Crash Outcome Data Evaluation System (CODES)

Child Passengers in Motor Vehicle Crashes, 1995-1997

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In Oklahoma, motor vehicle crashes are the leading cause of death and disability among persons 1-44 years of age (Oklahoma State Department of Health (OSDH), Injury Prevention Service (IPS), Oklahoma Motor Vehicle Crash Injuries Fact Sheet). According to Traumatic Brain Injuries In Oklahoma, 1992-1997 (OSDH IPS):

> "After the first year of life, traumatic brain injuries result in more childhood deaths than all diseases combined. Survivors of severe brain injuries have persistent physical and behavioral problems which may require months or years of rehabilitation. The lifetime costs for persons suffering the most severe brain injuries have been estimated at $4 million."

To explore the effects of safety restraint usage on child passengers of motor vehicle crashes, 1995-1997 Department of Public Safety (DPS) motor vehicle crash data was linked to inpatient hospitalization data from the OSDH. Police officers investigate the crash at the scene and complete reports that include information about the crash, vehicles, and persons involved. Inpatient hospitalization is billing data submitted annually to OSDH by short-term acute care hospitals. This report is based on 187 matched records for child passengers age birth to age 15 derived from the CODES linked dataset[1] (See Table 1).

The child passenger data was grouped based on recommendations for use of child safety restraints into two age groups: birth to eight years of age and nine through 15 years of age. The average age of child crash passengers hospitalized was 8 years. Fifty-four percent were male. Fifty-six percent of child passengers under 9 were front seat passengers as compared to 61% of passengers over age 8.

Only 12% of child passengers under age 9 were secured with child restraints—another 22% were wearing seat belts at the time of the crash (seat belts or seat belts and shoulder belts).

Of child passengers over age 8, only 23% were wearing seat belts at the time of the crash.

This may be an optimistic estimate as reports of seat belt use are typically inflated (National Highway Traffic Safety Administration 1996 Report to Congress).

Table 1. Crash Data

	Age		
	0-8	9-15	All
Characteristics of Passengers			
Average Age	3.7	12.5	8.3
Percent Male	60%	49%	54%
Location in Vehicle			
Front Seat	56%	61%	59%
Back Seat	40%	34%	37%
Seating Other/Unknown	3%	5%	4%
Percent in Child Restraint	12%	0%	
Percent in Seat Belts	22%	23%	
Number of Children	89	98	187
Characteristics of Vehicle			
Passenger Car	78%	60%	68.4%
Pick-up Truck	15%	36%	25.7%
Other Type	8%	4%	6%
Characteristics of Crash			
Two Lane Roads	62%	69%	66%
Four or More Lanes	26%	18%	22%
City Street	19%	24%	22%
County Road	28%	42%	35%
US or State or Interstate Highways	52%	34%	42%
Avg Legal Speed	51.0	50.1	50.6
Avg Speed Before Impact	43.2	39.9	41.6
Avg Speed at Impact	33.3	30.1	31.8
Front Impact	51%	49%	50%
Side Impact	43%	36%	39%
Characteristics of Injuries*			
Head	81%	71%	76%
Trunk	54%	51%	52%
Extremeties	42%	48%	45%

*DPS Officer Reports

Most crashes involving child passengers were in passenger cars (68%), followed by pick-up trucks (26%). Two-thirds of these crashes occurred on two lane roads and 22% occurred on roads with four or more lanes. Forty-two percent of these crashes occurred on US, State, or Interstate highways, 35% occurred on county roads and 22% occurred on city streets. The average speed of impact was estimated to be 32 miles per hour. One-half of crashes involved impact to the front of the vehicle, and another 39% involved impact to the side of the vehicle. Officers indicated that 76% of the child passengers suffered head injuries, half suffered injuries to the trunk and 45% sustained injuries to their arms or legs.

Table 2. Inpatient Hospitalization Data

	Age		
	0-8	9-15	All
Patient Days	515	624	1139
Average LOS	5.8	6.4	6.1
Total Charges	$44,512,392	$61,690,970	$107,240,283
Average Charge per Hospitalization	$500,139	$629,500	$573,477
Died In-hospital	5	3	8
Percent Died In-hospital	6.5%	3.6%	5.0%
Records with Discharge Status Information	77	83	160
Number of Children	89	98	187

The average hospitalization resulted in charges of almost six hundred thousand dollars and lasted approximately six days. Five percent of child passengers died in-hospital (Percent who died is based on the total number of records with non-missing discharge status). Total hospital charges for child passenger hospitalizations totaled over 100 million dollars (Since charges were missing for approximately one third of records, total charges for all hospitalizations were calculated by multiplying the average charge by the number of hospitalizations). Hospital charges include only institutional charges, not professional fees or emergency room charges incurred during the course of the hospitalization and is an underestimate of actual cost. It also does not include ambulance or rehabilitation charges. Based on principal diagnosis, almost four of every 10 child passengers under the age of nine and two out of every 10 child passengers age 9-15 suffered traumatic brain injuries as a result of the crash (principal diagnosis is the condition established after study to be main reason for the admission).

Table 3. Percent of Child Passengers by Principal Diagnosis* and Age Group.

Principal Diagnosis Age 0-8 Years	Principal Diagnosis Age 9-15 Years
39% Traumatic brain injury (21 with coma)	21% Traumatic brain injury (11 with coma)
10% Skull and face fractures (3 with coma)	16% Skull and face fractures (1 with coma)
10% Fracture of lower limb (7 femur, 1 ankle, 1 tibia)	15% Fracture of lower limb (9 femur, 4 tibia or fibula
8% Open wounds of head, neck, and trunk	12% Crushing injury or internal injury (1 duodenum, 1 thoracic aorta, 2 kidney, 3 liver, 3 spleen, 2 pneumothorax)
8% Superficial injury, contusion	11% Other fractures (3 pubis, 8 vertebra)
7% Crushing injury or internal injury (1 heart contusion, 1 kidney laceration, 1 liver laceration, 3 spleen injuries	6% Open wounds of head, neck, and trunk
4% Fracture of upper limb	5% Superficial injury, contusion
3% Other injuries and conditions due to external causes (2 injury multiple sites)	3% Fracture of upper limb
2% Other fractures	3% Other injuries and conditions due to external causes
	2% Joint disorders and dislocations, trauma-related

*Principal diagnoses were grouped into 259 mutually exclusive categories using the Agency for Healthcare Research and Quality Single-level Clinical Classification Software.

Child Restraint and Seat Belt Use

The National Highway Traffic Safety Administration (NHTSA) has made recommendations for use of motor vehicle child restraints (See Table 4).

NHTSA estimates that eighty percent (80%) of child restraints are used incorrectly.

Table 4. NHTSA Child Safety Seat Recommendations

Proper Child Safety Seat Use Chart Buckle Everyone. Children Age 12 and Under in Back!			
	INFANTS	**TODDLER**	**YOUNG CHILDREN**
WEIGHT	Birth to 1 year, up to 20-22 lbs.	Over 1 year and Over 20 lbs.-40 lbs.	Over 40 lbs. Ages 4-8, unless 4'9".
TYPE of SEAT	Infant only or rear-facing convertible	Convertible / Forward-facing	Belt positioning booster seat
SEAT POSITION	Rear-facing only	Forward-facing	Forward-facing
ALWAYS MAKE SURE:	Children to one year and at least 20 lbs. in rear-facing seats Harness straps at or below shoulder level	Harness straps should be at or above shoulders Most seats require top slot for forward-facing	Belt positioning booster seats must be used with both lap and shoulder belt. Make sure the lap belt fits low and tight across the lap/upper thigh area and the shoulder belt fits snug crossing the chest and shoulder to avoid abdominal injuries
WARNING	All children age 12 and under should ride in the back seat	All children age 12 and under should ride in the back seat	All children age 12 and under should ride in the back seat

Seventy percent of Child Passengers age zero to eight were not in the back seat as per NHTSA recommendations and 67% were not restrained (see Table 5). The average vehicle speed at impact was similar for restrained and unrestrained child passengers across age groups (30 to 37 miles per hour).

Length of hospitalization varied with the use or non-use of restraints.

- Children zero to 8 years of age who were in child restraints were hospitalized an average of 4 days, children wearing a seat belt were hospitalized an average of five days and unrestrained children were hospitalized an average of six days. Average charges per hospitalization were similar for children in child restraints and seat belts ($3,200 and $3,800 per hospitalization), however unrestrained children averaged $762,198 per hospitalization resulting in total charges of over forty-four million dollars.

- For nine to 15 year olds, children wearing seat belts had longer hospitalizations than did unrestrained children (8 days vs. 6 days), however average charges per hospitalization were 36 times higher for unrestrained child passengers ($23,790 vs. $846,641) resulting in total charges of over sixty-three million dollars for children not wearing seat belts.

Percent of child passengers who died in-hospital is included in Table 6, however caution is recommended in interpreting those rates due to the small sample sizes.

Table 5. Crash Data by Age and Restraint Use

	Age				
	0-8			9-15	
	Child Restraint	Seat Belt	Not Restrained	Seat Belt	Not Restrained
Characteristics of Passengers					
Average Age	2.0	4.1	3.9	12.7	12.5
Percent Male	64%	60%	59%	43%	51%
Location in Vehicle					
Front Seat	36%	65%	57%	65%	60%
Back Seat	64%	30%	40%	35%	33%
Seating Other/Unknown	0%	5%	3%	0%	7%
Percent of Age Group	12%	22%	65%	23%	77%
Number of Children	11	20	58	23	75
Characteristics of Vehicle					
Passenger Car	82%	60%	83%	74%	56%
Pick-up Truck	9%	20%	14%	22%	40%
Other Type	9%	20%	3%	4%	4%
Characteristics of Crash					
Two Lane Roads	55%	60%	64%	48%	76%
Four or More Lanes	36%	35%	21%	22%	17%
City Street	45%	25%	12%	13%	28%
County Road	9%	15%	36%	35%	44%
US or State or Interstate Highways	45%	55%	43%	43%	21%
Avg Legal Speed	54.1	53.5	49.8	55.7	48.3
Avg Speed Before Impact	40.0	48.3	41.5	40.7	40.5
Avg Speed at Impact	30.5	36.8	32.9	29.6	30.5
Front Impact	64%	45%	50%	57%	47%
Side Impact	27%	40%	47%	39%	35%
Location of Injuries*					
Head	64%	80%	84%	57%	76%
Trunk	73%	55%	50%	61%	48%
Extremeties	9%	40%	48%	57%	45%

*DPS Officer Reports

Table 6. Inpatient Hospitalization Data by Age and Restraint Use

	Age				
	0-8			9-15	
	Child Restraint	Seat Belt	Not Restrained	Seat Belt	Not Restrained
Patient Days	46	101	368	185	439
Average LOS	4.2	5.1	6.3	8.0	5.9
Total Charges	$34,672	$76,352	$44,207,466	$547,176	$63,498,061
Average Charge per Hospitalization	$3,152	$3,818	$762,198	$23,790	$846,641
Died In-hospital	0	1	4	2	1
Percent Died In-hospital	0.0%	5.6%	7.7%	11.8%	1.5%
Records with Discharge Status Information	7	18	52	17	66
Number of Children	11	20	58	23	75

Principal Diagnosis Groups

When the data is grouped by passenger age and restraint type, the sample size of several of the groups is small. Percent of children by principal diagnosis grouping is not provided because a change of one child produces a percent change that is large enough to distort comparisons between the groups. Instead, principal diagnosis groups containing more than one child are displayed in Table 7 and Table 8.

For child passengers age 0 through 8, traumatic brain injuries were the most frequent injury for all three restraint groups (See Table 7). One of five children who were in child restraints had traumatic brain injuries severe enough to produce coma, of children who wore seat belts, six of eight had traumatic brain injuries severe enough to produce coma, and 14 of 22 unrestrained children had traumatic brain injuries severe enough to produce coma. The seat belt group also had 4 skull and face fractures, one severe enough to produce coma. This group also had three children with internal injuries that most likely resulted from force against their seat belt. The unrestrained group had 9 children with leg fractures, 7 of which involved the femur indicating that they experienced extreme force to their lower extremities during the collision. This group also had 4 children with fractures of the skull or face, two of which were severe enough to produce coma. Injuries to multiple sites were more common in the unrestrained group.

Table 7. Number of Child Passengers by Principal Diagnosis - Age 0-8.

Child Restraint (n=11)	Seat Belt (n=20)	Not Restrained (n=58)
5 Traumatic brain injury (1 with coma)	8 Traumatic brain injury (6 with coma)	22 Traumatic brain injury (14 with coma)
2 Superficial injury, contusion	4 Skull and face fractures (1 with coma)	9 Fracture of lower limb (1 tibia, 1 ankle, 7 femur)
	3 Open wounds of head, neck, and trunk	5 Superficial injury, contusion
	3 Crushing injury or internal injury (1 kidney laceration, 2 spleen lacerations)	4 Skull and face fractures (2 with coma)
		4 Open wounds of head, neck, and trunk
		3 Other injuries and conditions due to external causes (2 injuries multiple sites)
		3 Fracture of upper limb
		3 Crushing injury or internal injury (1 heart contusion, 1 liver laceration, 1 spleen hematoma)
		2 Other fractures

For child passengers age 9 through 15, the group wearing seat belts had proportionally fewer brain injuries than did the unrestrained group. The most frequent principal diagnosis for the unrestrained group was brain injury, almost half of which were severe enough to produce coma. The second leading injury in the unrestrained group involved skull and/or

face fractures. As with the younger age group, fractures of the lower limb were common and most of those involved fractured femurs. Injuries to internal organs were also common in the unrestrained group.

Table 8. Number of Child Passengers by Principal Diagnosis - Age 9-15.

Seat Belt (n=23)	Not Restrained (n=75)
6 Crushing injury or internal injury (1 duodenum injury, 1 thoracic aorta injury, 1 liver laceration, 2 spleen injuries)	19 Traumatic brain injury (10 with coma)
4 Other fractures (4 vertebra)	15 Skull and face fractures (1 with coma)
4 Fracture of lower limb (2 femur, 2 tibia)	11 Fracture of lower limb (7 femur, 2 fibula, 1 kneecap, 1 ankle)
2 Traumatic brain injury (2 with coma)	7 Other fractures (3 pubis, 4 vertebra)
2 Open wounds of head, neck, and trunk	6 Crushing injury or internal injury (1 kidney hematoma, 1 kidney laceration, 1 spleen laceration, 1 liver laceration, 2 pneumothorax)
2 Other injuries and conditions due to external causes (1 injury multiple sites, 1 trunk injury)	4 Superficial injury, contusion
	4 Open wounds of head, neck, and trunk
	2 Fracture of upper limb
	2 Joint disorders and dislocations, trauma-related (2 dislocated hip)

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[1] Notes:

Data linkage was performed using CODES 2000 record linkage software. For each year, six matching passes were run using .90 cutoff probability and 28.30 cutoff weight. The six matched sets were merged retaining the matched record pairs with the highest probabilities from all six runs. The 1995-1997 CODES dataset contains 4,403 matched records of persons hospitalized from injuries sustained in crashes.

1995 was the first year that inpatient hospitalization data was collected and is mostly complete, however 1996 and 1997 hospitalization data is less complete. Rural hospitals may be underrepresented. Note also that the inpatient hospitalization data is based on discharges from hospitals-one person may be admitted to more than one hospital during the course of their medical care (e.g. stabilized and then transferred), thus the crash record could be matched to either of the hospitalization records.