Four Years of Enhanced Child Restraint Data Collection in NASS CDS

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ABSTRACT

In 2002, the National Highway Traffic Safety Administration's (NHTSA's), National Automotive Sampling System (NASS) improved its child safety data collection for the Crashworthiness Data System (CDS) by having each primary sampling unit (PSU), location, dedicate one data encoder to child safety issues. In turn, NASS data encoders took the PSU source data and created the CDS data entries. These CDS data were obtained via crash scene and vehicle inspections supplemented with occupant interviews and medical records, when available. Consequently, the NASS encoders were trained extensively on child safety seat technologies, as well as their installation and placement, and new variables and attributes were defined. The new variables and attributes allow encoders to describe fully the child safety seat within the vehicle during the crash, from post crash occupant interview and vehicle inspection. The expanded data compiles real-world crashes involving child occupants, providing a unique data set useful to NHTSA as well as the whole child occupant protection community.

This paper presents a description of the new data collection process, the new variables, and a first look at the analyses possible with the new data set.

BACKGROUND

Each year CDS collects detailed information on a nationally representative, random sample of police-reported, tow away traffic crashes involving passenger cars, light trucks, and vans. The bulk of this detailed information supports research into the crashworthiness of passenger vehicles, biomechanics of occupant trauma, and the development of test procedures and criteria. CDS data also supports the rationale for and development of motor vehicle safety standards and consumer information programs related to occupant protection.

INTRODUCTION

Beginning in 2002, the child safety data collection was revised for NASS CDS data sets. As before, child safety seat type may be identified, however, the archaic coding and formatting inconsistencies have been removed from the enhanced data sets. This was accomplished by encoding a more thorough understanding of the child safety restraint systems and the injury patterns for the restrained or inadequately restrained child.

NASS CDS has kept pace with newer technologies, and is continually assessed, and, when necessary, improved for its information collection practices. From these assessments, child restraint data collection methodologies have changed; most recently of note is the latest modification to the child restraint interview form (Murianka, 2005). This modification considered 4 years of real world data collection practices resulting in the development of a more appropriate tool for encoders to rely upon when eliciting information regarding a restrained child occupant.

With these modifications, the quality of the data continues to improve so that child safety seat information is continually considered and accurately reported.

This paper is designed to introduce the child safety community and the public to the child safety CDS enhancements expected to be released. It also provides guidance with respect to companion resources for the data.

The new child safety data sets since 2002 have not been made available to the public yet because an exhaustive quality control must be exercised for release of NASS, which has not yet been completed. For the purposes of this paper, however, the authors provided exhaustive quality control on the data presented. Although a true statistical analysis may not be undertaken owing to the small case counts available for study, an anecdotal demonstration of the new variables is possible. In sum, the paper only deals with data that would be ready for release;

however, the entire data set must be released together in accordance with practices followed by The National Center for Statistics and Analysis governing the NASS data. The variables and attributes populating the data set have been in place and approved since 2002.

Changes Since 2002

In 2002, the Child Restraint Interview Form was changed from a 1-page document to 12 pages, due to the addition of numerous questions, which would help the field researcher/analyst determine specifics about a child seat and its use when the child seat involved in the crash was no longer available and a telephone interview was the only option. It is fairly common for the child seat involved in the crash to be destroyed, thereby creating a situation where the parent/caregiver must rely on memory and familiarity of the child restraint in answering questions regarding its type and use. To avoid reuse subsequent to a crash, the destruction of the child seat is an accepted practice.

In 2005, the Child Restraint Interview Form was again revised eliminating many of the questions (answers to which were not coded in CDS) in order to assist better the field researchers in their information gathering as well as not to burden crash occupants unnecessarily. The current interview consists of 4 total pages, one of which is a graphic reference of child seat types providing a visual for in-person interviews when the child seat is no longer available.

In the summer of 2005, it was decided that a core group of field researchers would be selected, who would be assigned as "primary" researchers on child seat cases at their respective site. The impetus for this was two fold: specific trainings could be tailored to the needs of those conducting child seat interviews and inspections, resulting in the coding of fewer "Unknown" and "Other" data attributes

The CDS currently has 27 field researchers, a representative from each of the 27 field research teams, dedicated to crashes selected at their site involving a child restraint. In the spring of 2006, this core group of researchers received special child restraint training, which focused on interviewing techniques, and hands-on inspection of crash-involved child restraints.

Child restraint cases make up a small portion of all cases collected each year in CDS, as shown in Table 1. Note that in 2005, 4,481 cases were coded with only 234 cases involving one or more child restraints. Further, note that there are sometimes more than one child seat involved in a given crash case. For example, in 2005, there were 293 child seats involved in the 234 cases. The yearly totals dating back to 1999 are also listed in Table 1. The new data provides for better understanding of these seats and how they performed.

PROCEDURES

The CDS program utilizes trained field researchers to collect details on a limited number of crashes involving new and rapidly changing occupant protection technologies. In 2002, new and updated data collection methodologies related to child occupant restraints were incorporated into the NASS, CDS, Electronic Data Collection System. Major revision to certain data collection and coding tools were incorporated, for example., enhanced Child Restraint Interview Form, child seat make/model pick-list, as well as detailed information regarding the child seat installation using the vehicle belt system or Lower Anchors and Tethers for Children (LATCH).

An in-depth, 8-hour child restraint and safety belt training was provided to all field researchers prior to the 2002 data collection year. This training built upon the introductory/initial child seat and safety belt training each researcher receives during their basic training. A child seat and safety belt update training session has been provided to all field researchers during every year-end training through 2005.

In the most recent data year available, 2005, the CDS had 27 field research teams and 76 field researchers collecting data from about 4,500 crashes, 234 of which involved a child restraint. The CDS currently collects and codes crash information involving over 600 data elements obtained during on-site crash scene inspections and exterior and interior vehicle inspections. In-person and over the telephone interviews are also conducted with individuals involved in the crash and pertinent injury and medical records are obtained for those occupants injured and who sought medical treatment. Interviews with crash victims entail questions dealing with pre and post-crash events as related to all occupants of the vehicle. Details regarding each occupant, for example, seating position, restraint type available, and use, along with any available medical/injury information, are collected and coded into each case.

Data Summarization

The usage of child restraints is of paramount importance; however, many misconceptions exist with respect to the selection, installation, age appropriateness, and finally graduation to an adult restraint system. Historically and as a convenience child safety advocates have used singular measures of age, height, or weight. It must be considered, however, that the current demographic make up of the children in the United States does not fit one profile. For this reason, NHTSA provides guidelines for appropriate usage by age, weight, and seating position.

The children reported in the NASS CDS enhanced reporting were separated into age categories specified by the authors. This segmentation was based upon a rough age range for graduation to the booster seat and subsequent movement to vehicle-installed restraint systems. The restraint usage categories were assessed based upon the child safety seat type and the manual restraint usage. Age, manual restraint usage and child safety seat type are variables found in the NASS CDS Coding Manual (DOT, 2000), as well as the electronic case access. The child safety seat type variable in NASS CDS identifies type of child safety system relevant to the case child occupant. If the child was unrestrained, as dictated by the manual restraint usage, then the child was categorized as unrestrained.

New or Enhanced Variables

With the advent of the expanded data sets, the new understanding and fuller reporting could be captured in unique research data sets. Previously, the NASS CDS reported any child seat information with general occupant demography. In the new data set, the presence of a child safety seat is reported at the occupant level and acts as a flag. This flag indicates that relevant information will be placed in the child safety seat data set. The child safety data set contains information relevant to the placement of the seat with respect to the vehicle seating positions, orientation, and position of occupant. In addition, the presence and design of LATCH, child restraint harness, and harness chest clip are reported.

Child Occupant Demography with respect to Age and Restraint Usage

The enhanced data sets allow for finer disaggregation of the data with respect to demography. One modification has been to the units of age, as shown in Table 2.

In children less than three years old, development from month to month becomes more meaningful when assessing the crash outcome. Further, the gradation, with respect to biomechanical tolerance, from birth to one year old is more crucial than the 12-month increments after the age of three years. Table 2 segments child occupants, without respect to their restraint usage, into months from birth through two years and years for children 3 through 12 years.

Few automotive manufacturers continue to produce child restraints specifically designed for their vehicles. Although limited data exists regarding the benefit of proprietary versus commercially produced child safety seat systems, and while the benefit of children placed in any child safety system has been proven, integration of the technology makes sense conceptually. Nevertheless, restraint usage must be a key consideration in analyzing child safety.

For example, the child who benefited from one of the child safety seat types, and was less than ten years old, was considered to be restrained. If the child was 10 through 12 years at the time of the crash, and was deemed to be restrained by virtue of the manual restraint usage, an active restraint usage characterization reported in NASS CDS, then the child was said to be restrained. Finally, children who were restrained by some other means than a child safety system were considered restrained by an age inappropriate device. It must be recalled that the child safety seat couples with the vehicle restraint system, at the most generic level, as specified by NHTSA. For this reason, both the manual restraint usage, an observation of active restraint usage, and the child safety seat usage must be considered when determining the restraint status of a child.

Results for newborn children through 3 years old keep with the messages suggesting that caregivers are restraining smaller children. As previous mandates dictated, restraint by any means would be better than no restraint at all. In keeping with this mandate nearly one-third of children benefited from a caregiver who took some action. This by no means assures the occupant outcome and this will be addressed in subsequent sections of this paper.

For children 4 through 7 years old, it should be noted that two issues exist with segmentation of few years of data. The cell size may suffer because the children of this age range are not being injured or merely because the sampled cases did not have vehicles transporting this age group. In studying this group, this must be considered. Unrestrained children do

increase from the previous age range, as well as those who are inappropriately restrained. The inappropriately restrained children may have been subjected to a premature graduation from a child restraint to a vehicle-installed restraint system.

The children of age 8 and 9 years were segmented because this marks a graduation of many children regardless of their readiness. Questions of peer pressure and parental involvement may also be suggested as potential reasons for this decrease.

The oldest age group, 10 through 12 years, was retained for comparative purposes in this section only. These were deemed to be the group that would be subject to a generally justifiable graduation to a vehicle-installed restraint system.

It should be noted that children of 9 years and less were reported to have used a child safety seat. Children above this age were reported to have used a vehicle-installed restraint or were unrestrained, as seen in Table 3.

With benefit of greater training and experience, NASS CDS researchers may discern the subtleties of seemingly similar child restraints. This information may be coupled with manual restraint usage data to understand better the restraint usage habits of children from birth through 12 years old.

Based upon the enhanced and tailored training of NASS researchers and stringent quality control standards, several conclusions may be reached based upon the child safety seat disaggregation. First, young children are generally placed in age-appropriate child safety seats, and these are used according to manufacturer recommendations. Further, children of 4 through 7 years old, follow a similar pattern. With an eye toward cell size and children of ages 8 through 9 years not being captured in the sampling design of NASS CDS, approximately 8 percent of children are unrestrained. More than 90 percent of this age group is transported in some sort of restraint system. Less than one percent of this age group makes use of an age appropriate system. In trying to understand such findings, this leaves researchers with the question of early graduation versus robustness of children of this age warranting graduation.

Prior to 2002, older formatting was retained and accurate characterization of booster seats was not possible. Additionally, archaic child seat types were eliminated and better definitions were provided for the child restraints, per Table 4.

In the new data set, improved descriptions have become available with respect to harness design. Previously, analysts imagined configuration of the child restraints based upon the child safety seat. Currently, it is possible to identify harness, clip, tether, and latch design, as seen in Table 5.

Placement of Child Safety Seat

Another variable allowing for better characterization of the child safety seat is the placement variable, as shown in Table 6. This allows for the precise location of the child seat with respect to the vehicle interior.

In cases where a placement was other than the seat, consultation of other relevant variables might be necessary to understand fully the circumstance. Further, as with any other interview tool, the researchers must rely upon cooperation from the crash occupant and their ability to elicit appropriate information from the interviewee.

With nearly 90 percent of child restraints reported on the vehicle seat, installation issues may be ebbing. However, concern rests with the remaining ten percent that were found on the floor or an unknown location. The unknown location may stem from the absence of a vehicle/child restraint inspection, or lack of crash occupant interview. It should be noted that this is only one element that might be considered when assessing improper restraint usage and installation. Prior to 2002, improper restraint usage was reported in the data set, as determined by the CDS researcher based upon experience. The enhanced variables and attributes allow the data user to characterize proper restraint usage by interpreting the encoded child safety seat data encoded.

Orientation of the child with respect to the safety seat is a further enhancement to this description. The child orientation may be described, per Table 7.

The orientation might be used to signal problems of child placement. For instance, with the accompanying variables describing the child seat make and model, it might be possible determine the validity of the caregiver's installation of the car seat and the child within the car seat.

Child Safety Seats and Occupant Injury Severity

Historically, the use of child restraint systems has been the preferred child protection. During recent years, the idea of some restraint system being better

than nothing has been considered. By consensus, however, unrestrained children are the most vulnerable, per Table 8.

Among children, birth through 12 years old, less than ten percent are unrestrained. Further, less than one percent of the child occupant population sustains critical or maximum injuries. The unrestrained children sustain the majority of MAIS 5 and 6 injuries. This is followed by those children who graduate early to lap and shoulder belts.

Table 9, provides evidence for the age appropriate restraint usage. Among occupants restrained by a child safety seat, less than one percent sustains MAIS 5 or 6 injuries. More than 50 percent of those occupants sustaining critical and maximum injuries were restrained by an unknown type of child restraint. This reinforces the message in support of age-appropriate child restraints.

SUMMARY

As introduced in Murianka (2005), the enhanced data sets were unavailable for the public at the time of publication. However, in December 2006, these data sets were made available to the authors under the condition of use for the quality-controlled segments of the data set. The exhaustive review of the child safety data made this possible. At this moment, the remaining portions of the data set are undergoing rigorous quality control to ensure accurate codification of the data, as dictated by NASS data release practices.

At this stage in data collection, the child safety data contained in the enhanced data set may be considered for anecdotal representation. Although weighting factors accompany each record as set forth by the sampling design, reliance on the differences in frequency amongst any of these attributes would be reckless owing to the small cell sizes found upon disaggregating the data. With the accumulation of added years of data, tests of significance might be applied to reach meaningful conclusions.

The data eventually will allow the safety community to identify child passenger restraint usage. Among those children who benefit from child safety systems additional data will be available relevant to the technologies used, the child seat and vehicle interaction, and the occupant interaction with the child safety system.

CASE AVAILABILITY

As previously, electronic case files may be accessed via the NHTSA website, Electronic Case Access Screen. The hyperlink is as follows: http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa. This allows users to obtain elements that might not be available in the 11-file SAS data sets, also available on the NHTSA website.

REFERENCES

Association for Advancement of Automotive Medicine, Abbreviated Injury Scale (AIS) 1990 - Update 98, Barrington, 1998.

United States Department of Transportation, National Highway Traffic Safety Administration, National Automotive Sampling System, Crashworthiness Data System, 2002-2005, NHTSA, Washington, D.C.

United States Department of Transportation, National Highway Traffic Safety Administration, "National Automotive Sampling System, Crashworthiness Data System, 2000 Coding and Editing Manual", NHTSA, Washington, D.C.

Table 1: Number of Cases Coded in NASS CDS, Unweighted Data			
YEAR	**Total # of CDS Cases**	**Child Seat Cases**	**# of Child Seats Coded**
1999	4,274	182	230
2000	4,307	210	248
2001	4,090	188	220
2002	4,589	225	279
2003	4,754	219	276
2004	5,624	271	351
2005	4,481	234	293

Table 2: NASS CDS Occupants, in Years and Months, 2002 - 2005			
Age in Years	**Age in Months**	**Total Occupants, Raw**	**Total Occupants, Weighted**
0	1 - 3	72	26,618
0	4 - 6	70	27,091
0	7 - 9	72	37,646
0	10- 12	155	79,896
1	13 - 15	35	12,848
1	16 - 18	64	27,452
1	19 - 21	55	25,211
1	22 - 24	333	137,374
2	25 - 27	1	387
2	28 - 30	3	452
2	31 - 33	0	0
3	34 - 47	296	112,849
4	48 - 59	259	95,566
5	60 - 71	267	95,520
6	72 - 83	275	127,092
7	84 - 95	270	96,869
8	96 - 107	274	148,051
9	108 - 119	273	116,490
10	120 - 131	268	142,111
11	132 - 143	260	75,132
12	144 - 155	280	156,002
Total		3,582	1,540,659

Table 3 Annualized NASS CDS Occupants, in Years and Months, NASS CDS					
Restraint Usage	**Birth through 3 Years**	**4 through 7 Years**	**8 through 9 Years**	**10 through 12 Years**	**Total**
Unbelted	7,638	12,157	5,226	11,952	36,973
Child Safety Seat	101,888	24,712	625	0	127,225
Lap and Shoulder Belt	6,380	49,329	48,864	71,087	175,660
Other or Unknown	6,051	17,563	11,421	10,273	45,307
Total	121,957	103,762	66,135	93,311	385,165

Table 4: Annualized Child Safety Seat Usage, Children Birth through 9 Years, NASS CDS, 2002 - 2005				
Child Safety Seat	**Birth through 3 Years**	**4 through 7 Years**	**8 through 9 Years**	**Total**
Convertible Seat, CSS	40,511	1,881	0	42,393
Forward Facing Only, FSS	13,797	5,881	150	19,828
Infant Seat, ISS	13,944	0	0	13,944
Booster Seat, BSS	12,356	13,463	468	26,287
Integrated Seat, INT	359	167	0	526
Special Needs, SNSS	0	20	0	20
Booster/Forward Facing Seat, BSS/FSS	0	31	0	31
Booster Seat/ Convertible Facing Seat, BSS/CSS	3	0	0	3
Other or Unknown	23,646	4,770	7	28,422
Total	104,616	26,214	625	131,455
Note: Child Safety Total is slightly different owing to rounding, and variable and attribute combination				

Table 5: Description of Design Aspects Available in Enhanced NASS CDS			
Table 5a: Attributes Relevant to Harness	**Table 5b: Attributes Relevant to Clip**	**Table 5 c: Attributes Relevant to Tether**	**Table 5d: Attributes Relevant to Latch**
Three point	No clip available (OR Not Designed with Harness Retainer Clip)	No tether available (OR Not designed with Tether)	No LATCH available (OR Not designed with LATCH)
Five Point	Clip available (OR Designed with Harness Retainer Clip)	Tether available (OR Designed with Tether)	LATCH available (OR designed with LATCH)
T-Shield	Unknown	Unknown	Unknown
Tray Shield			
Shield			
No harness/shield available (OR Not designed with harness/shield)			
Unknown			

Table 6: Annualized Child Seat Placement, Birth through 12 Years, NASS CDS 2002 - 2005				
Child Safety Seat	**Seat**	**Floor**	**Other or Unknown**	**Total**
Convertible Seat, CSS	50,237	101	73	50,411
Forward Facing Only, FSS	21,434	194	48	21,676
Infant Seat, ISS	13,897	317	111	14,324
Booster Seat, BSS	29,306	5	143	29,454
Integrated Seat, INT	1,039	0	160	1,198
Special Needs, SNSS	20	0	0	20
Booster/Forward Facing Seat, BSS/FSS	39	0	0	39
Booster Seat/ Convertible Facing Seat, BSS/CSS	7	0	0	7
Other or Unknown	19,446	0	12,535	31,981
Total	135,424	617	13,070	149,110
Note: Child Safety Total is slightly different owing to rounding, and variable and attribute combination				

Table 7: Annualized Child Seat Orientation, Children Birth through 12 Years, NASS CDS, 2002 - 2005					
Child Safety Seat	**Rear Facing**	**Forward Facing**	**Supine**	**Other or Unknown**	**Total**
Convertible Seat, CSS	5,128	41,429	0	3,854	50,411
Forward Facing Only, FSS	0	21,360	0	316	21,676
Infant Seat, ISS	13,643	344	150	187	14,324
Booster Seat, BSS	0	27,716	0	1,738	29,454
Integrated Seat, INT	0	1,198	0	0	1,198
Special Needs, SNSS	0	20	0	0	20
Booster, Forward Facing Seat, BSS/FSS	0	39	0	0	39
Booster Seat/ Convertible Facing Seat, BSS/CSS	0	7	0	0	7
Other or Unknown	2,540	8,715	0	20,727	31,981
Total	21,310	100,827	150	26,822	149,110
Note: Child Safety Total is slightly different owing to rounding, and variable and attribute combination					

Table 8: Annualized Child Safety Seat Usage, by Maximum Injury Severity, Children Birth through 9 Years, NASS CDS, 2002 - 2005									
Child Safety Seat	Uninjured MAIS 0	Minor MAIS 1	Moderate MAIS 2	Serious MAIS 3	Severe MAIS 4	Critical MAIS 5	Maximum MAIS 6	Other or Unknown MAIS 7, 9	Total
Unrestrained	15,868	16,062	2,299	1,319	469	197	41	718	36,973
Child Safety Seat	99,159	22,229	706	207	190	81	43	4,610	127,225
Lap and Shoulder Belt	121,652	49,983	2,250	476	137	105	18	1,034	175,654
Other or Unknown	28,401	11,156	830	205	60	13	11	4,631	45,307
Total	265,079	99,429	6,086	2,207	856	396	113	10,992	385,159

Table 9: Annualized Child Safety Seat Usage, by Maximum Injury Severity, Children Birth through 9 Years, NASS CDS, 2002 - 2005									
Child Safety Seat	**Uninjured MAIS 0**	**Minor MAIS 1**	**Moderate MAIS 2**	**Serious MAIS 3**	**Severe MAIS 4**	**Critical MAIS 5**	**Maximum MAIS 6**	**Other or Unknown MAIS 7 or 9**	**Total**
Convertible Seat, CSS	32,804	6,418	72	45	5	11	2	3,037	42,393
Forward Facing Only, FSS	14,508	5,008	77	94	124	13	0	5	19,828
Infant Seat, ISS	11,948	1,783	125	10	20	32	25	0	13,944
Booster Seat, BSS	20,579	5,536	98	21	44	3	0	6	26,287
Integrated Seat, INT	463	40	9	11	0	0	0	3	526
Special Needs, SNSS	20	0	0	0	0	0	0	0	20
Booster/Forward Facing Seat, BSS/FSS	31	0	0	0	0	0	0	0	31
Booster Seat/ Convertible Facing Seat, BSS/CSS	0	3	0	0	0	0	0	0	3
Other or Unknown	21,589	4,832	347	37	10	24	20	1,564	28,422
Total	101,943	23,621	727	218	203	81	47	4,615	131,455
Note: Child Safety Total is slightly different owing to rounding, and variable and attribute combination.									