by Restraint Use and Seating Position Relative to Lateral Impact Point**

Restraint Use	Seating Position Relative to Impact Point					Total
	Near Side Left Seat	Near Side Right Seat	Middle	Far Side Left Seat	Far Side Right Seat	
Child Safety Seat	21	62	33	20	8	144
Lap and/or Shoulder Belt	1	2	0	0	1	4
None Used	14	18	16	4	3	55
Other/Unknown	2	3	7	3	3	18
<b>Total</b>	<b>38</b>	<b>85</b>	<b>56</b>	<b>27</b>	<b>15</b>	<b>221</b>

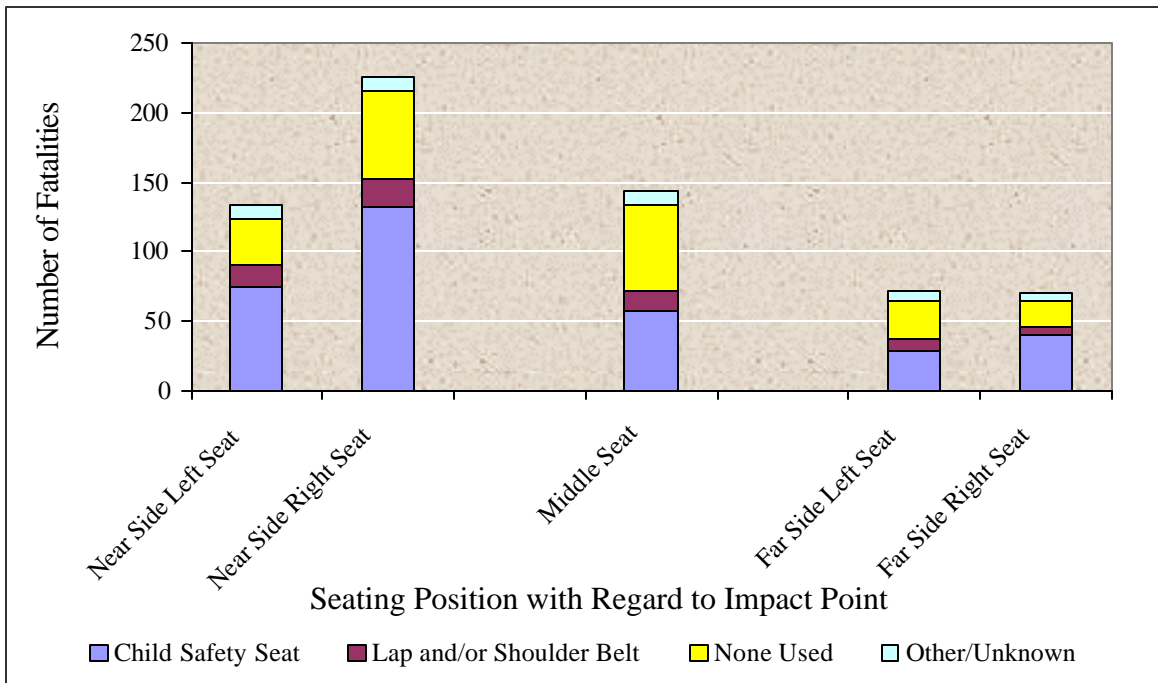
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.8 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Point of Side Impact, Second Seat, Age 1 – 3

The number of passenger vehicle occupant fatalities in the second seat aggregated from 1991 through 2000, for children 1 through 3 years old, categorized by restraint use, impact point, and seating position is shown in Table 31. Within the second seat, 63 percent of children killed in near side crashes were seated on the right side, and 50 percent of children killed in far side fatalities were seated on the left side.

After combining all side impact crashes where the passenger was seated on the near side or far side, it is seen that 60 percent of these crashes occurred when the vehicle was hit from the right side, while 40 percent of these crashes occurred when the vehicle was hit from the left side. As with children less than one year old, this pattern suggests that drivers are more likely to place young children in a seating position that is convenient to their range of vision.

Chart 42: Second Seat Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old, by Lateral Impact Point Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 31**  
**Second Seat Passenger Vehicle Occupants Killed, Age 1 - 3 Years Old,**  
**by Restraint Use and Seating Position Relative to Lateral Impact Point**

Restraint Use	Seating Position Relative to Impact Point					Total
	Near Side Left Seat	Near Side Right Seat	Middle	Far Side Left Seat	Far Side Right Seat	
Child Safety Seat	74	132	58	29	40	333
Lap and/or Shoulder Belt	16	20	13	8	6	63
None Used	34	63	62	28	19	206
Other/Unknown	9	10	10	6	5	40
<b>Total</b>	<b>133</b>	<b>225</b>	<b>143</b>	<b>71</b>	<b>70</b>	<b>642</b>

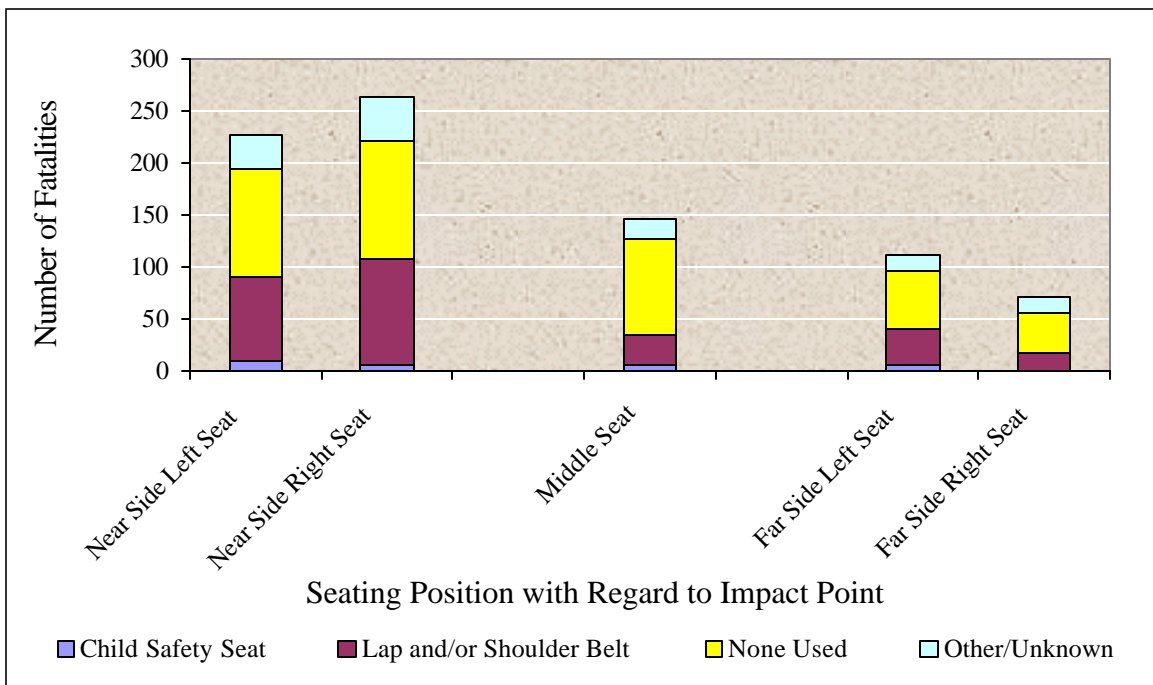
**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

8.2.9 Passenger Vehicle Occupants Killed, by Restraint Use, Seating Position Relative to Point of Side Impact, Second Seat, Age 4 – 8

Table 32 shows the number of passenger vehicle occupant fatalities, for children 4 through 8 years old, categorized by restraint use, impact point, and seating position aggregated over a ten-year period. Within the second seat, 54 percent of children killed in near side crashes were seated on the right side, and 61 percent of children killed in far side crashes were seated on the left side.

After combining all side impact crashes where the passenger was seated in the near side or far side, it is seen that 56 percent of these crashes occurred when the vehicle was hit from the right side, while 44 percent of these crashes occurred when the vehicle was hit from the left side. These percentages show that in the second seat, the heterogeneity in seating position of children 4 through 8 years old is greater than among children less than 4 years old.

Chart 43: Second Seat Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old, by Lateral Impact Point Relative to Seating Position and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000

**Table 32**  
**Second Seat Passenger Vehicle Occupants Killed, Age 4 - 8 Years Old,**  
**by Restraint Use and Seating Position Relative to Lateral Impact Point**

Restraint Use	Seating Position Relative to Impact Point					Total
	Near Side Left Seat	Near Side Right Seat	Middle	Far Side Left Seat	Far Side Right Seat	
Child Safety Seat	10	6	5	5	1	27
Lap and/or Shoulder Belt	81	102	29	35	17	264
None Used	103	113	93	57	38	404
Other/Unknown	34	43	20	14	15	126
<b>Total</b>	<b>228</b>	<b>264</b>	<b>147</b>	<b>111</b>	<b>71</b>	<b>821</b>

**Source: National Center for Statistics and Analysis, NHTSA, FARS 1991-2000**

## **9. PASSENGER VEHICLE OCCUPANT INJURIES, BY RESTRAINT USE, ABBREVIATED INJURY SCALE AND INJURED BODY REGION**

This chapter studies passenger vehicle occupant injuries, broken down by restraint use, injured body region, and Abbreviated Injury Scale (AIS). This data set includes injuries sustained by children 0 through 8 years old from 1991–1996 and 1998–2000. The injured body regions include abdomen, chest, head, lower extremity, neck, and upper extremity. The AIS injury categories are defined as follows:

- AIS 1 – Minor
- AIS 2 – Moderate
- AIS 3 – Serious
- AIS 4 – Severe
- AIS 5 – Critical
- AIS 6 – Maximum (untreatable).

Due to the limited sample size of the CDS database, the injury data within this chapter was categorized using the age range of 0 through 8 years old. The standard errors for each of these estimates may be calculated using SUDAAN, a statistical package for analysis of correlated or clustered data. SUDAAN takes account of weights and intraclass correlations in estimating variances of the parameters.

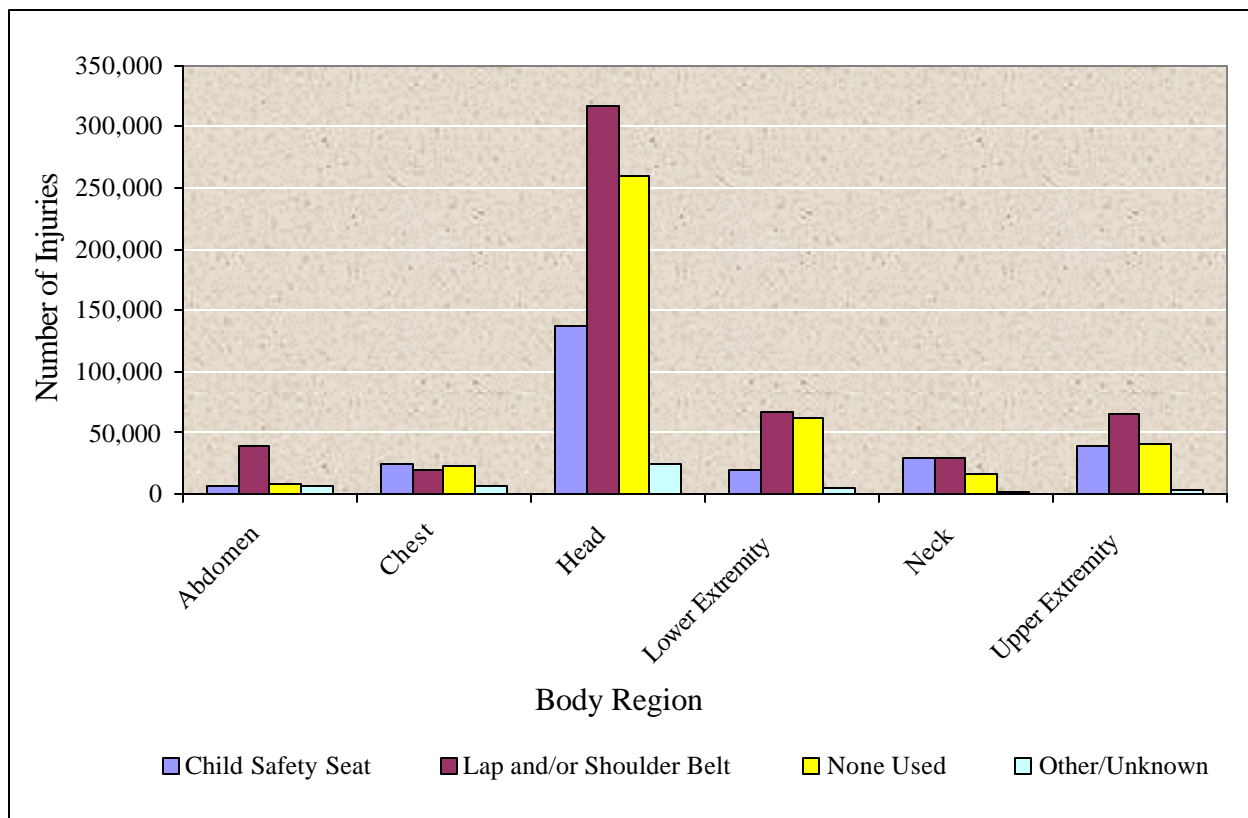
### **9.1 Passenger Vehicle Occupant AIS 1 Injuries, by Restraint Use and Injured Body Region**

Table 33 shows the estimated number of AIS 1 passenger vehicle occupant injuries, for children in the 0 through 8 year old age range, categorized by restraint use, and injured body region. Of all injuries reported for children 0 through 8 years old, 91 percent of these injuries were within the AIS 1 category, whereas 88 percent of injuries to occupants of all ages were AIS 1. This clarifies that an overwhelming percentage of injuries which occupants experience are minor injuries.

Among children 0 through 8 years old, approximately 740,000 head injuries of severity AIS 1 occurred, representing 58 percent of AIS 1 injuries. Comparatively, only 30 percent of the injuries to occupants of all ages affected the head. While the unrestrained occupant was very vulnerable in both age ranges, the anatomical disadvantage of a disproportionately large head increases the child's injury risk.

Only 33 percent of AIS 1 injuries to children occurred while the child was unrestrained, as compared with 42 percent of AIS 1 injuries sustained by occupants of all ages. These estimates suggest that restraint use often limits the severity of injuries.

Chart 44: Passenger Vehicle Occupant AIS 1 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

**Table 33**  
**Passenger Vehicle Occupant AIS 1 Injuries, Age 0 - 8 Years Old,**  
**by Restraint Use and Injured Body Region**

Restraint Use	Injured Body Region							Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	Unknown	
Child Safety Seat	6,860	24,732	137,569	19,244	29,044	39,359	6,954	263,763
Lap and/or Shoulder Belt	38,986	20,125	317,454	67,726	29,165	65,257	9,497	548,209
None Used	8,106	23,335	259,345	62,346	17,081	40,497	6,483	417,193
Other/Unknown	6,290	6,114	25,445	4,877	1,853	3,254	2,224	50,057
<b>Total</b>	<b>60,242</b>	<b>74,307</b>	<b>739,813</b>	<b>154,192</b>	<b>77,143</b>	<b>148,367</b>	<b>25,157</b>	<b>1,279,222</b>

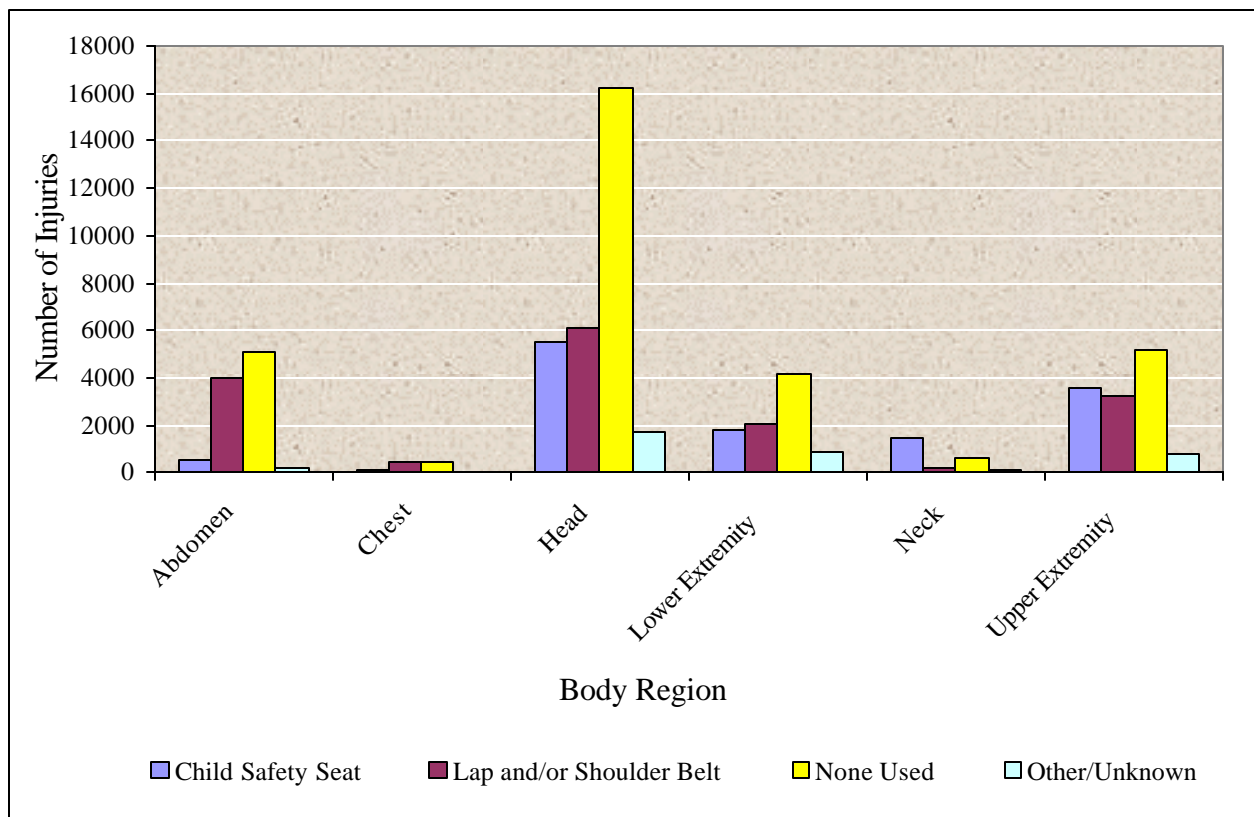
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

## 9.2 Passenger Vehicle Occupant AIS 2 Injuries, by Restraint Use and Injured Body Region

Table 34 shows the estimated number of AIS 2 passenger vehicle occupant injuries, for children in the 0 through 8 year old age range, categorized by restraint use and injured body region. Of all injuries reported for children 0 through 8 years old, 5 percent of these injuries were within the AIS 2 category, while AIS 2 injuries represented 8 percent of injuries to occupants of all ages. The significantly smaller number of AIS 2 injuries, as compared with AIS 1 injuries, is put more clearly into perspective when comparing the magnitude of the bars seen in Chart 45 versus Chart 44.

Children 0 through 8 years old experienced nearly 29,000 head injuries of severity AIS 2, representing 46 percent of all AIS 2 injuries. Forty-nine percent of AIS 2 injuries involved children who were unrestrained. As with AIS 1 injuries, restraint use among all ages was also very similar to that of the 0 through 8 year olds for AIS 2 injuries. For children 0 through 8 years old, as well as occupants of all ages, the head and extremities (lower and upper) were the regions most frequently sustaining a moderate injury, accounting for approximately 80 percent of all AIS 2 injuries.

Chart 45: Passenger Vehicle Occupant AIS 2 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000



**Table 34**  
**Passenger Vehicle Occupant AIS 2 Injuries, Age 0 - 8 Years Old,**  
**by Restraint Use and Injured Body Region**

Restraint Use	Injured Body Region						Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	
Child Safety Seat	530	107	5,507	1,792	1,429	3,580	12,944
Lap and/or Shoulder Belt	4,005	478	6,063	2,083	196	3,239	16,064
None Used	5,079	466	16,188	4,122	609	5,188	31,652
Other/Unknown	169	0	1,711	867	62	771	3,581
<b>Total</b>	<b>9,783</b>	<b>1,050</b>	<b>29,469</b>	<b>8,864</b>	<b>2,296</b>	<b>12,779</b>	<b>64,241</b>

**Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000**

### **9.3 Passenger Vehicle Occupant AIS 3 - 6 Injuries, by Restraint Use and Injured Body Region**

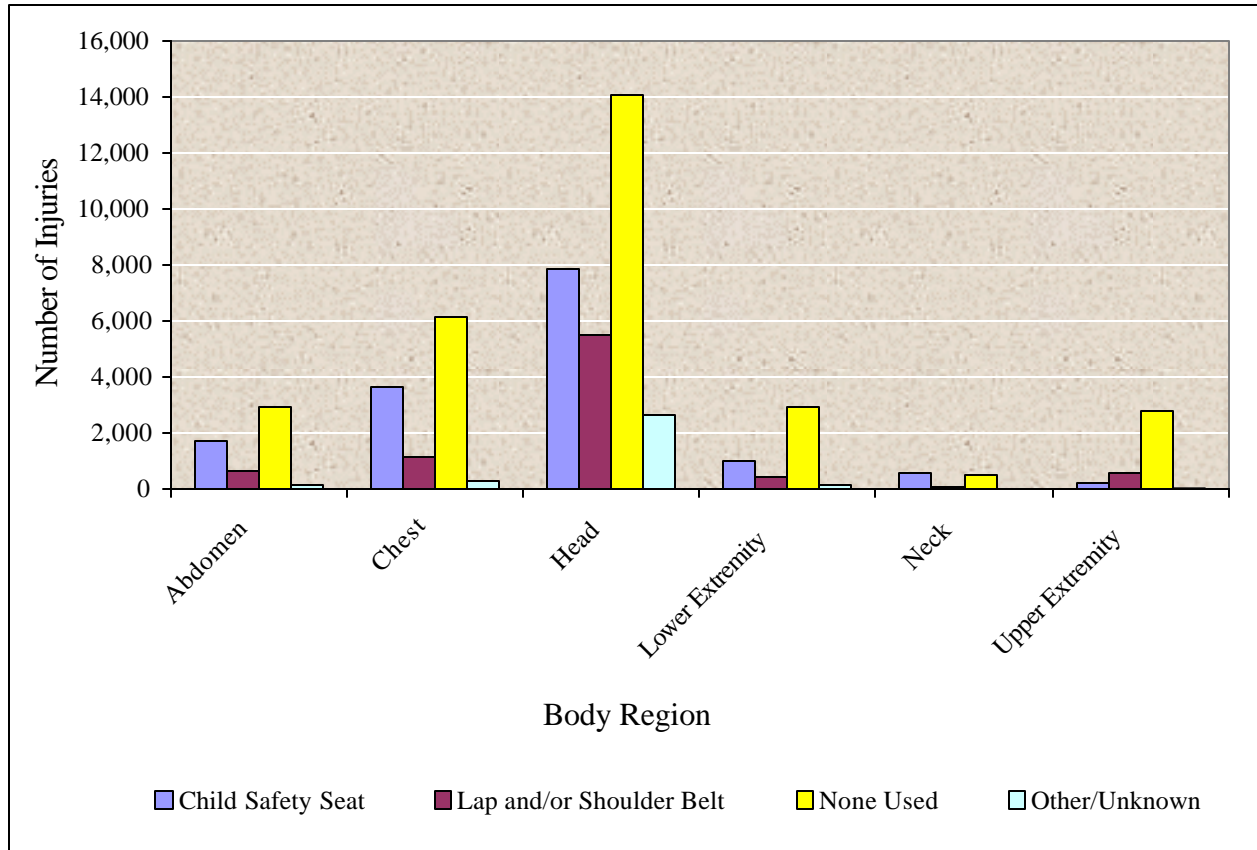
The estimated number of AIS 3 through AIS 6 passenger vehicle occupant injuries, for children in the 0 through 8 year old age range, categorized by restraint use and injured body region, is shown in Table 35. These four AIS categories combined represent the most severe injuries, from AIS 3 (serious) through AIS 6 (maximum). Of all injuries reported for children 0 through 8 years old, 4 percent of these injuries fell within AIS 3 through AIS 6. Similarly, 4 percent of injuries to occupants of all ages were AIS 3 through AIS 6.

Among children 0 through 8 years old, 52 percent of AIS 3 through AIS 6 injuries involved children who were unrestrained, as compared to 62 percent of occupants of all ages, suggesting that injuries of the highest severity are most likely to occur when the occupants are unrestrained.

A total of nearly 30,000 head injuries of severity AIS 3 through AIS 6 affected children 0 through 8 years old. Similar to the previously mentioned injury severities, head injuries represented more than half of the AIS 3 through AIS 6 injuries for children 0 through 8 years old. The chest was the second most frequently injured body region, accounting for 20 percent of AIS 3 through AIS 6 injuries, while 10 percent of these injuries involved the abdomen.

While 84 percent of AIS 3 through AIS 6 injuries involving children 0 through 8 years old were located in the head (54 percent), chest (20 percent), or abdomen (10 percent), these three injured body regions accounted for only 67 percent of AIS 3 through AIS 6 injuries among occupants of all ages. Many upper body structures, including chest and abdomen, are not fully formed in children, thereby increasing their vulnerability to severe upper body injuries.

Chart 46: Passenger Vehicle Occupant AIS 3 - 6 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

**Table 35**  
**Passenger Vehicle Occupant AIS 3 - 6 Injuries, Age 0 - 8 Years Old,**  
**by Restraint Use and Injured Body Region**

Restraint Use	Injured Body Region							Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	Unknown	
Child Safety Seat	1,695	3,661	7,888	1,015	549	237	22	15,068
Lap and/or Shoulder Belt	667	1,110	5,511	411	101	584	0	8,384
None Used	2,919	6,150	14,061	2,926	468	2,769	33	29,325
Other/Unknown	129	281	2,662	163	0	29	201	3,464
<b>Total</b>	<b>5,410</b>	<b>11,202</b>	<b>30,121</b>	<b>4,515</b>	<b>1,118</b>	<b>3,619</b>	<b>256</b>	<b>56,241</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

## **10. CONCLUSIONS**

The findings of this report support a variety of conclusions about the safety of children in passenger vehicles. This report also demonstrates the efficacy of using different data sources relating to the different types of injuries. This report does not consider all variables within the motor vehicle crash databases. Further studies need to be undertaken by examining other variables within FARS, GES and CDS databases that may provide additional information. The National Highway Traffic Safety Administration (NHTSA) plans to conduct these analyses and report the findings.

### **10.1 Fatality Rate per Vehicle Miles Traveled**

The number of vehicle miles traveled (VMT) by passenger vehicles has increased nearly 25 percent from 1991 to 2000, while the number of passenger vehicle fatalities among children 0 through 8 years old has dropped slightly during this time period. When these two trends are examined together, it is shown that among age groups less than one, one through three, and four through eight, the fatality rate per vehicle miles traveled has dropped significantly, as the usage rates for child safety seats and lap and/or shoulder belts have increased.

### **10.2 Overall Fatalities**

During the ten-year period from 1991 through 2000, the number of annual fatalities decreased 9 percent within the 0 through 3 year old age range. From 1996 through 2000, the number of fatalities among children less than one year old dropped from 178 to 131, a decline of 26 percent, while the number of 1 through 3 year old fatalities dropped 11 percent from 347 to 310. These reductions in fatalities coincide with the 1996 implementation of the NHTSA Buckle Up America campaign and the National Safety Council's Airbag and Seatbelt Safety campaign.

The trend in fatalities among children 4 through 8 years old differed from the trend seen among children 0 through 3 years old. Fatalities among 4 through 8 year olds rose from 440 in 1991 to 512 in 1998, an increase of 16 percent. Following this increase, the number of fatalities among 4 through 8 year olds dropped significantly from 512 in 1998 down to 454 in 2000, a reduction of 11 percent. The majority of this reduction occurred from 1999 to 2000, when fatalities dropped sharply from 499 to 454.

### **10.3 Fatalities Involving Unrestrained Occupants**

The number of fatalities where the child was unrestrained dropped significantly from 1991 through 2000. When this reduction is combined with the increase seen in VMT, these trends together imply that increases in restraint use are saving many lives. Among children less than one year old, fatalities involving unrestrained passengers dropped from 80 in 1991 to 36 in 2000, a reduction of 55 percent. During the year 2000, children 1 through 3 years old traveling unrestrained experienced only 114 fatalities, as compared with 201 in 1991. This represents a 43 percent decrease over this time period.

The number of fatalities among 4 through 8 year old children who were unrestrained dropped from 283 in 1991 to 217 in 2000, a decrease of 23 percent. However, the majority of this reduction occurred from 1999 to 2000, where the number of fatalities dropped from 268 to 217, a sharp decline of 19 percent.

#### **10.4 Fatalities by Seating Position**

Concurrent with the goals of the 1996 NHTSA Buckle Up America campaign and the National Safety Council Airbag and Seatbelt Safety campaign involving child passenger safety, the seating position of many children 0 through 8 years old shifted from the front seat to the second seat. While the number of fatalities was evenly divided between the front and second seats in 1991, by 2000 the front seat accounted for 56 percent fewer fatalities than the second seat. The number of fatalities in the front seat remained relatively constant from 1991 through 1996, then dropped 42 percent by the year 2000, from 415 in 1996 to 239 in 2000.

As restraint use among children age 0 through 8 years old improved in the second seat, the percent of second seat fatalities involving unrestrained children dropped from 56 percent in 1991 to 33 percent in 2000.

#### **10.5 Fatalities by Longitudinal Principal Impact Point**

Many more fatalities among children 0 through 8 years old were due to frontal impact crashes as opposed to rear impact crashes. In the front seat, a total of 1812, frontal impact fatalities and 131 rear impact fatalities occurred from 1991 through 2000, as frontal impacts accounted for 13.8 times as many fatalities as rear impacts. The ratio of frontal impact to rear impact fatalities was a much lower (3.2) in the second seat (1724 frontal impact versus 531 rear impact), suggesting that during a frontal crash, the child is safer in the second seat. The lower fatality ratio seen in the second seat (3.2) versus the front seat (13.8) is based on the proximity of the child to the impact point. However, the lower average change in velocity seen within rear impact crashes accounts for the child generally being safer when located in the rear seat.

#### **10.6 Fatalities by Lateral Principal Impact Point**

Among side impact crashes, as expected, the number of side impact fatalities involving children seated adjacent to the struck side (near side crash) is 2.6 times greater than the number of side impact fatalities involving children seated opposite the struck side (far side crash). The prevalence of near side impacts, which induce fatalities, is consistent over the three age categories (<1, 1 – 3, and 4 – 8 years old). The confounding issue that arises among fatally injured near side crash occupants is the high proportion of restraint use within each of these age categories.

Understandably, the front middle seat yields a much higher unrestrained subgroup, reaching 80 percent among the 4 through 8 year olds killed in side impacts. Occupants are more likely to be unrestrained in the front middle seat, owing to the absence or

inaccessibility of the lap and/or shoulder belt. Prior to the mid-1990s, if lap and shoulder belt combinations were available in the rear seat, only the outboard (near and far side) positions were equipped with this restraint hardware. Children were thus placed in the outboard seating positions, which are more vulnerable in side impacts, or situated in the rear center seating position, where they were restricted to a lap belt only.

## **10.7 Injury Severity**

Of the six medically assessed Abbreviated Injury Severity (AIS) levels ranging from minor (AIS 1) to maximum (AIS 6), 92 percent of all injuries occur within the injury category of least severity, minor. Although severe injuries are far less prevalent than minor injuries, the severity of injury increases as the incidence of restraint use decreases. For children 0 – 8 years old injured at an AIS 1 level, 33 percent were unrestrained, as compared with 52 percent of AIS 3 – 6 injuries. In general, the AIS 1 reporting is frequently limited to children with minor overall injury patterns. In situations where children sustain injuries of high severity, the reporting of corresponding lower severity injuries may be omitted. Injuries at the lower severities for the most exposed body regions tend to be most frequently reported.

## **10.8 Body Region Vulnerability**

During childhood, the bodily structures are in a developmental stage. Head injuries account for 57 percent of all injuries. Owing to the disproportionate dimension of the head with relation to the body, injuries may be received and imparted (e.g. neck injuries). In this case, the head is shaken or bruised but may also cause strain to the neck. The loading on the neck may cause further injury.

The hierarchy of injured body regions changes as the severity of injuries increases. Head injuries account for 58 percent of AIS 1 injuries, 46 percent of AIS 2 injuries, and 54 percent for AIS 3 through AIS 6 injuries. Beyond the consistently high frequency of head injuries, the children begin to experience chest, extremity (upper and lower), and abdominal injuries more often at higher severities. As with the head, the upper body and pelvic regions are undergoing full formation. In the case of abdominal injuries, the iliac crests will not exist until the child is older, thereby leaving internal organs unprotected.

## 11. APPENDIX

Section 11.1 includes the information about the data sources used in this report. Section 11.2 has tables and charts from numbers relating to NASS CDS data that were not used in the analysis.

### 11.1 Data Sources

#### 11.1.1 Fatality Analysis Reporting System

The Fatality Analysis Reporting System (FARS) dataset is a census of all crashes occurring on an open roadway resulting in a fatal injury, no more than 30 days from the date of the crash. The fatalities considered in this report account for crashes occurring in the 50 states and the District of Columbia, however, FARS also compiles crash data for Puerto Rico. Although operational since 1975, the crashes considered in this report span the years 1991 through 2000. The police accident report (PAR) becomes the basis for the FARS crash data. Generally, the PAR is prepared by the responding police officer and it outlines the participants in the crash, roadway geometry, legal violation, and some basic crash reconstruction, generally aided by a scene diagram.

FARS is divided into three files describing the fatal crashes. These files are the Accident File, Vehicle File, and Person File. The Accident File depicts the general crash environment and roadway geometry elements. The Vehicle File describes the vehicles by type, make, model, year, and other identifying characteristics. The Person File details the occupants of the vehicle, regardless of fatal injury.

The elements considered for this report were queried from each of the three files. Once resolved by age, restraint use variables were queried as a baseline for impact location with regard to seating position.

#### 11.1.2 National Automotive Sampling System

National Automotive Sampling System (NASS) case collection began in 1979. Based on nationally representative sampling units, PARs are collected from these sites for review and subsequent inclusion in the General Estimates System (GES) or Crashworthiness Data System (CDS) databases. GES concentrates on police-reported crashes of greatest concern to the highway safety community and the general public. CDS is a representative sample of crashes occurring in the United States. By virtue of weighting factors, the CDS crashes may be projected into the population, thereby providing a yearly crash estimate for a given crash type/mode that will occur. The number of yearly crashes causing major concern in the safety community may be ascertained using the weighted number of cases in GES. These weighting factors either count the number of times a case should be

projected into the population or can be multiplied by people, vehicle, or injury counts to obtain a sample population pertinent to the data element in question.

#### NASS – GES

GES provided basic injury data based on a nationally representative probability sample of police-reported crashes. For a case to become eligible for GES, it must have a completed PAR, the crash must involve at least one motor vehicle traveling on a traffic way, and result in property damage, injury, or death. GES started sampling cases in 1988.

Data are reported in three files. These files are the Accident, Vehicle, and Person Files. The injury data are based on the injury severity scale with the categories including K (killed), A (incapacitating injury), B (non-incapacitating injury), C (possible injury), and O (no injury). GES yielded overall child occupant exposure for the study rather than specific injury classification owing to the subjective nature of the “KABCO” injury severity scale.

#### NASS - CDS

CDS yields a comprehensive description of the crash events based on the PAR. These cases are then investigated to obtain a complete file on the vehicles involved in the crash, the geometry of the crash location, the interaction of the vehicles with the geometry/location attributes, the demography of the Passenger Vehicle Occupants, and the injury mechanisms/patterns, if any exist, for each of the occupants. With regard to this report, the strength of CDS lies in the injury severity ratings and the associated injury sources. The abbreviated injury scale (AIS) is used to assess risk of fatality. The AIS injury categories are defined as follows:

- AIS 1 – Minor
- AIS 2 – Moderate
- AIS 3 – Serious
- AIS 4 – Severe
- AIS 5 – Critical
- AIS 6 – Maximum (untreatable)

Currently, CDS integrates 11 files: Accident Description, Accident, Event, General Vehicle, Occupant Assessment, Occupant Injury, Person Profile, Accident Type, Vehicle Exterior, Vehicle Profile, Vehicle Interior. The Accident Description, Person Profile, Accident Type, and Vehicle Profile are text descriptions of the people, crash, and vehicles as summarized by the investigator. The Accident and Event files convey the most general crash elements such as roadway geometry, crash type, numbers of vehicles and occupants, offending roadside elements, and general vehicle classifications. The General Vehicle, Vehicle Exterior, and Vehicle Interior files convey vehicle related attributes of the



crash. The Occupant Assessment and Occupant Injury files compile the crash demography placing the occupant in the vehicle and associating him with crash attributes and injury mechanisms.

The elements used for the study were taken from the Occupant Assessment and Occupant Injury files. These files indicated the age, seating position, injury level and injury type for each occupant within the struck vehicle.

#### 11.1.3 United States Census Bureau

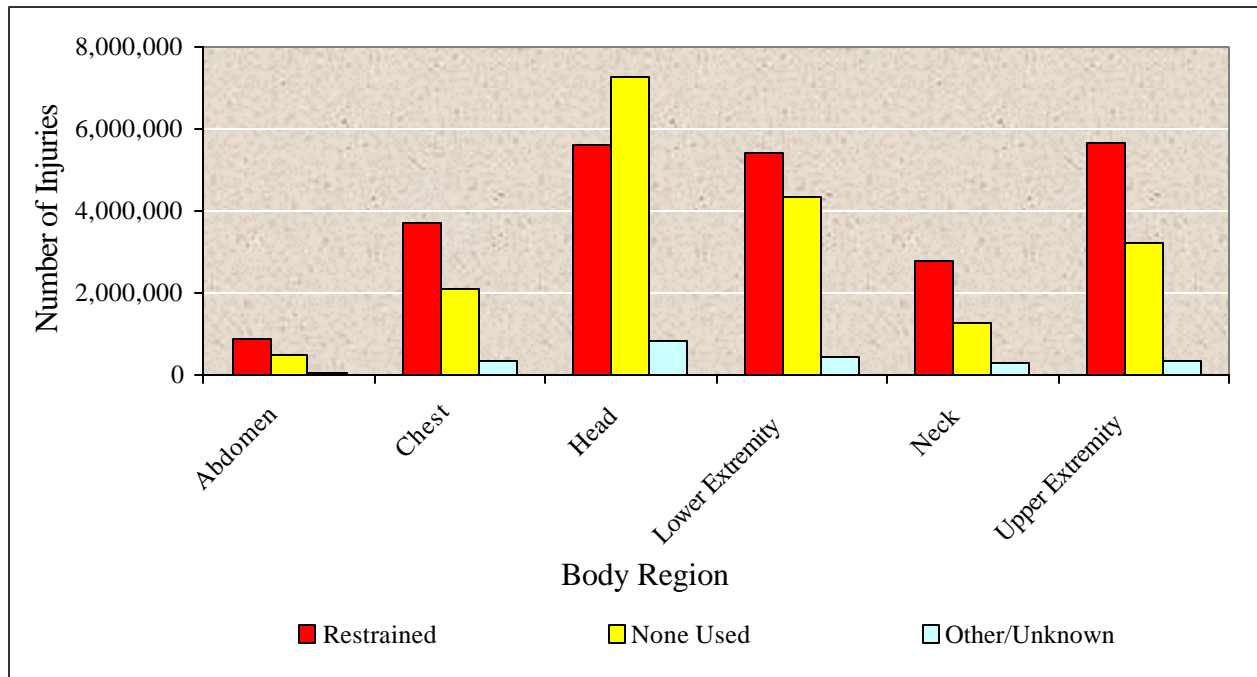
The U.S. Census Bureau was consulted owing to their yearly demographic data on children 0 through 8 years old. These figures became exposure measures used to frame the issue of child occupant restraint use. Specifically, the population data yielded annual counts of children by age.

#### 11.1.4 Federal Highway Administration

The 2000 Traffic Safety Facts reprinted and calculated rates based on the FHWA vehicle miles traveled (VMT). VMT became one of two exposure measures used to frame the issue of child occupant restraint use. Although the vehicle miles traveled spanned the entire driving public, these were used as a surrogate of vehicle miles traveled for the 0 – 8 year olds.

## 11.2 Passenger Vehicle Occupant AIS Injuries, by Restraint Use and Injured Body Region

Chart 47: Passenger Vehicle Occupant Injuries, All Ages, AIS 1, by Injured Body Region and Restraint Use

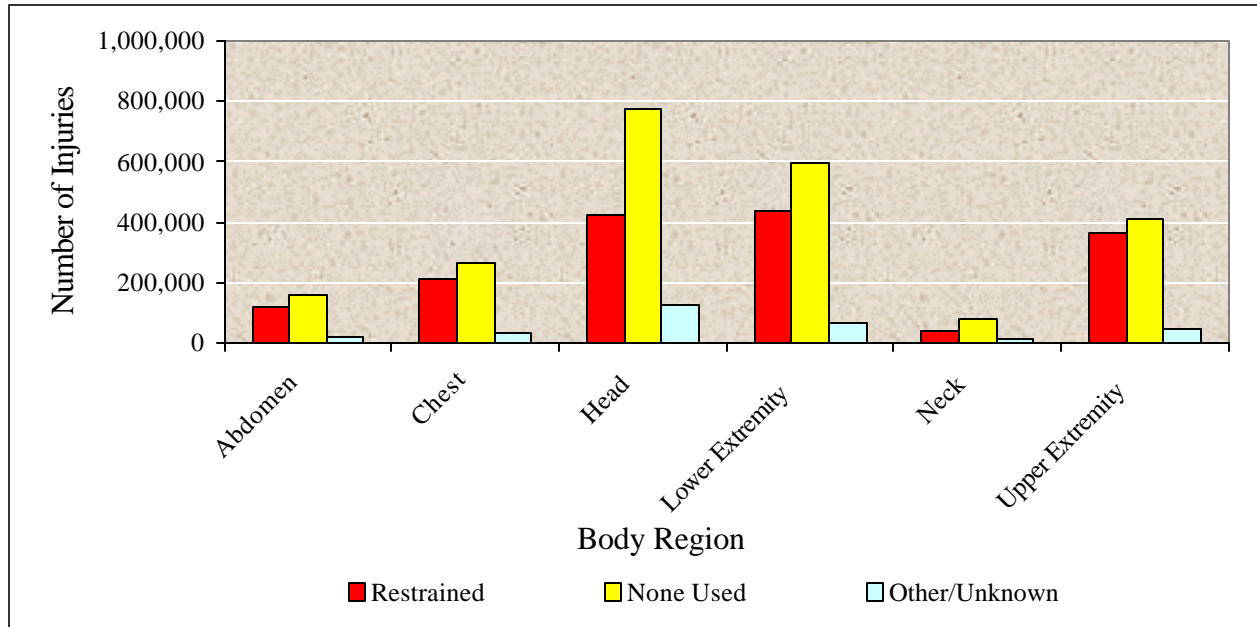


Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Restraint Use	Injured Body Region							Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	Unknown	
Restrained	854,946	3,705,273	5,622,413	5,413,296	2,776,245	5,645,305	356,666	24,374,144
None Used	483,186	2,116,238	7,287,395	4,360,003	1,249,228	3,209,319	365,101	19,070,469
Other/Unknown	42,114	314,036	838,133	432,866	278,257	346,514	53,613	2,305,533
<b>Total</b>	<b>1,380,246</b>	<b>6,135,547</b>	<b>13,747,941</b>	<b>10,206,165</b>	<b>4,303,729</b>	<b>9,201,139</b>	<b>775,380</b>	<b>45,750,146</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Chart 48: Passenger Vehicle Occupant Injuries, All Ages, AIS 2, by Injured Body Region and Restraint Use



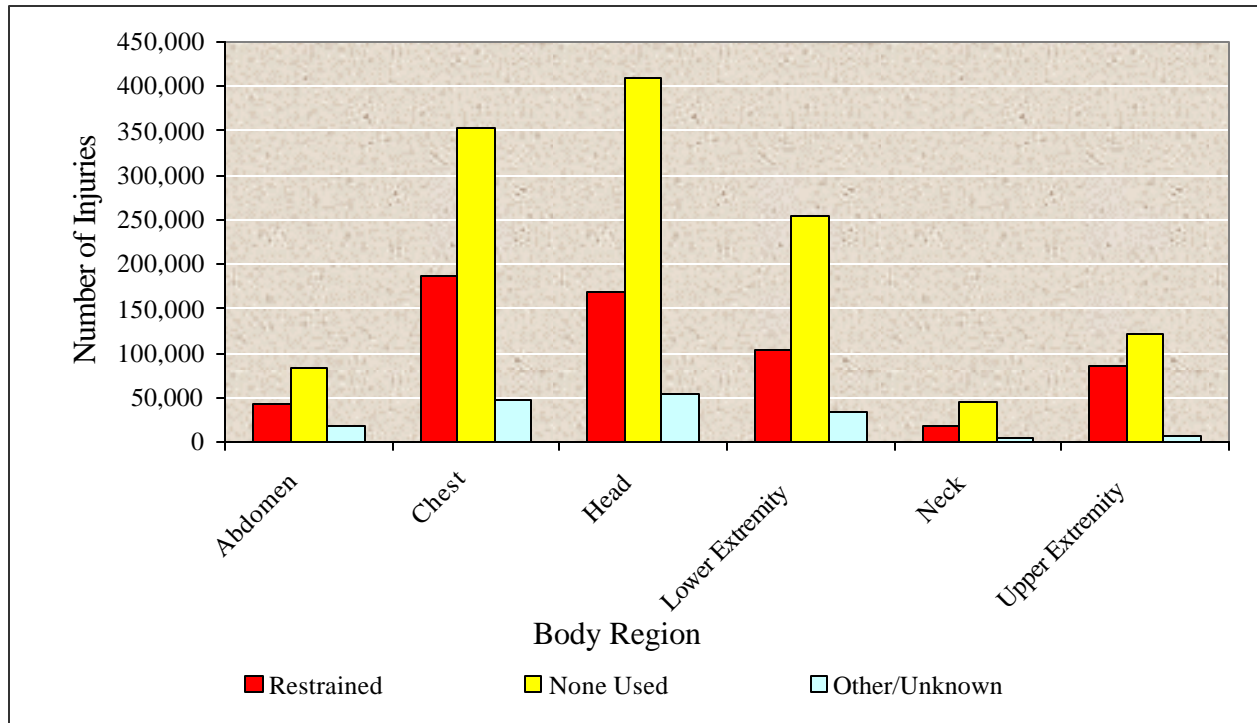
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

**Table 37**  
**Passenger Vehicle Occupant Injuries, All Ages, AIS 2,**  
**by Restraint Use and Injured Body Region**

Restraint Use	Injured Body Region							Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	Unknown	
Restrainted	118,132	214,364	425,584	438,047	37,465	363,663	498	1,597,752
None Used	158,260	263,366	772,184	592,822	80,653	411,219	645	2,279,149
Other/Unknown	21,398	30,996	124,997	64,383	10,205	42,914	110	295,002
<b>Total</b>	<b>297,789</b>	<b>508,726</b>	<b>1,322,764</b>	<b>1,095,252</b>	<b>128,322</b>	<b>817,796</b>	<b>1,253</b>	<b>4,171,902</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Chart 49: Passenger Vehicle Occupant Injuries, All Ages, AIS 3 - 6, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

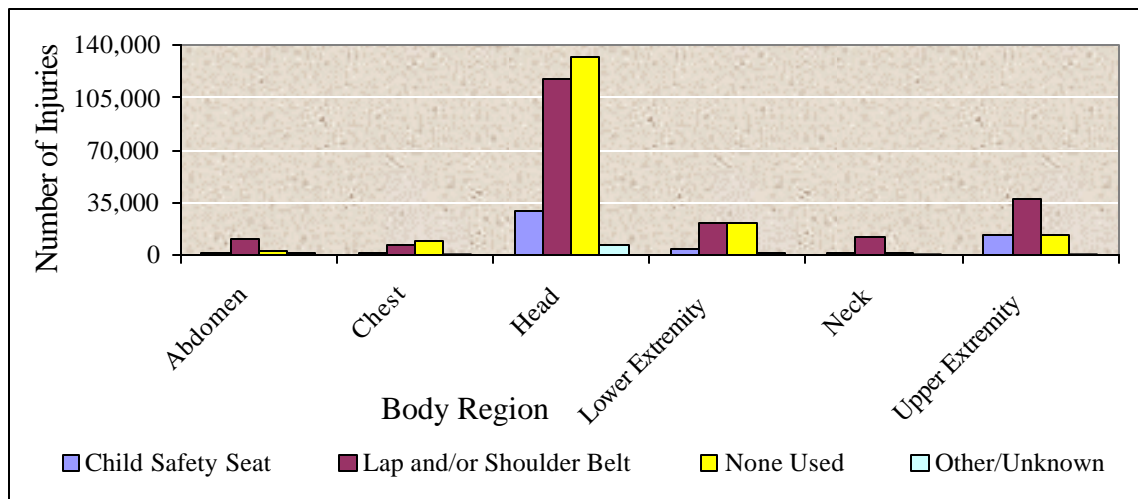
Restraint Use	Injured Body Region							Total
	Abdomen	Chest	Head	Lower Extremity	Neck	Upper Extremity	Unknown	
Restrained	42,223	187,449	169,415	103,382	18,432	85,479	1,068	607,447
None Used	83,222	353,625	409,618	254,056	44,105	120,791	1,306	1,266,722
Other/Unknown	17,652	47,835	54,790	35,044	5,093	7,444	5,172	173,030
<b>Total</b>	<b>143,096</b>	<b>588,909</b>	<b>633,823</b>	<b>392,482</b>	<b>67,630</b>	<b>213,714</b>	<b>7,545</b>	<b>2,047,198</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

### 11.3 Passenger Vehicle Occupant AIS Injuries, by Restraint Use, Seating Position, and Injured Body Region

#### 11.3.1 Front Seat Passenger Vehicle Occupant AIS 1 Injuries, by Restraint Use and Injured Body Region

Chart 50: Front Seat Passenger Vehicle Occupant AIS 1 Injuries, Age 0 to 8 Years Old, by Injured Body Region and Restraint Use



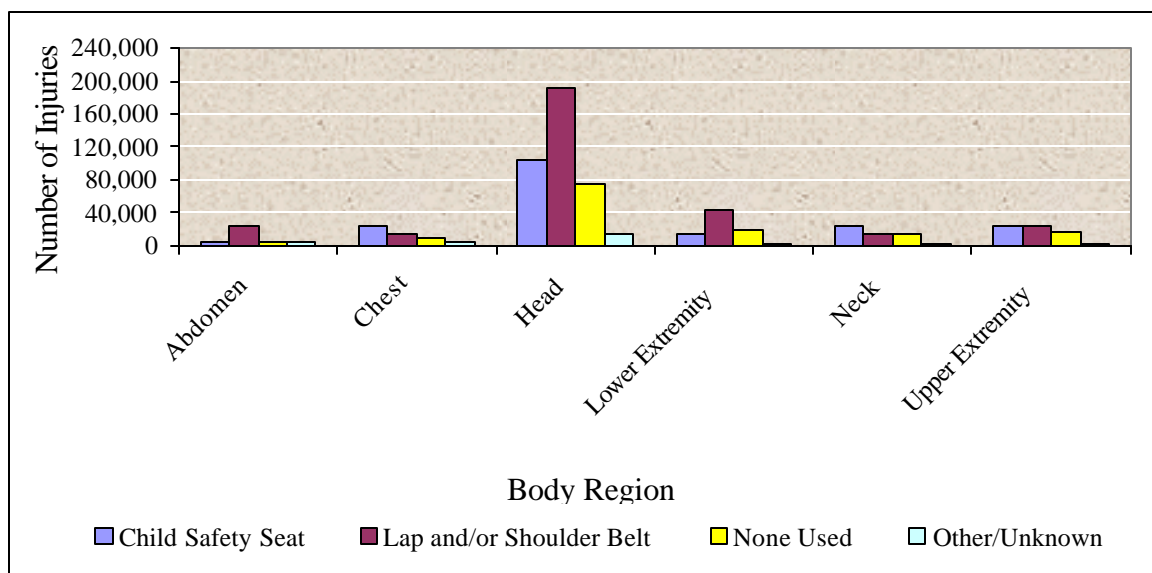
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Injured Body Region	Seating Position – Front Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other Unknown	
Abdomen	1,731	10,629	2,512	1,058	15,930
Chest	1,315	6,460	9,226	470	17,471
Head	28,951	116,941	132,246	7,500	285,638
Lower Extremity	4,155	21,375	22,204	1,306	49,040
Neck	1,845	12,835	1,453	119	16,252
Upper Extremity	13,974	37,950	13,636	792	66,352
Unknown	429	3,554	1,093	91	5,166
<b>Total</b>	<b>52,398</b>	<b>209,744</b>	<b>182,371</b>	<b>11,336</b>	<b>455,849</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

### 11.3.2 Second Seat Passenger Vehicle Occupant AIS 1 Injuries, by Restraint Use and Injured Body Region

Chart 51: Second Seat Passenger Vehicle Occupant AIS 1 Injuries, Age 0 to 8 Years Old, by Injured Body Region and Restraint Use



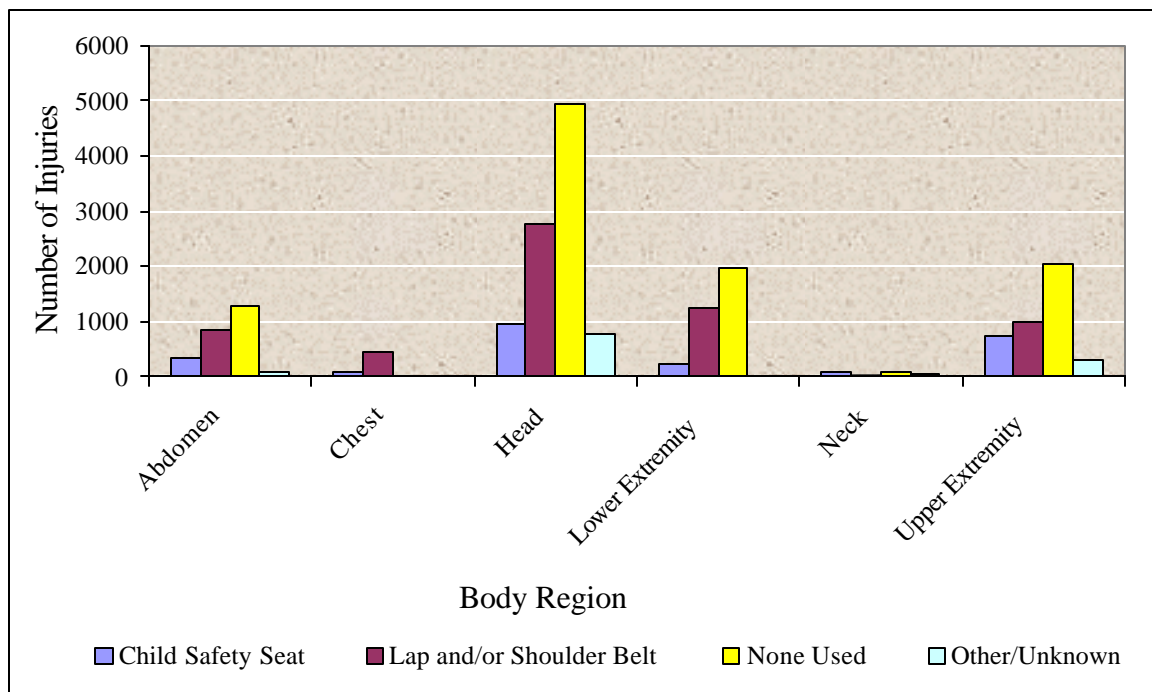
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Injured Body Region	Seating Position – Second Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	
Abdomen	5,129	23,874	3,907	5,156	38,065
Chest	23,329	12,796	8,902	5,547	50,575
Head	104,941	190,770	74,298	14,844	384,853
Lower Extremity	14,524	42,701	18,995	2,672	78,893
Neck	24,165	14,711	13,36	1,712	54,324
Upper Extremity	24,079	23,558	17,276	1,476	66,389
Unknown	6,443	5,547	1,764	1,852	15,605
<b>Total</b>	<b>202,610</b>	<b>313,957</b>	<b>138,878</b>	<b>33,259</b>	<b>688,704</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

### 11.3.3 Front Seat Passenger Vehicle Occupant AIS 2 Injuries, by Restraint Use and Injured Body Region

Chart 52: Front Seat Passenger Vehicle Occupant AIS 2 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



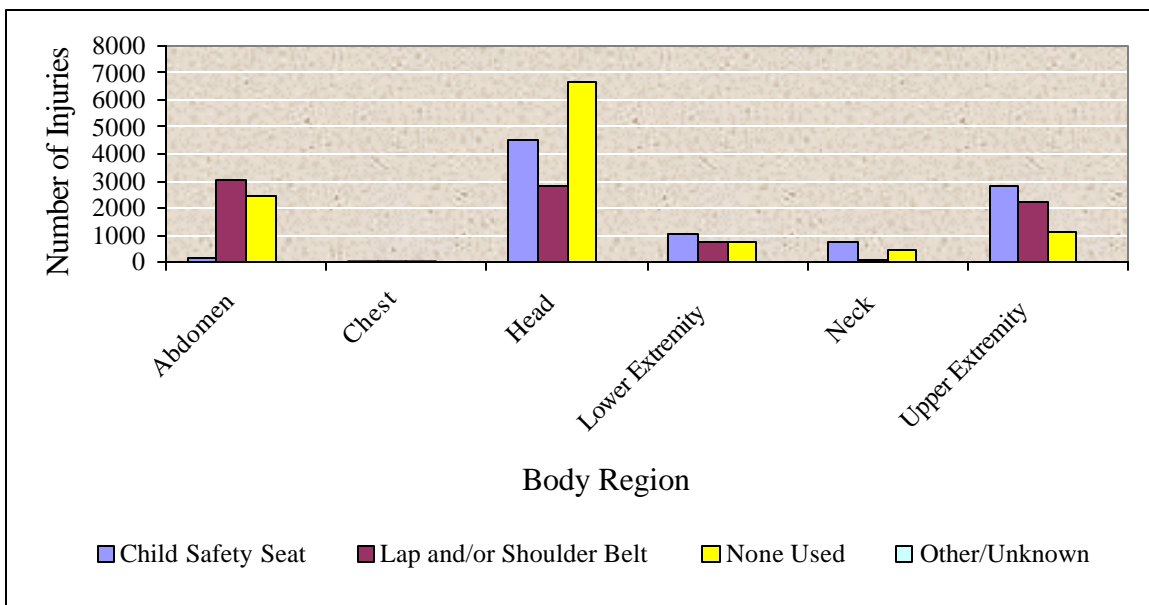
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Injured Body Region	Seating Position – Front Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	
Abdomen	348	828	1,268	76	2,520
Chest	100	447	0	0	546
Head	952	2,761	4,951	765	9,430
Lower Extremity	223	1,255	1,956	0	3,435
Neck	82	30	93	62	267
Upper Extremity	735	994	2,035	310	4,074
<b>Total</b>	<b>2,440</b>	<b>6,315</b>	<b>10,303</b>	<b>1,213</b>	<b>20,272</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

### 11.3.4 Second Seat Passenger Vehicle Occupant AIS 2 Injuries, by Restraint Use and Injured Body Region

Chart 53: Second Seat Passenger Vehicle Occupant AIS 2 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

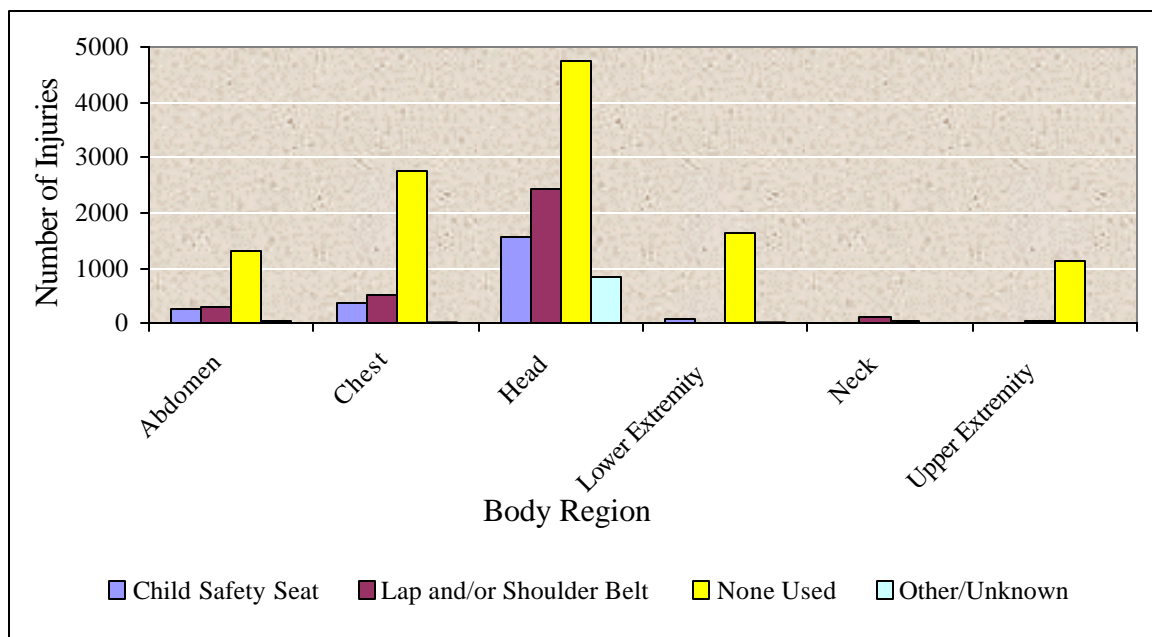
Injured Body Region	Seating Position – Second Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	
Abdomen	182	3,058	2,417	93	5,750
Chest	7	31	41	0	79
Head	4,496	2,800	6,678	736	14,711
Lower Extremity	1,041	771	761	509	3,081
Neck	723	111	478	0	1,312
Upper Extremity	2,845	2,194	1,109	387	6,534
Total	9,294	8,965	11,483	1,725	31,467

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000



### 11.3.5 Front Seat Passenger Vehicle Occupant AIS 3-6 Injuries, by Restraint Use and Injured Body Region

Chart 54: Front Seat Passenger Vehicle Occupant AIS 3 - 6 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



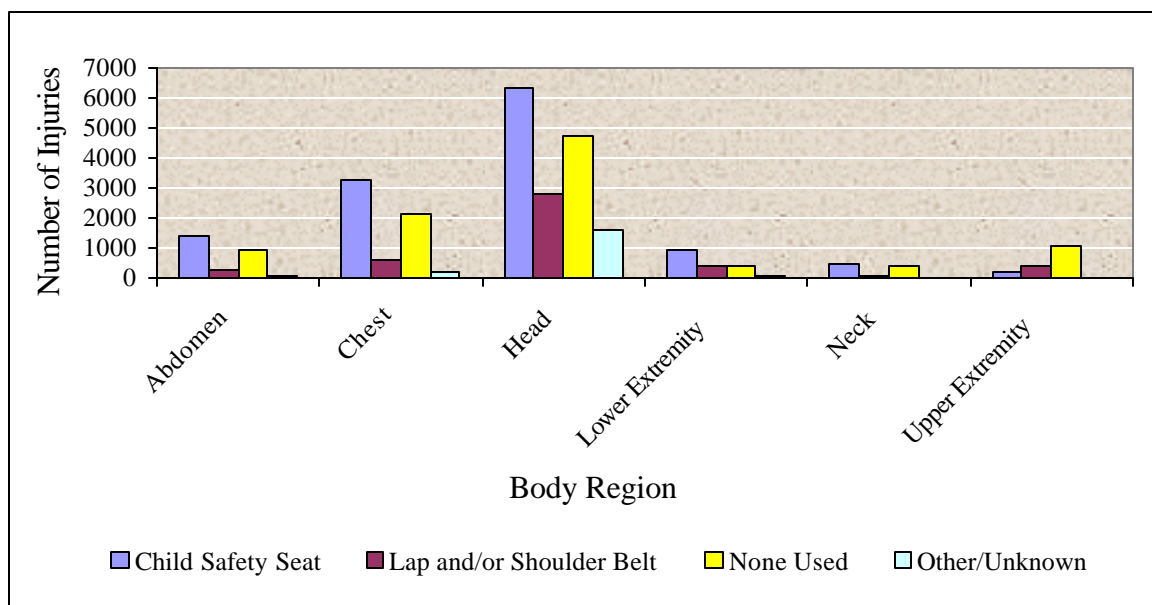
Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Injured Body Region	Seating Position – Front Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	
Abdomen	271	288	1,311	44	1,915
Chest	378	509	2,757	25	3,668
Head	1,552	2,444	4,747	859	9,602
Lower Extremity	64	0	1,642	25	1,731
Neck	99	0	32	0	131
Upper Extremity	0	38	1,115	0	1,154
Unknown	22	0	0	29	51
<b>Total</b>	<b>2,386</b>	<b>3,279</b>	<b>11,604</b>	<b>983</b>	<b>18,252</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

### 11.3.6 Second Seat Passenger Vehicle Occupant AIS 3 - 6 Injuries, by Restraint Use and Injured Body Region

Chart 55: Second Seat Passenger Vehicle Occupant AIS 3 - 6 Injuries, Age 0 - 8 Years Old, by Injured Body Region and Restraint Use



Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

Injured Body Region	Seating Position – Second Seat				Total
	Restraint Use				
	Child Safety Seat	Lap and/or Shoulder Belt	None Used	Other/Unknown	
Abdomen	1,424	301	965	73	2,764
Chest	3,284	601	2,146	196	6,226
Head	6,336	2,800	4,734	1,613	15,483
Lower Extremity	951	411	438	75	1,875
Neck	450	101	381	0	932
Upper Extremity	237	390	1,067	5	1,699
Unknown	0	0	0	172	172
<b>Total</b>	<b>12,682</b>	<b>4,603</b>	<b>9,731</b>	<b>2,134</b>	<b>29,150</b>

Source: National Center for Statistics and Analysis, NHTSA, NASS CDS 1991-1996, 1998-2000

## 11.4 U.S. Resident Population Data

<b>Table 45</b>				
<b>U.S. Resident Population by Year and Age</b>				
<b>Year</b>	<b>Age</b>			<b>Total</b>
	<b>&lt; 1</b>	<b>1-3</b>	<b>4-8</b>	
1991	4,009,515	11,468,844	18,154,546	33,632,905
1992	3,982,857	11,739,325	18,296,744	34,018,926
1993	3,908,335	11,898,416	18,612,278	34,419,029
1994	3,854,882	11,821,298	18,958,858	34,635,038
1995	3,813,169	11,668,778	19,309,487	34,791,434
1996	3,769,544	11,499,426	19,610,009	34,878,979
1997	3,779,543	11,371,094	19,788,553	34,939,190
1998	3,790,645	11,301,476	19,814,280	34,906,401
1999	3,819,903	11,269,665	19,629,729	34,719,297
2000	3,815,469	11,318,813	19,325,803	34,460,085

**Source: U.S. Census Bureau**

## 12. REFERENCES

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