WHEELCHAIR SECUREMENT AND OCCUPANT RESTRAINTS: A CROSS-SECTIONAL ANALYSIS OF USE AND EFFECT ON MOTOR VEHICLE RELATED INJURIES

by

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ABSTRACT

Objective: The goal of this project was to describe the characteristics related to motor vehicle transportation among wheelchair users, who remain in their wheelchair while in the vehicle. Particular focus was placed on identifying how these individuals utilize occupant restraint and wheelchair securement devices. Also, the study examined the epidemiology of motor vehicle related injuries, and reports on the relationship between these injuries and the identified use of occupant restraint and wheelchair securement systems.

Methods: A 12-page survey was completed, via mail, by 336 wheelchair users, who self-reported that they remain seated in their wheelchair at least some point in their transportation use. These individuals were recruited through various nationwide disability related service and advocacy organizations, as well as through disability related internet message boards. Descriptive, chi-square and t-test analysis was completed using SPSS statistical software.

Results: The results of this study show that traveling as a private vehicle passenger is the most common manner in which motor vehicle transportation is used by wheelchair occupants, with 70.2% of the sample population reporting to using this mode within the past month and 50.0% reporting this mode as their primary means of transportation. Limited significant difference existed in regard to subject's gender, age, disability or wheelchair type and the reported use of

either an occupant restraint device or a wheelchair securement system. There were also limited significant findings seen in regard to the use of either an occupant restraint device or wheelchair securement system and the occurrence/severity of a motor vehicle crash, or non-crash related injury. Finally, in regard to motor vehicle related adverse events that resulted in an injury, descriptive statistics showed that there were limited events (crash: n = 15, non-crash: n = 71), with even less resulting in an injury requiring the need to seek medical attention (crash: n = 10, non-crash: n = 9).

Conclusion: This study is one of the first efforts to describe the real-world transportation characteristics of wheelchair-seated passengers, as well as an examination of the relationship between the use of either occupant restraints or wheelchair securement devices and the occurrence of motor vehicle related injuries. These data demonstrate that private vehicles are the most widely used form of motor vehicle transportation, suggesting that research focused in this area may be beneficial. Also, limited significant findings were seen in regard to the relationships between the use of either an occupant restraint or wheelchair securement, independent of each other, and the occurrence of motor vehicle related injuries. These results may be interpreted in two ways 1) that these safety systems are not being used effectively, or 2) that use of an occupant restraint and wheelchair securement independent of one another may not reduce injury risk in a motor vehicle crash or non-crash incident. The analysis of the use of a 3-point occupant restraint, together with a forward facing wheelchair securement system, as recommended by the SAE J2249, may produce different results. It should also be noted that based on descriptive statistics alone, it is evident that for those individuals who were injured severely enough in a non-crash incident to require medical attention, there was limited reported usage of wheelchair

securement and occupant restraints. These findings may suggest that the use of such devices may decrease the number of severe non-crash related injuries. Based on the limitations of this study and trends seen within the descriptive statistics, more research in this area is required to develop more inferential findings between the use of these devices and the occurrence of injuries related to motor vehicle transportation.

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1. BACKGROUND

Use of wheeled mobility devices in the United States has increased in past years and is expected to continue to increase in the future. It is currently estimated that 1,700,000 Americans, both adults and children use wheeled mobility devices as their primary means of mobility (Kaye, 2000). With the passage of several pieces of legislation, more opportunities have been presented to individuals with disabilities. These include the Individuals with Disability Education Act (IDEA), the Americans with Disabilities Act (ADA), and the New Freedom Initiative. These laws were designed to enhance the quality of life for individuals with disabilities by providing opportunities in the areas of employment, recreation and transportation. With these new opportunities, transportation use by individuals who must remain in their wheelchair while in the vehicle has increased, and it is important that they are provided the same high standards of safety that all other Americans have while in a motor vehicle.

In recent years several initiatives have been taken to enhance the issue of safe transportation for wheelchair-seated occupants. These include: 1) improvements to the Federal Motor Vehicle Safety Standard (FMVSS 222), which focuses on School Bus Passenger Seating and Crash Protection 2) ADA Regulations focused on the public motor vehicles 3) the creation of a Society of Automotive Engineers (SAE) Recommended Practice J2249, *Wheelchair Tiedown and Occupant Restraint Systems for use in Motor Vehicles* (SAE, 1996) and 4) ANSI/RESNA WC-19, *Wheelchairs Used as Seats in Motor Vehicles* (ANSI/RESNA, 2000). However, for future advancements and improvements to be made to these initiatives, a real-world understanding of transportation use by wheelchair seated riders is necessary.

These standards establish the requirements, definitions and the best practice guidelines for wheelchair transportation safety products, including wheelchair tiedowns and occupant restraints (WTORS), as well as transit tested (WC-19) wheelchairs. As stated above, the SAE J2249 (SAE, 1996) specifically focuses as wheelchair tiedowns and occupant restraints. It specifies the design requirements, test methods and performance requirements for these devices, as well as the requirements for manufacturer's instructions to installers and users, and the requirements for product marking and labeling. Schneider, Hobson and Bertocci (1999), published the guidelines for the recommended practice for this standard. This document states that recommended practice applies to WTORS that utilize all types of securement methods, with the condition that they are designed for use with forward facing wheelchairs and occupants. However, it should be noted that current wheelchair securement regulations and guidelines are focused on four-point strap type tiedowns and automated docking systems, which are the most commonly used.

In regard to occupant restraints, the J2249 Recommended Practice states that the WTORS must include either the three-point occupant restraint provided by the vehicle manufacturer or an upper and lower torso restraints included in the complete WTORS system. As stated in the guidelines (Schneider et al, 1999) there are several terms related to occupant restraints, including independent, fully integrated and partially integrated occupant restraints. An independent occupant restraint, which is the commonly used design of an occupant restraint, is defined as a device that is anchored directly to the vehicle, to the components of the wheelchair tiedown or to tiedown components fastened to the wheelchair. A fully integrated occupant restraint's anchor points are located on the seat or wheelchair and the partially integrated occupant restraint requires that only the pelvic belt be anchored to the wheelchair, while the shoulder belt be

anchored to the vehicle. While an independent occupant restraint is the design addressed by the recommended practice, more recent studies have advocated the use of integrated occupant restraints, which are an option of WC-19 compliant wheelchairs (Bertocci and Evans, 2000; and VanRoosmalen, Bertocci, Ha and Karg, 2001).

To date little research has been completed on the injury risk to wheelchair users who remain in their wheelchair, while utilizing motor vehicle transportation; or the extent to which wheelchair securement and occupant restraints are used in real world situations. Most injury data currently available is unclear on whether the injury occurred while the vehicle was in motion. A study by the National Highway Traffic Safety Administration (NHTSA, 1997) reported a total of 1500 injuries, requiring emergency care. These incidents were non-crash related and included events related to exposure to lifts, transfers and improper wheelchair securement. The most common reported injury was due to improper securement (35%), followed by collisions between the vehicle and wheelchair (26%) and lift malfunctions (19%). Another study conducted by the National Center for Transit Research (NCTR, 2001) surveyed Florida transit agencies about their wheelchair securement policies and difficulties. The results showed that 45% of the respondents indicated that there had been injuries related to securement devices, and that most often (33%) those injures occurred because of improper securement by drivers or attendants.

Other studies have been completed that examine injuries caused while the vehicle was in motion, however, these studies are based on data sources which are often incomplete and are limited in the identification of a wheelchair user. Three reports (Shaw, 2000; ECRI 1994; and Richardson, 1991), based on these sources, all suggest that the injury risk to wheelchair users is small and that there have been very few deaths and hospitalization injury cases to wheelchair

users involving motor vehicles. For example, Richardson (1991) reported that there were 2200 injuries among wheelchair users in motor vehicles from 1986-1990. Again, most injuries were attributed to improper securement during an emergency maneuver. Additionally, Shaw (2000) estimated that only 1320 injuries occurred between the years of 1988 and 1996. Due to the insufficient data sources used by these studies it is often difficult to distinguish the vehicle type, the mode of transportation (private or public), the extent of vehicle modification, the seating position of the wheelchair user (wheelchair or vehicle seat), whether the wheelchair user was a driver or passenger in the incident, and whether wheelchair securement was used. Possible relationships between the above variables and injury risk to wheelchair-seated riders have been identified in preliminary reports (Bertocci, 1999; Shaw, 2000), thus establishing a need for future investigation.

1.1. OBJECTIVES

This project is designed to examine the characteristics of how wheelchair users utilize motor vehicle transportation. Specifically, the project will focus on the use of securement devices and occupant restraints in motor vehicles and their role in injury prevention. A self-reported survey will identify the varying types of wheelchair securement, in addition to the vehicles (e.g. private, public bus, taxi, subway, railway, paratransit) in which they are used. Injuries obtained in either a motor vehicle crash or an emergency maneuver (non-crash incident) will also be identified. This will allow for the following research questions to be examined for any correlation between wheelchair securement and occupant restraint use and injury type and severity.

Research Question 1: Is the injury risk from motor vehicle crashes or emergency maneuvers greater for individuals who do not use occupant restraints while in transport?

Research Question 2: Is the injury risk from motor vehicle crashes or emergency maneuvers greater for individuals who do not use wheelchair securement while in transport?

The goal of this study is to investigate the epidemiology of injuries to wheelchair users related to motor vehicle transportation and to report on the relationship between these injuries and the identified occupant restraint and wheelchair securement use. The specific aims of the study include:

Aim 1: To describe the characteristics of how wheelchair users use motor vehicle transportation, in addition to how they utilize the different kinds of occupant restraints and wheelchair securement devices.

Aim 2: To determine the incidence and severity of injury to wheelchair users, obtained in either a motor vehicle crash or an emergency maneuver (non-crash incident), as well as the effect that the use of occupant restraints and wheelchair securement devices has on the occurrence of those injuries.

1.2. SIGNIFCANCE OF CONDUCTING THIS RESEARCH

Due to the passage of the Americans with Disabilities Act, economic and social opportunities have increased for persons with disabilities. In order for these individuals to take full advantage of these opportunities, accessible and safe use of motor vehicle transportation is necessary. Transportation plays an imperative role in an individual's ability to travel outside the home and participate in these employment and recreational activities (Linden, 1996). Therefore, in order to maximize motor vehicle safety, it is important that we have an understanding of how these individuals, who use the wheelchair as the vehicle seat, utilize motor vehicle transportation and the different types of wheelchair securement and occupant restraint devices. In addition, it is also important to determine whether or not the use of these safety devices actually decreases the number, nature and severity of motor vehicle related injuries. With this knowledge, we will be able to determine which areas of wheelchair transportation safety need to be examined in more detail.

Currently, research has shown that there are specific barriers present in motor vehicle transportation, especially public transportation, that prevent wheelchair seated riders from properly using the different wheelchair securement devices, or from using them at all. Some of the most prominent obstacles include; insufficient bus operator training; attitudes of bus operators toward wheelchair users; malfunctioning, poorly fitting, or missing tiedowns and restraints; use of wheeled mobility devices that are not designed for transportation use and a lack of education among wheelchair users. (Armstrong, 2004; NCTR, 2001)

If the results of this project do demonstrate that there is a relationship between the use of wheelchair transportation safety devices and a decrease in the incidence of injury to wheelchair seated riders, then this will demonstrate the effectiveness of current systems and practices. With

the knowledge produced by this project, we can better inform wheelchair users, transit agencies, public vehicle drivers, driver rehabilitation specialist, and personal care assistants, etc. of the need for consistent and proper securement of wheelchairs during transit.

2. METHOD

2.1. STUDY DESIGN

This descriptive study was designed around the idea of looking at the wheelchair using population from two different perspectives: 1) the wheelchair user as the driver and 2) the wheelchair user as a passenger. Through this manner, it will be possible to further categorize the sample population by vehicle type (e.g. private vehicle or public vehicle), and wheelchair type (e.g. power or manual). With this design it will also be possible to examine the exposure to the various forms of transportation, the typical use of wheelchair securement and occupant restraints in these transportation vehicles and any previous crash or injury events related to motor vehicle transportation.

The two major phases in the project are to 1) identify the population of wheelchair users and 2) to survey these individuals, using a questionnaire format, on the characteristics of their wheelchair, their transportation use, their use of wheelchair securement, occupant restraint and any motor vehicle crashes or emergency maneuvering events, occurring within the past three years that may have resulted in an injury. The data provided by this design will provide an understanding of real world situations that occur and possible ways we may reduce the risk of injury for individuals who must remain in their wheelchair while traveling in a motor vehicle. Prior to commencing the subject recruitment, survey distribution and data collection, Institutional Review Board (IRB) approval was obtained.

2.2. PARTICIPANTS

Subjects for this project were recruited through a process of self-referral. These subjects became aware of the study through various disability related agencies/organizations. These organizations, some nationwide, were identified by the investigators in an attempt to reduce potential bias. The agencies were chosen and contacted on the basis of recruiting individuals from a variety of disability populations, in addition to individuals who utilize a mix of different motor vehicles (e.g. private and public). A total of 118 agencies agreed to participate in the project. All agencies who participated in the project, agreed to assist in the recruitment process. With the help of these organizations, a total of 43 advertisements were placed in newsletters nationwide, in addition to the distribution of over 1600 brochures. In addition, study advertisements were also posted on various disability related internet message boards.

After obtaining study details and our contact information through the study brochures, newsletters or internet postings, the interested individuals were instructed to contact one of the investigators, at which point the study was explained and a telephone screening survey was performed (see Appendix A). The screening process took approximately 10-15 minutes to complete, and was used to identify the following inclusion criteria: 1) that the individual used a wheelchair or scooter as their primary means of mobility and 2) that at least some point in their motor vehicle transportation use, they remained seated in their wheelchair. A total of 600 individuals were identified and screened, of which, 428 met the inclusion criteria and were sent the consent form and questionnaire (see Appendix B). A total of 336 surveys and consent forms were returned to the investigators for analysis.

2.3. STUDY PROTOCOL AND INSTRUMENTATION

If the subject met the inclusion criteria, and agreed to participate, both the consent form and the questionnaire were mailed to the individual. Instructions were provided over the phone to read, initial and sign the consent form and to return it to the investigators along with the completed survey. They were also instructed to contact one of the investigators if any concerns or questions should arise. If the subject was unable to complete the questionnaire due to their disability, a proxy (e.g. spouse, aid) was asked to complete the survey for the subject. Non-respondents were contacted by telephone or email and spurred to return the survey to the investigators. If the subject consented to participate in the study and returned the completed questionnaire, they were compensated $20.00 for their time and effort.

Follow-up calls were made in order to verify or correct any incomplete or contradicting information provided by the subject, as well as to gather data on additional reported crashes or non-crash injuries. This was found necessary because numerous participants reported to being involved in 3 or more crashes/non-crash injuries, while the survey only provided space for the information on 2 incidents. The investigators agreed to collect information on up to 4 crashes/non-crash injuries. This number was decided, because it was felt that recall error of the details of the incident may exist if the subjects were asked to remember information on more than 4 incidents.

The questionnaire (see Appendix B) consisted of a total of 63 questions, including 2 incident forms which were used to acquire detailed information about specific crashes or non-crash incidents. The questionnaire was designed to cover information regarding demographics, current health status and motor vehicle transportation, as well as the use of any wheelchair

securement devices and occupant restraint systems. It has been reported that the survey takes less than 1 hour to complete.

2.4. DATA MANAGEMENT

Completed surveys and consent forms were returned to the investigators via mail. All information was kept confidential, with hard copies of the questionnaires, subject contact information and consent forms locked in filing cabinets. An electronic database, protected by password, was used for the data entry of all responses. As stated above, these responses were checked for correctness and verified through a telephone call to the participant if a discrepancy existed. Subject identification numbers were assigned to link the questionnaire to the participant's name, thus eliminating any identifying information in the database.

2.5. STATISTICAL ANALYSIS

Both qualitative and quantitative data was collected in this research study. Numerical coding was provided to all qualitative responses prior to data entry, allowing for the easy categorization and analysis of these answers. SPSS 12.0 was used to analyze the data. Descriptive statistics (frequencies, standard deviation, mean) were used to describe the demographics, wheelchair use, motor vehicle transportation use, wheelchair securement use, occupant restraint use, as well as the occurrence of adverse events and resulting injuries of the sample population. In addition, chi-square and t-test analysis was completed to examine the observed frequencies and their variation from the expected. The following tables describe the inferential analysis (chi-square

and t-test) that was completed, both in regard to the use of wheelchair securement and occupant restraints and their effect on the occurrence of a motor vehicle related injury.

Table 1: Analysis of the Use of WTORS and User Characteristics

	Gender	Age	Wheelchair Type	Disability Type
Occupant Restraint Use				
Driver				
Private Passenger				
Bus Passenger				
Paratransit Passenger				
Wheelchair Securement Use				
Driver				
Private Passenger				
Bus Passenger				
Paratransit Passenger				

Table 2: Analysis of the Occurrence of a Motor Vehicle Injury and the Use of WTORS

	Injured in a Motor Vehicle Crash	Crash Injury Requiring Medical Attention	Injured in a Non-Crash Incident	Non-Crash Injury Requiring Medical Attention
Occupant Restraint Use				
Yes				
No				
Wheelchair Securement Use				
Yes				
No				

In regard to the different transportation modes covered within the questionnaire, a decision was made to exclude taxi, subway and railway use, and only focus on private vehicle (driver and passenger), mass transit bus and paratransit use, within the statistical analysis. This decision was made based on the reported motor vehicle usage by the subjects. The majority of participants reported to using private vehicles (driver: 28.0%, passenger: 70.2%), mass transit buses (22.0%) or a paratransit service (36.5%) as their means of motor vehicle travel, while few reported to using taxi (4.6%), subway (5.2%) or railway services (1.8%).

Also, a decision was made to base the majority of the statistical analysis on the primary transportation use, reported by the participants, rather than the overall transportation use.

Primary transportation use was determined by comparing the weekly mileage traveled in each mode of transportation to the total mileage traveled per week by that individual. The mode of transportation used the most by the individual was then identified as their primary form of transportation. Overall transportation use was determined by asking the participant if they have used the specified form of transportation at all within the past week. If this was reported, then the subject was identified as using that specific transportation mode. The decision to focus the analysis on the primary use was made by comparing the exposure (mileage) of both the primary and overall usage. It was found that primary users have a higher exposure rate within each of the four transportation modes (see figure 1).

The use of both securement and occupant restraints were categorized into a yes/no variable, which allowed for the chi-square analysis of the remaining categorical variables, as well as the independent sample t-test of the age (continuous variable) of the subject. In some instances the, cell sizes were less than five, requiring a Fisher's Exact Test to be used.

In regard to the occurrence of adverse events and the resultant injuries, additional analysis was completed. Chi-Square analysis was used to determine if a relationship existed between the use of either wheelchair securement devices or occupant restraints, as well as the specific types, and the occurrence of an injury (either minor, or severe enough to require medical attention) due to a motor vehicle crash. Chi-Square analysis was also completed to determine if a relationship existed between the use of such devices and the occurrence of an injury, requiring medical attention, caused by a non-crash incident.

RESULTS

2.6. DESCRIPTIVE STATISTICS

2.7. Demographics

The 336 responding individuals reported to being 46.7% male and 53.3% female, with a mean age of 42.7 ± (14.6) years. 6.9% of the subjects fell in the under 18 age category, with 22.4% between the age of 19 and 34, 35.6% between the age of 35 and 49, 29.3% between the age of 50 and 64 and 6.7% above the age of 65. In regard to occupation, 37.7% reported to being employed, either in a part-time (20.5%) or full-time position (17.3%), 19.3% identified as a student, 11.9% reported that they were currently unemployed and looking for work, 36.7% reported that they were unable to work due to disability, 8.3% reported be being a homemaker and 10.7% identified as being retired.

2.7.1. Disability Type

The participants of this study represented a diverse sample population in regard to disability type. Cerebral palsy was the most reported disability with 21.6% of the population, followed by quadriplegia (20.1%), multiple sclerosis (11.1%), paraplegia (9.0%), muscular dystrophy (8.4%), polio myelitis/post polio syndrome (6.9%), spina bifida (3.9%), neurological disorders (3.3%) and finally cerebral vascular accidents/hemiplegia (3.0%). 12.6% of the population, however, did report other disability types (e.g. amputee, arthritis, osteogenesis imperfecta).

2.7.2. Wheelchair Characteristics

The characteristics of the wheelchairs were determined through the survey questions. The data show that 66.7% of the population reported to using a power wheelchair as their primary means of mobility, while 33.3% reported to using a manual wheelchair. The makes and models of the wheelchair varied greatly among this sample population. The mean age of all wheelchairs was 4.2 ± (3.7) years. However, there was a significant difference between the wheelchair type and age. Manual wheelchairs were significantly (p= <.0001) older (manual: 5.5 ± (5.1) years, power: 3.7 ± (2.9) years). The mean length of overall wheelchair use was also determined to be 18.8 ± (13.4) years.

2.7.3. Transportation Use

The motor vehicle transportation use of the 336 subjects was analyzed from two differing perspectives. The first being overall transportation use, while the second referred to the primary transportation use. Primary transportation use was determined by comparing the weekly mileage traveled in each mode of transportation to the total mileage traveled per week by that individual.

2.7.3.1. Overall Transportation Use

Overall transportation use, meaning that the participant reported to using the specified transportation mode, is described as follows. Ninety-four individuals (28%) reported to traveling as a driver of a motor vehicle, while 228 (70.2%) stated that they have traveled as a passenger in a private vehicle, 72 (22.0%) reported to riding as a passenger in a mass transit bus and 119 (36.5%) of the population stated that they have traveled as a passenger in a paratransit vehicle.

When examining the miles traveled per week in each of the specified transportation modes, individuals who drive reported the highest mileage, over all other transportation modes. Drivers reported to traveling a total of 131.01 ± (137.83) miles within a week, private vehicle

passengers traveled 102.95 ± (149.45) miles, paratransit passengers rode a total of 52.64 ± (77.74) miles and mass transit bus passengers reported to traveling only 36.21 ± (43.0) miles within the past week. It should be noted however that the distribution of miles traveled per week is highly skewed for all transportation modes.

2.7.3.2. Primary Transportation Use

As stated above, the primary transportation use of the study participants was also examined. The data demonstrates that half (50.0%) of the sample population primarily traveled as a passenger in a private vehicle, 22.2% traveled as a driver as their primary mode of motor vehicle transportation, 19.3% primarily traveled as a passenger in a paratransit vehicle, while only 8.5% of the subjects stated had a primary mode of transportation of traveling as a passenger in a mass transit bus.

The transportation exposure was also examined based on the primary motor vehicle use. For all transportation modes, the mileage was higher for the individual who used the specified transportation mode as their primary use, rather than for those who used the specified vehicle at any point. As similar to overall transportation use, the individuals who reported to driving as their primary means of transportation, showed a higher mean weekly mileage than those who primarily traveled as a passenger in a private vehicle, mass transit bus or paratransit vehicle. Primary drivers reported to driving a total of 160.58 ± (138.34) miles in the past week, primary private passengers rode a total of 131.88 ± (163.77) miles, primary bus passengers rode a total of 52.08 ± (53.59) miles and primary paratransit passengers traveled a mean of 77.83 ± (95.21) miles within the past week.

Based on the exposure for both overall and primary transportation usage (see figure 1), the decision was made to focus all of the following statistical analysis on primary transportation

usage of the subjects. This decision can be justified by the fact that those individuals who reported to using a specific transportation mode most frequently, traveled longer distances within a weekly period, when compared to those individuals who reported to only using the specified transportation mode within the past month. This increased exposure warrants the need to examine subject characteristics and motor vehicle related injuries based on primary transportation use.

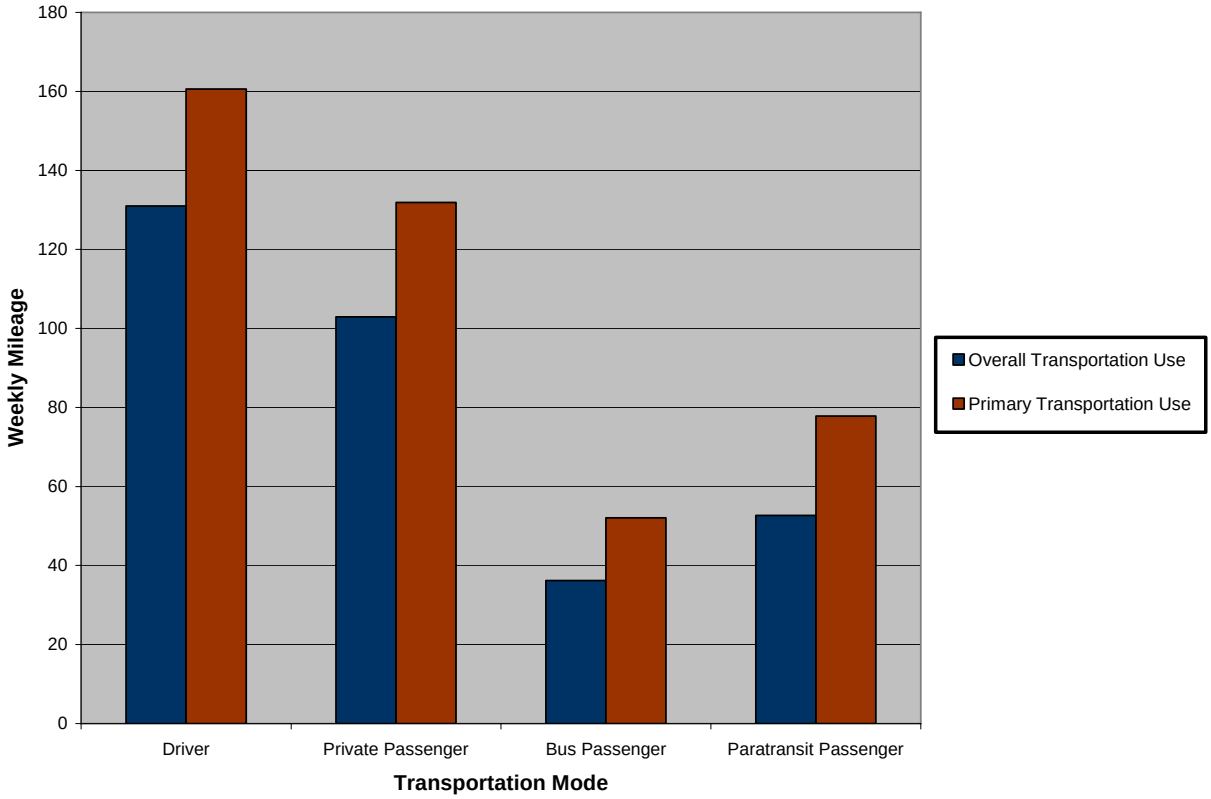

Figure 1: Exposure Comparison between Overall and Primary Transportation Usage

The characteristics in regard to gender, age, disability type, wheelchair type (manual / power) and seating position (vehicle seat / wheelchair) were examined for each of the primary transportation modes (see table 1).

The 68 individuals who primarily drive as their mode of transportation were 64.7% male with a mean age of 46.06 ± (12.71) years. 58.2% of these individuals used a power wheelchair

as their primary means of mobility and 47.7% remained in their wheelchair, rather than transferred to the vehicle seat, while driving. The top disability types for this group of individuals included; quadriplegia (32.8%), paraplegia (26.9%), multiple sclerosis (7.5%) and polio/post-polio syndrome (7.5%).

For the 153 participants who primarily traveled as a passenger in a private vehicle the characteristics were slightly different. 40.5% of these individuals were male, with a mean age of 41.26 ± (15.70) years. 69.7% used a power wheelchair as their primary means of mobility and 71.9 % remained in their wheelchair while traveling. The top disability types for these individuals included; cerebral palsy (24.5%), quadriplegia (23.2%) and muscular dystrophy (13.2%).

The 26 participants who reported to primarily riding as a passenger in a mass transit bus were 50.0% male, with a mean age of 38.04 ± (13.9) years. 75.0% of these individuals used a power wheelchair, with 92.0% remaining in their wheelchair while in transport. The top disability types for these individuals included; cerebral palsy (26.9%), multiple sclerosis (15.4%), quadriplegia (7.7%), spina bifida (7.7%) and neurological disorders (7.7%).

For the 59 subjects who primarily traveled as a passenger in a paratransit vehicle, 44.1% reported to being male, with a mean age of 44.10 ± (13.39) years. A total of 60.0% of this group reported to using a power wheelchair as their primary means of mobility, with 94.9% remaining in their wheelchair while traveling in the vehicle. The top disability types for paratransit passengers included; cerebral palsy (28.8%), multiple sclerosis (16.9%) and muscular dystrophy (8.5%).

Table 3: Characteristics of Subjects in Regard to Primary Transportation Mode

	Gender (male)	Age (mean yrs.)	WC Type (power)	Seating Position in Vehicle (remain in WC)	Weekly Mileage	Top Disability Types
Primary Driver (n=68)	64.7%	46.06	58.2%	47.7%	160.58	Quad – 32.8% Para – 26.9% MS – 7.5% Polio/Post-polio – 7.5%
Primary Private Passenger (n=153)	40.5%	41.26	69.7%	71.9%	131.88	CP – 24.5% Quad – 23.2% MD – 13.2%
Primary Bus Passenger (n=26)	50.0%	38.04	75.0%	92.0%	52.08	CP – 26.9% MS – 15.4% Quad – 7.7% Spina Bifida – 7.7% Neuro Disorder – 7.7%
Primary Paratransit Passenger (n=59)	44.1%	44.1	60.0%	94.9%	77.83	CP – 28.8% MS – 16.9% MD – 8.5%

2.7.4. Occupant Restraint Use

Questions concerning the occupant restraint use (e.g. shoulder belts, lap belts) were asked of the 336 subjects. Analysis of this use was completed by examining those individuals who remained in their wheelchair while traveling in the motor vehicle and in each of the four primary modes of transportation separately. For those individuals who reported to using some form of occupant restraint, Figure 2 portrays the percentage of individuals reporting the use of the specified occupant restraint belts.

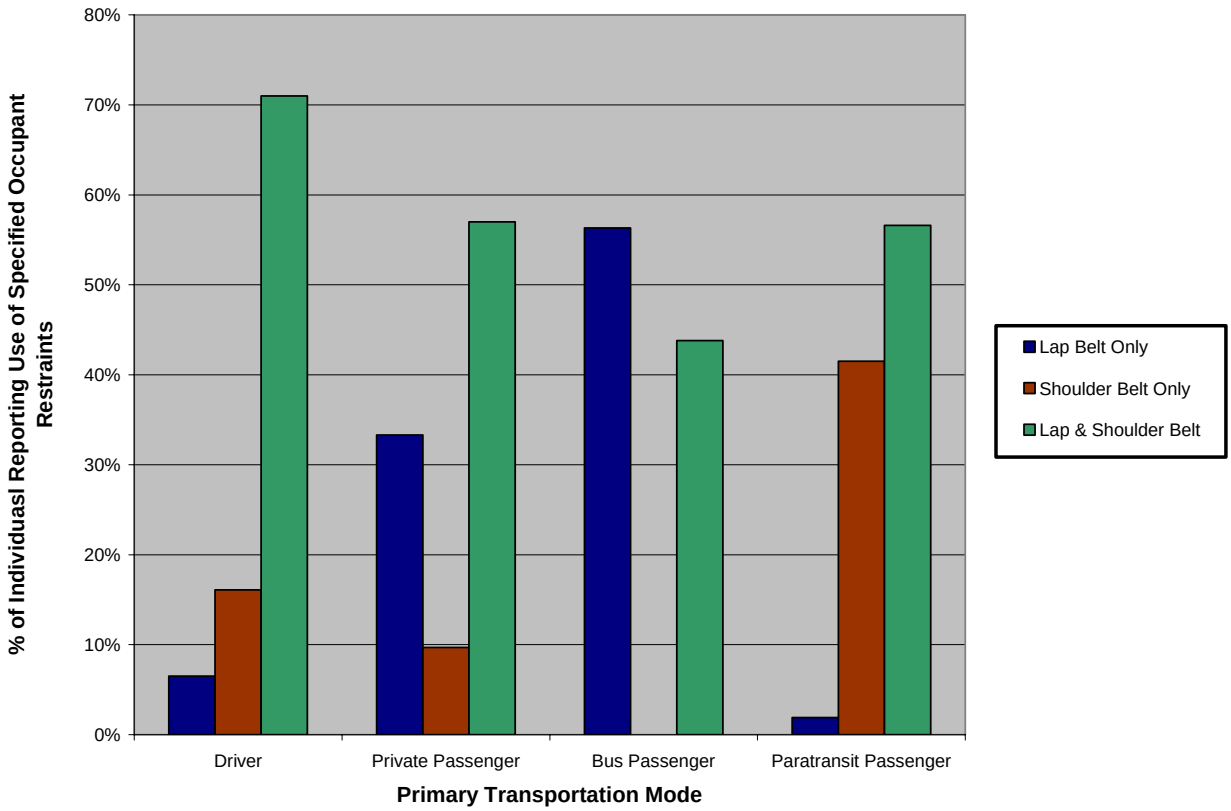

Figure 2: Typical Use of Occupant Restraints

For those subjects who reported to primarily driving a motor vehicle from their wheelchair (n=31), the use of an occupant restraint was determined, in addition to the type of occupant restraint and the attachment point (e.g. wheelchair, vehicle). The data showed that 93.5% of primary drivers who drove from their wheelchair reported to using some type of occupant restraint. 71.0% of the subjects reported to using both a lap and shoulder restraint, with 16.1% identifying the use of a shoulder restraint only, and 6.5% reporting the use of a lap restraint only. Further analysis examining the attachment point of the occupant restraints showed that 62.1% of the restraints were attached to the motor vehicle, 24.1% were attached to the motor vehicle and the wheelchair, while only 13.8% were attached to solely the wheelchair.

For individuals who identified in the survey that they were primarily passengers in private vehicle and traveled while seated in their wheelchair (n=110), 84.5% reported that they used some form of occupant restraint while traveling. 57.0% of these individuals identified as using both lap and shoulder restraint, 33.3% reported the use of a lap restraint only, and 9.7% stated that they only used a shoulder restraint.

Additional analysis was completed identifying the occupant restraint use of individuals who primarily traveled as a passenger in a mass transit bus (n=23). The data showed that 72.7% identified as using some form of occupant restraint while traveling in a bus. 56.3% of these subjects reported the use of only a lap belt, while 43.8% stated that they used both a lap and shoulder belt as their form of occupant restraint.

Finally, in regard to occupant restraint, analysis was completed to examine the use of such devices by individuals who primarily traveled as paratransit passengers, while seated in their wheelchair (n=56). The analysis showed that number of individuals who used occupant restraint in this mode of transportation (94.6%) was much higher than all other modes of transportation examined in this study. 56.6% of these individuals who used occupant restraints, reported to using both a lap and shoulder restraint, 41.5% identified as using a lap restraint only, while only 1 individual (1.9%) reported to using only a shoulder belt.

2.7.5. Securement Use

The survey also addressed the use of wheelchair securement systems (see background for detailed descriptions). Analysis of this use was completed by examining the four primary modes of transportation and the individuals who traveled in those specified modes, while seated in their wheelchair. In the survey, the subjects were asked to report on their typical securement use. For

those individuals who reported to using some form of wheelchair securement, Figure 3 portrays the percentage of individuals reporting the use of the specified wheelchair securement devices.

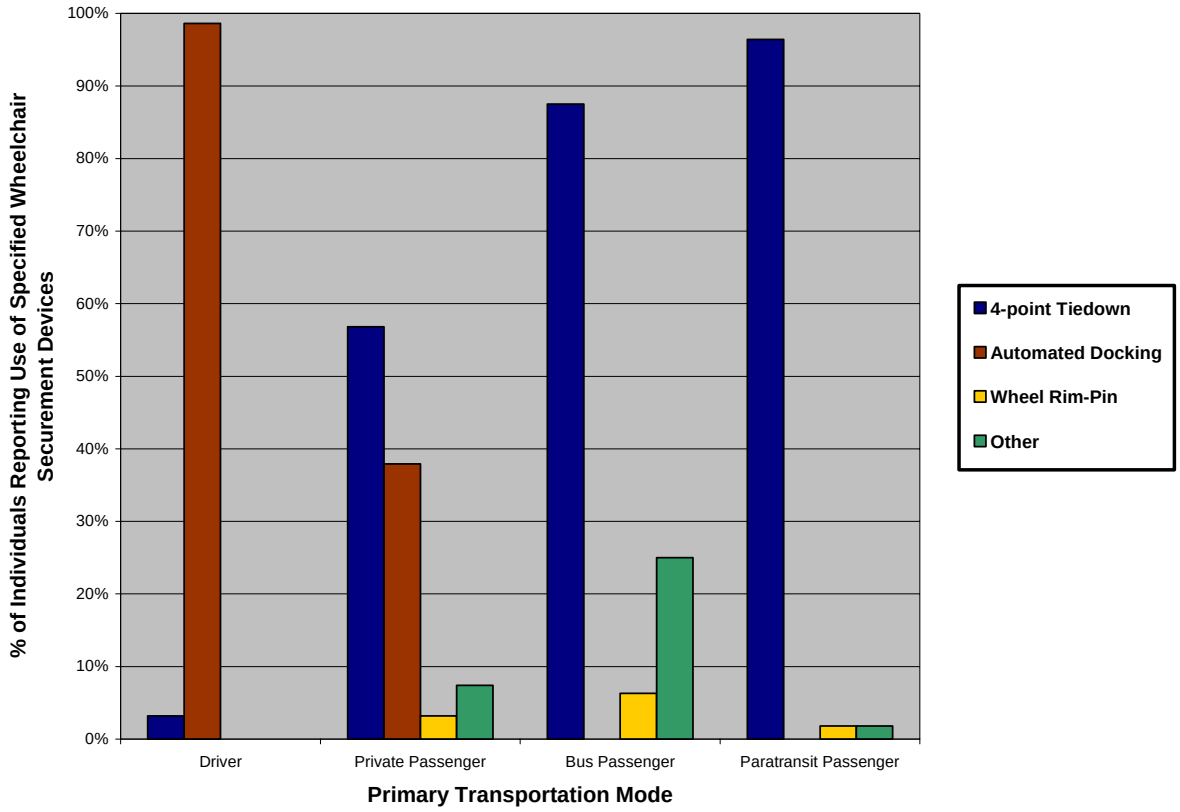

Figure 3: Typical Use of Wheelchair Securement Devices

For those subjects who primarily reported to driving a motor vehicle from their wheelchair (n=31), 100.0% claimed to use some form of wheelchair securement. 96.8% stated that they generally use an automated docking system, while 3.2% use a 4-point tie down system.

Wheelchair securement analysis was also completed for those individuals who remain in their wheelchair and primarily travel as passengers in private vehicles (n=110). 86.4% of these individuals reported in the survey that they generally use some form of wheelchair securement system. The following is a breakdown of the specific securement systems used by wheelchair-seated private vehicle passengers. 56.8% of the individuals who reported to using some form of

securement device, identified that they generally use 4-point tie downs, 37.9% reported that they use an automated docking system, 7.4% stated that they use another, unidentified securement system, and only 3.2% reported to using a wheel rim-pin system.

For those individuals who primarily travel as a passenger in a mass transit bus, while seated in their wheelchair (n=23), 72.7% reported to using some form of a wheelchair securement device. 87.5% of those individuals who generally use a securement system, use a 4-point tie down device, 25.0% use another, unspecified system, and only 6.3% use a wheel rim-pin system.

Finally, wheelchair securement analysis was also completed for the subject who primarily traveled in a paratransit vehicle as a wheelchair-seated passenger (n=56). 100.0% of these individuals reported to using some form of wheelchair securement. 96.4% generally use a 4-point tie down system, while only 1.8% use a wheel rim-pin device and 1.8% use an unspecified securement device.

2.7.6. Incident Involvement & Resulting Injuries

2.7.6.1. Motor Vehicle Crashes

In the main survey a total number of 50 individuals (14.9% of the entire sample population) reported a total of 65 motor vehicle crashes. These numbers were further analyzed by breaking down the crash involvement into two categories, driver and passenger. 17 subjects reported to being involved in a total of 23 crashes as the driver of the motor vehicle, and 33 claimed that they were involved in a total of 42 crashes as a passenger in either a private or public vehicle. Of those total 65 motor vehicle crashes, 55 were reported in detail in the incident forms that accompanied the main survey.

Within the context of the incident forms, 18 driver crashes were reported, however only 11 of those crashes occurred while the subject was driving from the wheelchair, rather than the vehicle seat. A description of those 11 driver crashes follow. 54.5% (n=6) of the individuals involved in a driver crash while seated in their wheelchair were male, and 72.7% (n=8) were using a power wheelchair. The mean age of these individuals was 51.45 ± (11.39) years. Of those 11 crashes, 10 (90.9%) occurred in a private vehicle, while 1 (9.1%) occurred in a paratransit vehicle. A total of 4 (36.4%) of the crashes resulted in an injury, all of which required medical assistance.

The incident forms also identified 37 passenger crashes; 32 of those crashes occurred while the individual was seated in their wheelchair. 43.8% (n=14) of the individuals involved in those 32 crashes were male, and 62.5% (20) were using a power wheelchair. The mean age of these individuals was 32.97 ± (14.71) years, much younger than those individuals involved in a driver crash. In regard to vehicle type, 70.0% (n=21) occurred in a private vehicle, 23.4% (n=7) occurred in a paratransit vehicle, and 6.7% (n=2) occurred in a mass transit bus. A total of 11 (34.4%) of the passenger crashes resulted in a injury, however only 6 of these resulted in the need to seek medical assistance.

2.7.6.2. Non-Crash Incidents

In the main survey 52 subjects (15.5% of the entire sample population) reported a total of 105 emergency maneuvers (non-crash incidents) that resulted in an injury. Of those 105 incidents, 73 were reported in detail in the additional incident forms. Within the incident forms, the data demonstrates that 71 of those 73 non-crash incidents occurred while the subject was seated in the wheelchair, rather than the motor vehicle seat.

When examining the characteristics of the individuals involved in the 71 incidents in which the person was injured in a motor vehicle emergency maneuver, while seated in their wheelchair, the following was shown to be true. 46.6% (n=34) of the individuals involved in these events were male, and 67.2% (n=43) were using a power wheelchair. The mean age of this group was 40.41 ± (14.75) years. The percentage of incidents involving a private vehicle and a paratransit vehicle were the same, with 38.0% (n=27) for each transportation mode, mass transit bus incidents followed with 22.5% (n=9) of the incidents, while only 1 incident (1.5%) occurred in unspecified form of transportation (e.g. subway, train, taxi). It was reported however, that only 9 individuals (12.7%) injured in an emergency maneuver required the need to seek medical attention.

2.8. INFERENTIAL STATISTICS

Statistical analysis was completed, however, very few significant relationships were found to exist. The use of wheelchair securement and occupant restraint systems, as well as the types of these devices, were analyzed in this manner, against the gender, disability type, wheelchair type and age of the subjects. Chi-square analysis was completed to examine the relationships, because at no time did the Fisher's Exact Test result in different findings. Due to this finding, all statistics provided will be based on the chi-square analysis.

In regard to the occurrence of adverse events and the resultant injuries, additional analysis was completed. Chi-square analysis was used to determine if a relationship existed between the use of either wheelchair securement devices or occupant restraints, as well as the specific types, and the occurrence of an injury (either minor, or severe enough to require medical attention) due to a motor vehicle crash. Also, in order to determine if a relationship existed

between the use of such devices and the occurrence of an injury caused by a non-crash incident, chi-square analysis was again completed. It should be noted however, that when comparing

2.8.1. Occupant Restraint Use

In regard to occupant restraints, statistical analysis (chi-square and t-test) was completed for wheelchair-seated travelers in all four primary transportation modes. As stated above, limited statistical relationships were identified within any of the transportation modes and between the use of occupant restraints and the following variables; gender, wheelchair type, disability type and age.

One relationship, however, did exist among wheelchair-seated drivers. The analysis demonstrated that drivers with quadriplegia were significantly more likely ($p = 0.03$) to use an occupant restraint device, over any other disability type. Also, it was determined that individuals with cerebral palsy, who travel as passengers in paratransit vehicles are significantly more likely ($p = 0.04$) to use some form of occupant restraint over any other disability.

In addition, while not significantly different ($p=0.24$) more primary private vehicle passengers who used a manual wheelchair while traveling in a motor vehicle tended to utilize occupant restraints (94.4%), when compared to power wheelchair users (84.5%).

Another trend was seen concerning the use of occupant restraints and primary bus passengers. Again, while not significantly different ($p=0.42$) more female wheelchair-seated bus passengers (80.0%), used some form of occupant restraint, than male wheelchair-seated bus passengers (66.7%). Within the primary bus passenger transportation mode, another trend was seen among the disability types of the subjects. While 100.0% of individuals with quadriplegia, paraplegia, and spina bifida reported to using an occupant restraint device, only 60.0% of individuals with cerebral palsy and 66.7% of individuals with multiple sclerosis reported the

same. Also, when traveling in a mass transit bus, more manual wheelchair users (80.0%) reported the use of an occupant restraint device, than power wheelchair users (68.8%). Finally, in regard to the use of occupant restraints in paratransit vehicles, there were no major trends that stood out in the analysis.

Due to the lack of significant outcomes, the overall use of occupant restraint devices can be interpreted by stating that regardless of the subject's gender, wheelchair type, disability type and age, no one group is more likely to use occupant restraint devices than the other (exception: drivers with quadriplegia and paratransit passengers with cerebral palsy).

2.8.2. Wheelchair Securement Use

In regard to the use of wheelchair securement devices, statistical analysis (chi-square and t-test) was completed for wheelchair-seated travelers in all four primary transportation modes. Within this analysis, no statistical relationships were identified within any of the transportation modes and between the use of securement devices and the following variables; gender, wheelchair type, disability type and age.

Statistical analysis concerning the use of wheelchair securement devices and individuals who reported to traveling both as wheelchair-seated primary drivers and primary paratransit passengers was not completed, due to the fact that all individuals falling into these categories (100.0%), reported the use of wheelchair securement.

In regard to primary private passengers who remained in their wheelchair while in transport, a trend was evident within the disability types of the subjects. While 100.0% of individuals with paraplegia, multiple sclerosis, polio/post-polio, stroke, and other neurological disorders reported the use of a wheelchair securement system, 92.3% of individuals with cerebral palsy, 79.4% of individuals with quadriplegia, 78.9% of individuals with muscular dystrophy and

66.7% of individuals with spina bifida did the same. It was also observed that while 100.0% of all manual wheelchair users who traveled as primary private vehicle passengers reported the use of a wheelchair securement device, only 85.7% of power wheelchair users did. All manual wheelchair users, traveling primarily in a mass transit bus, reported the use of a securement device, while only 66.7% of power wheelchair users did the same.

Again, due to the lack of significant outcomes, the overall use of wheelchair securement devices can be interpreted by stating that regardless of the subject's gender, wheelchair type, disability type and age, no one group is more likely to use wheelchair securement than the other.

Table 4: Significant Findings in Regard to the Use of WTORS and User Characteristics

	Gender	Age	Wheelchair Type	Disability Type
Occupant Restraint Use				
Driver				**Significant**
Private Passenger				
Bus Passenger				
Paratransit Passenger				**Significant**
Wheelchair Securement Use				
Driver				
Private Passenger				
Bus Passenger				
Paratransit Passenger				

Note: Blank cells indicate that a non-significant finding was identified

2.8.3. Injuries as a Result of a Crash

No statistical differences were seen when comparing the occurrence of injury with the use of either occupant restraint systems or wheelchair securement devices. Similar percentages were seen regardless of whether the individual was using an occupant restraint system (35.3%), or not (40.0%) and the occurrence of an injury. However, in regard to the need for medical attention, 66.7% of the subjects wearing an occupant restraint required medical attention, while all (100.0%) of those not wearing any restraint needed to seek such assistance. In regard to the type

of occupant restraint, the most (28.6%) were wearing only a lap belt anchored to the wheelchair, this was followed with 21.4% of the subjects injured while wearing only a shoulder belt anchored to the vehicle.

In regard to the use of a wheelchair securement device and the occurrence of an injury due to a motor vehicle crash, slightly more individuals who reported to not using any form of wheelchair securement (50.0%) were injured when compared to individuals who reported to using such a device (34.3%). It was also seen for those individuals who did report a motor vehicle crash injury, that nearly half (46.7%) reported to using a 4-point tie down system, followed by 20.0% who reported to using an automated docking system and 20.0% who reported to using no securement device at all.

Due to the lack of statistically significant differences, no inferences concerning the relationships between the use of occupant restraints or wheelchair securement systems and the occurrence of an injury due to a motor vehicle crash can be made. The above percentages only provide a description of such events and the corresponding safety device usage.

2.8.4. Injuries as a Result of a Non-Crash Incident

An examination of the occupant restraint and wheelchair securement use was done for both those individuals who were and who were not injured in a non-crash type incident. The findings showed no significant differences for all transportation modes. For those individuals who reported driver, private vehicle passenger, bus passenger or paratransit passenger as their primary means of transportation, their chance of a non-crash related injury did not change regardless of whether they were using an occupant restraint or wheelchair securement system.

Also, analysis of those requiring medical attention due to a non-crash injury, and the use of both occupant restraints and wheelchair securement devices was completed. Again, no

statistical differences were evident. For those individuals who did require medical attention, 55.6% reported to not using any form of occupant restraint, while 44.4% reported to using a lap belt anchored to the wheelchair. Similar percentages were seen concerning the analysis of wheelchair securement use. Again, 55.6% of those individuals seeking medical attention, reported to not using any form of wheelchair securement, while 44.4% of those seeking medical attention reported to using a 4-point tie down system.

Table 5: Significant Findings in Regard to a Motor Vehicle Injury and the Use of WTORS

	Injured in a Motor Vehicle Crash	Crash Injury Requiring Medical Attention	Injured in a Non-Crash Incident	Non-Crash Injury Requiring Medical Attention
Occupant Restraint Use				
Yes				
No				
Wheelchair Securement Use				
Yes				
No				

Note: Blank cells indicate that a non-significant finding was identified, thus showing that there were no statistically significant results

2.8.5. Description of Motor Vehicle Incidents and Related Injuries

A total of 19 incidents, both crash and non-crash, occurred where the injury acquired was severe enough to require medical attention. Due to the small sample size, two tables were created to describe the *person*, *environment* and *injury* characteristics of each incident, both crash (see table 2) and non-crash (see table 3). The *person* description encompasses characteristics of the individual subject, including the disability type, gender, age, and position in vehicle (driver or passenger). The *environmental* description, provides a picture of the circumstances surrounding the actual incident, and included specifics in regard to the wheelchair, vehicle, and use of occupant restraints and wheelchair securement. Finally, the description of the *injury*, gives the

reader a better picture of the type and severity of the injury. All of the above variables are important in gaining an understanding of the adverse events reported by the subjects.

2.8.5.1. Overall Description of Crashes Requiring Medical Attention

Ten of the 19 (52.6%) injuries requiring medical attention occurred because of a motor vehicle crash. When examining those 10 crashes more closely, gender was evenly distributed and most subjects fell into the middle-age range, with the exception of a 12 year-old female. There was a high percentage of individuals with quadriplegia (60%) injured in a motor vehicle crash, and an interesting finding shows that all drivers experiencing injuries requiring medical attention were diagnosed with quadriplegia. Also, while there was an even distribution of crashes requiring medical attention between private and paratransit vehicles, there were no bus related crashes requiring the same.

In regard to occupant restraint and wheelchair securement use, most individuals (70.0%) reported to using both at the time of the crash. Concerning the most severe injuries (based on the number of days required off of work or school), the individual who reported contusions on the head and leg, and required 210 days off, was only wearing an occupant restraint at the time of the crash. Another individual who reported a hip fracture and required 25 days off, only reported the use of a wheelchair securement device. The mean days required off of work and/or school for individuals injured and requiring medical attention in a motor vehicle crash was 24.7 ± (65.6) days. Based on these results and Table 2, it is evident that the days required off were highly skewed.

Table 6: Overall Description of Crashes Requiring Medical Attention

	PERSON				ENVIRONMENT						INJURY		
ID #	**Disability**	**Gender**	**Age (yrs)**	**Driver or Passenger**	**Secure-ment Use**	**Occupant Restraint Use**	**Wheel-chair Type**	**Vehicle Type**	**# of Vehicles Involved**	**Vehicle Towed**	**Body Part Injured**	**Injury Type**	**Days Off**
1	Quad	Male	44	Driver	X	X	Manual	Private	2		Neck & Hands	Whiplash	0
2	Quad	Male	44	Driver	X	X	Manual	Private	2	X	Abdomen & Neck	Whiplash	4
3	Quad	Female	34	Passenger		X	Power	Private	1	X	Head & Leg	Contusion	210
4	Quad	Male	56	Passenger	X	X	Power	Private	2	X	Head	Head Trauma & Abrasions	7
5	Quad	Female	63	Driver	X	X	Power	Private	1	X	Face	Abrasions	0
6	CP	Female	33	Passenger	X	X	Manual	Para-transit	2		Ankle	Fracture	0
7	MS	Female	46	Passenger			Manual	Para-transit	Missing	Missing	Face	Contusion	0
8	Spina Bifida	Male	30	Passenger	X	X	Manual	Para-transit	1	X	Upper Back	Whiplash	1
9	CP	Female	12	Passenger	X		Power	Para-transit	2	X	Hip	Fracture	25
10	Quad	Male	55	Driver	X	X	Manual	Para-transit	1	X	Head	Fractures & Contution	0

X = Yes

Overall Description of Non-Crash Injuries Requiring Medical Attention

In regard to non-crash incidents resulting in an injury requiring medical attention, the sample population reported 9 events. A further examination of these events showed that there was great variation among disability types and while all fell into the middle age range, more females (66.7%) were injured and required medical attention. Also, in regard to transportation mode, most of the incidents (n=6) involved a paratransit vehicle, 2 involved a mass transit bus and only 1 involved a private vehicle. It should be noted, however, that no wheelchair-seated driver experienced a non-crash injury severe enough to require medical attention.

Only one individual in this situation reported the use of both an occupant restraint and a wheelchair securement device. Three subjects reported the use of only a securement system, 3 reported only the use of an occupant restraint, anchored to the wheelchair and 2 reported to not using any safety device at all. In regard to the most severe injuries (based on the number of days required off of work or school), one individual reported a dislocated shoulder and an injury to the head, required nearly a year (360 days) off of work or school. This individual reported that he/she was not using any form of occupant restraint or wheelchair securement. Another individual who required 90 days off and reported internal injuries to the abdomen and contusions to the leg, reported only the use of an occupant restraint (lap belt) anchored to the wheelchair. The mean days required off of work and/or school for individuals injured and requiring medical attention due to a non-crash event was 57.1 ± (126.3) days. Again, based on these results and Table 2, it is evident that the days required off were highly skewed.

Table 7: Overall Description of Non-Crash Injuries Requiring Medical Attention

PERSON					INJURY						
ID #	**Disability**	**Gender**	**Age (yrs.)**	**Driver or Passenger**	**Securement Use**	**Occupant Restraint Use**	**Wheelchair Type**	**Vehicle Type**	**Body Parts Injured**	**Injury Type**	**Days Off**
1	Amputee	Male	48	Passenger	X		Manual	Paratransit	Ribs & Thigh	Fractures & Contusion	0
2	TBI	Male	39	Passenger			Manual	Paratransit	Face & Head	Abrasions & Swelling	2
3	Degenerative Bone Disease	Female	53	Passenger	X	X	Power	Paratransit	Chest & Ribs	Contusion	0
4	CP	Female	33	Passenger		X	Power	Paratransit	Abdomen & Leg	- Internal Injuries & Contusion	90
5	MS	Female	51	Passenger			Power	Paratransit	Shoulder & Head	- Dislocation	360
6	TBI	Male	39	Passenger		X	Manual	Paratransit	Face	Abrasions	1
7	Quad	Female	52	Passenger	X		Power	Private	Left Ankle	Fractures	Missing
8	MS	Female	39	Passenger	X		Power	Bus	Knee & Hip	Contusions	1
9	Para	Female	50	Passenger			Manual	Bus	Head, Arm & Leg	Head Trauma, Sprain & Contusion	3

X = Yes

3. DISCUSSION

This study was designed to describe the characteristics of wheelchair users in regard to motor vehicle transportation use, as well as the use of wheelchair securement and occupant restraint devices, and their impact on the occurrence of motor vehicle related injuries. While limited significant differences were found within the results of this research, several points of interest and trends should be brought to attention. Key findings from this study include:

1) Traveling as a private vehicle passenger was the most utilized mode of motor vehicle transportation, with 70.2% of the sample population reporting that they have traveled in this manner within the past month and 50.0% reporting this as their primary mode of transportation.
2) The independent use of occupant restraints and wheelchair securement systems was high among this sample population. Reported use of occupant restraint use is as follows: primary driver: 93.5%, primary private vehicle passenger: 84.5%, primary mass transit bus passengers: 72.7% and primary paratransit passengers: 94.6%. In regard to wheelchair securement systems, the following was shown: primary driver: 100.0%, primary private vehicle passenger: 86.4%, primary mass transit bus passengers: 72.7% and primary paratransit passengers: 100.0%.
3) There were limited significant differences in regard to subject's gender, age, disability or wheelchair type and the reported use of an occupant restraint device *(exceptions: individuals with quadriplegia who primarily drive are significantly more likely (p=0.03) to use an occupant restraint device; and individuals with cerebral palsy who primarily*

travel as paratransit passengers are significantly more likely (p=0.04) to use an occupant restraint device).

4) There was no significant difference in regard to subject's gender, age, disability or wheelchair type and the reported use of a wheelchair securement system.
5) There was no significant difference seen in regard to the use of either an occupant restraint device or wheelchair securement system and the self-reported occurrence or severity of a motor vehicle crash related injury.
6) There were no significant differences seen in regard to the use of either an occupant restraint device or wheelchair securement system and the self-reported occurrence of an injury caused by an emergency (non-crash) maneuver.
7) There was no significant difference seen in regard to the use of either an occupant restraint device or wheelchair securement system and the self-reported need to seek medical assistance due to an emergency (non-crash) maneuver.

3.1. OCCUPANT RESTRAINT USE

Findings show that, aside from individuals with quadriplegia, who drive and paratransit passengers with cerebral palsy, no one particular group of wheelchair users, in regard to gender, age, disability or wheelchair type, is significantly more likely to use an occupant restraint device, over another. Individuals with quadriplegia were significantly more likely (p=.033) to use some form of occupant restraint. This may be explained by the fact that persons with quadriplegia may be more likely to be accompanied by a personal care attendant or other individual, who would implement the use of the occupant restraint system. Another reason may be the idea that a

person with quadriplegia may already have an occupant restraint device integrated within their wheelchair or seating system.

A high compliance of occupant restraint usage was seen within this sample population (driver: 93.5%, private passenger: 84.5%. public bus: 72.7%, paratransit: 94.6%). With these percentages, it is obvious that only a small portion of the subjects reported to typically not using any form of occupant restraint in each of the transportation modes. If the sample population consisted of more individuals who did not use these devices, we would have a better understanding of the user characteristics and injury incidence of these individuals, and would have a stronger statistical comparison between those persons who did and did not use occupant restraints while in a motor vehicle. With this comparison, results may have differed.

This confusion between the definition of what is actually considered to be a wheelchair integrated occupant restraint, and what is only a postural support belt may also account for the high compliance with the use of these systems. The survey design of this study does not specify the anchor point (e.g. vehicle, wheelchair, wheelchair tiedown system) of the occupant restraint belts for those individuals who travel primarily as private vehicle, bus or paratransit passengers. This may have caused confusion concerning the definition of what is actually considered an occupant restraint. With this limitation, subjects may have considered belts used solely for pelvic or chest support, which are attached directly to the wheelchair, as actual occupant restraints. The SAE J2249 standard (1996) states that occupant restraints should include both pelvic and upper torso restraints, and that the restraints may be anchored directly to the vehicle, to the components of the wheelchair tiedown, or to the tiedown components attached to the wheelchair. Two studies have advocated the use of integrated occupant restraints (Bertocci et al,

2000; and VanRoosmale et al, 2001), however, this recommendation is based on the condition that the integrated occupant restraints be anchored to a WC-19 compliant wheelchair.

However, it should be noted that it was not possible to determine whether the subject's reported belt use was actually anchored to a WC-19 compliant wheelchair, indicating that it was used properly, if the belt was only designed as a postural support device, or if it was used properly (e.g. correct location across the body, correct anchor point location). The actual amount of incorrect usage is unknown, however if existing, may provide a possible explanation for the non-significant results found to exist between the use of occupant restraints and the occurrence of motor vehicle related injuries.

When comparing the use of occupant restraint of the entire population to the reported use of this sample population (see previous paragraph), it is observed that wheelchair-seated travelers report higher use of occupant restraints. A study by the National Highway Traffic Safety Administration (NHTSA, 2005), completed random observation of 52,000 non-wheelchair seated motorists in 2004, located both in the front and rear seats of private motor vehicles, for the use of occupant restraints. The NHTSA data show that 80.0% of the sampled population seated in the front seat were using an occupant restraint, while 47.0% of those seated in a rear seat were seen doing the same.

3.2. WHEELCHAIR SECUREMENT USE

As similar to the use of occupant restraint devices, there was a high compliance with the usage of wheelchair securement systems (driver: 100.0%, private passenger: 86.4%. public bus: 72.7%, paratransit: 100.0%). Again, this indicates a low percentage of individuals who reported to typically not using any form of wheelchair securement. With a higher number of non-users in

the sample it would have been possible to make a stronger statistical comparison between those individuals who did and did not use wheelchair securement and the user characteristics and injury incidence. With this comparison, results may have differed.

When discussing the use of wheelchair securement, one finding that stands out is the fact that all primary wheelchair-seated drivers, within this sample, reported the use of a wheelchair securement device. Of those drivers (n=31), only one reported the use of a 4-point tiedown system, while all others reported the use of an automated docking system. This finding may be explained by motor vehicle modification. Some extent of vehicle modification is required to allow for individuals to drive from their wheelchair. A study by the National Highway Traffic Safety Administration (2002), examined the safety issues involved with adapted vehicles, and found that the majority (71%) of vehicles were adapted for driver use.

Similarly to the primary driver statistic, we also found that all primary paratransit passengers (n=56) reported the use of a wheelchair securement device. Ninety-six percent of primary paratransit passengers stated that they generally use a 4-point tiedown system. Again, this may be a function of the vehicle and the type of wheelchair securement devices that are typically installed. A study completed by the National Center for Transit Research (2002) surveyed transit agencies in Florida, many of which provide paratransit services. This study found that 94% of the agencies typically use a 4-point tiedown system. This number is congruent with the high percentage (96%) of paratransit users who reported the use of a 4-point tiedown system within our study.

As comparable to the use of occupant restraints, the sample population shows no difference, in regard to gender, age, disability or wheelchair type and the use of wheelchair securement devices, however some non-significant trends were observed. For those individuals

who primarily traveled as a private vehicle passenger, disability type did have some effect on the use of securement. Individuals with quadriplegia (79.4%), muscular dystrophy (78.9%) and spina bifida (66.7%), tended to use a wheelchair securement device less than all other disability types. This again may be due to the functional limitations of these individuals and their inability to independently engage the systems. Also, in regard to wheelchair type, for both primary private vehicle and mass transit bus passengers, a trend was seen. All manual wheelchair users (100.0%), in both transportation modes, reported that they generally use some form of wheelchair securement, whereas, power wheelchair users tended to utilize these systems less (private vehicle passenger: 85.7%, bus passenger: 66.7%). Again, this may be attributed to the functional abilities of the individuals, and the idea that power wheelchair users may have functional limitations that may prohibit them from securing their wheelchair to the vehicle floor independently.

Again, as similar to the reported use of occupant restraints, it was not possible to determine if the wheelchair securement device was used properly. Based on the design and selection of questions asked in the survey, it was not possible to identify how the individuals actually used the different devices. For example, for a subject who reported to typically using a four-point strap type system, it may have been possible that this individual only used 2 of the 4 straps and may have secured the straps to a location on the wheelchair not recommended in the best practice guidelines. The extent to which the occurrence of improper wheelchair securement use existed among this sample population in unknown, however results may have differed if this variable could have been identified.

3.3. MOTOR VEHICLE CRASH INJURIES AND USE OF WTORS

The analysis of these data demonstrate that no significant difference exists between the use of either an occupant restraint device or a wheelchair securement system and the self-reported occurrence or severity of a motor vehicle crash related injury. This can be interpreted by saying that whether a wheelchair-seated driver/passenger uses an occupant restraint or wheelchair securement device or not, there appears to be no difference in injury risk in a motor vehicle crash.

As stated in the results section, 50 individuals (14.9% of the sample population) reported a total of 65 motor vehicle crashes. Of those total crashes, 55 were reported in detail, with only 10 being severe enough to require medical attention. When examining those 10 more closely, only half reported that they required days off of work or school because of the injury. It should also be noted that 32 of the 55 reported crashed involved a completed police report and only 15 of those required the vehicle to be towed from the scene. The minimal number of severe motor vehicle crash related injuries, and the limited number of towed vehicles may suggest two things. First, these findings may suggest that the use of occupant restraints and wheelchair securement devices may provide appropriate injury prevention in the crashes experienced by this sample population. It may also suggest that there were minimal high velocity crashes reported within this survey, and that future research in this area, particularly high velocity motor vehicle crashes may produce differing results.

3.4. NON-CRASH INJURIES AND USE OF WTORS

When examining the difference between those individuals injured in an emergency (non-crash) maneuver, and those not injured, in regard to the use of an occupant restraint and wheelchair securement device, no significant differences were found. For all modes of transportation this can be interpreted by stating that regardless of whether the wheelchair-seated driver/passenger is using an occupant restraint or wheelchair securement device, the injury risk in an emergency maneuver situation is the same.

These results may be a function of the circumstances of the incident. As stated in the results section, 52 subjects reported a total of 105 non-crash incidents. For individuals who remained in their wheelchairs while traveling in a motor vehicle, 71 non-crash incidents were reported in detail in the incident forms. Of those 71 incidents, only 9 required medical assistance. The description of these events demonstrates a high number of minor injuries, and the idea that for these minor injuries the reported use of occupant restraints and wheelchair securement devices may be sufficient motor vehicle safety protection for wheelchair-seated travelers. In the case of the more severe non-crash injuries, requiring medical attention and time off of work or school (n=6), it should be noted that only 1 individual was using a wheelchair securement system at the time of the incident. This finding could possibly suggest that use of wheelchair securement, may decrease the number of severe non-crash related injuries. However, based on the descriptive nature of these incidents, this should only be regarded as a preliminary conclusion. This suggestion is supported by work completed by VanRoosmalen, Bertocci and Herring (2003) which investigated the wheelchair-occupant response to emergency maneuvers in less than optimal wheelchair securement conditions. It was determined based on computer model simulation that unsecured, unbelted wheelchair occupants may be at a higher injury risk in

non-crash incidents, and that there is a need for proper wheelchair securement and occupant restraints in these situations.

3.5. SAMPLE POPULATION

While research in this area is limited, some demographic statistics of this sample, do differ from other reports of wheeled mobility device users. The sample population participating in this research study is described as 46.7% male, with 6.9% of the subjects falling into the under 18 age category, 22.4% between the ages of 19 and 34, 35.6% between the ages of 35 and 49, 29.3% between the ages of 50 and 64 and only 6.7% above the age of 65. Also, it was reported that 66.7% of the population uses a power wheelchair, while only 33.3% reported to using a manual wheelchair.

Similar to this study, Kaye (2000) reported that in regard to gender, fewer males reported to using wheelchairs, with the rate of 5.5 per 1,000 for male users and 7 per 1,000 for females. However, differences were seen between the ages and wheelchair types of the subjects. It was reported by Kaye (2000) that users of wheeled mobility devices are slightly more likely to be elderly, with 55.6% of the entire population over the age of 65. In regard to wheelchair type, only 9.0% of the population sampled, reported to using a power wheelchair, while the remaining reported to using a manual.

The discrepancies seen between these two reports of wheeled mobility devices might be explained by several different reasons. The first being the limited amount of research completed within this area. It is not clear what the population characteristics of permanent wheelchair users are. This study included only those individuals who used a wheelchair as their primary means of

mobility, while Kaye (2000) included all individuals who reported to using such a device, even if it were for only a small amount of time during the day. Another explanation may be the requirement for participants of our study to remain in their wheelchair while in the motor vehicle, rather than transfer to the vehicle seat. This variable was not addressed in the Kaye (2000) study, and may alter the characteristics of the sample populations. These differing inclusion criteria are possible explanations for the discrepancies seen between the two reports and the above variables (gender, age and wheelchair type). It is possible that there are some major differences between those individuals who require the use of a wheelchair for any amount of mobility and those who require it to assist them only when moving longer distances or for greater amounts of time, such as when going through a store or down the street.

Table 8: Differences in Sample Characteristics Between this Study and Kaye (2000)

	This Project	**Kaye (2000)**
Gender		
(% male)	46.7%	41.2%
Age Categories		
0 – 17 yrs.	6.9%	5.2%
18 – 64 yrs.	87.3%	39.2%
65 + yrs.	6.7%	55.6%
Wheelchair Type		
(% manual)	33.3%	83.0%
Disability Type (%)		
Cerebral Vascular Disease/Accidents	3.0%	11.1%
Arthritis	1.8%	13.4%
Multiple Sclerosis	11.1%	5.0%
Amputee	0.9%	3.7%
Paraplegia	9.0%	3.6%
Cerebral Palsy	21.6%	3.1%

This sample population can also be compared to the general population on the basis of crash occurrence and severity. The National Highway Traffic Safety Administration (NHTSA) compiles motor vehicle crash data from the Fatality Analysis Reporting System (FARS) and the General Estimates Systems every year into a Traffic Safety Facts Report. This report (NHTSA,

2005) showed that 6.3% of the general population has experienced a motor vehicle crash within the past three years, requiring the completion of a police report, whereas 9.5% of our sample population has experienced the same. Also, between the years of 2001-2003, this document reported a total of 18,967,000 police reported crashes. Of those total reported crashes, 30.9% (n=5,857,000) resulted in a non-fatal injury. For our study, there were 32 police reported crashes, of which 14 or 43.8% resulted in a non-fatal injury. In comparison, these results show that our population has a slightly higher incidence of motor vehicle crashes and a high occurrence of injury causing crashes than the general population.

These findings may be explained by a couple of different reasons. First, the wheelchair using population, who remains in their wheelchair while in a motor vehicle, may be at a higher risk of both crash involvement and/or injury occurrence than the general population, thus warranting the need for increased research and dissemination of information in the area of wheelchair transportation safety. Second, these increased percentages may be a function of the study design, suggesting that individuals who have experiences a motor vehicle crash and/or related injury may be more willing to participate in research focused on wheelchair transportation safety.

3.6. INCREASED USE OF PRIVATE VEHICLES

A key finding in this study shows that private vehicles are the most widely used mode of motor vehicle transportation. Most individuals reported to traveling as a passenger in this mode, with 70.2% of the population riding as a private vehicle passenger within the past month and 50.0% reporting this as their primary mode of transportation. Traveling as a private vehicle driver was

also reported by a large percentage of our sample population, with 28.0% driving within the past month and 22.2% reporting this mode as their primary form of transportation. Combining these percentages shows that 72.2% of the population primarily uses private vehicles, either as a driver or passenger. These findings may suggest that research focused on the privately owned vehicle may be beneficial. This suggestion may also be supported by the work done by Shaw (2003), which showed that mass transit bus crashes are rare events, with fewer fatalities (0.01 per million miles) than private vehicle crashes (0.95 per million miles). Based on our study's data that private vehicles are the most utilized form of transportation and that they have a higher crash and fatality rate than mass transit buses, further research into wheelchair-seated occupant protection is suggested for private vehicles.

3.7. LIMITATIONS

A number of limitations could influence the study findings and should be taken into consideration when interpreting these data. First, these results are based on information provided by a convenience sample of wheelchair users, thus potentially limiting the generalizability of the results. Results taken from a random sample of wheelchair-seated travelers may differ (Gross-Portney & Watkins, 2000). The fact that this study asked subjects to volunteer, may result in bias with respect to their personal transportation experiences. For example, it may be possible that individuals who have experienced a motor vehicle related injury, either due to a crash or non-crash incident, may be more likely to participate in research such as this. Also, a large portion of the recruitment effort was based on internet advertising. This method of recruitment focused the advertising to only those who had access to a computer with internet connection. It

is possible that these individuals may possess different demographic characteristics that may skew the sample population.

The self-report nature of this study may pose a second limitation. Subjects were asked to report on their use of transportation, occupant restraint and wheelchair securement use, as well as any motor vehicle crash or injury related to an emergency within the past three years. This fact may have introduced a recall bias into the findings, however, the extent to which this exists is not clear. Also, it is possible that subjects may have been inclined to answer the "correct or expected" way. For example, the high compliance with the use of occupant restraints and wheelchair securement may have been evident because subjects felt it was the "correct" way to answer.

A third limitation existed within the wording of the occupant restraint question. The question did not specify the actual SAE J2249 definition of an occupant restraint. This standard states that occupant restraint belts must be anchored directly to the vehicle, to the components of the wheelchair tiedown, or to the tiedown components attached to the wheelchair (SAE, 1996). It does not include pelvic or shoulder belts attached directly to the wheelchair and used as postural supports. The wording and lack of definition within the question may have been an area of confusion for the subjects.

Also, this study was limited in its ability to identify the proper usage of these devices, both wheelchair securement and occupant restraint. It may have been possible that a subject who reported to using a specific device, may have in fact been using the device improperly. For example, it is unknown whether the individual, who reported to using a four-point strap type system, was in fact using all four straps of the device and if those straps were anchored to the

correct location on the wheelchair. However, the extent to which improper use actually did occur is unknown.

Finally, the data reflects all non-fatal crash experiences. The number of severe, high-velocity motor vehicle crashes is small in this regard. The impact of the use of wheelchair securement or occupant restraints may be most pronounced in high-velocity crashes.

3.8. FUTURE RESEARCH AND STANDARDS DEVELOPMENT

This work is one of the first attempts to describe the transportation characteristics of wheelchair-seated passengers, as well as a real-world examination of the relationship between the use of occupant restraint and wheelchair securement devices and the occurrence of motor vehicle related injuries. Information found within this study will serve as a foundation for the design of future research in the area of wheelchair transportation safety.

This project is a cross-sectional, convenience sample based study. As stated in the limitations section, this study design may present bias, and could potentially limit the generalizability of the results to the overall wheelchair using population. Further research with a larger sample population may reduce these biases. Also, an increased sample would provide greater numbers of motor vehicle crashes, non-crash incidents and resultant injuries. These greater numbers would allow for more statistical analysis and inferences, in regard to occupant restraint and wheelchair securement use and their effect on motor vehicle related injuries. This increased number of motor vehicle crashes may also capture a greater number of high-velocity crashes, which seem to be lacking in this study.

Also, this paper analyzed the use of the occupant restraint and wheelchair securement device independent of one another. The Recommended Practice SAE J2249 states that the occupant restraint should consist of 3 attachment points, anchored directly to the vehicle, to components of the wheelchair securement system, or to tiedown components fastened to the wheelchair; and that the occupant restraint be used in conjunction with a forward facing wheelchair securement system Therefore, statistical analysis of the occupant restraint and wheelchair securement devices used concurrently, as recommended by SAE J2249, is suggested and may produce different results.

In regard to standards development, this study reinforces the emphasis that the current ANSI/RESNA (2000) standards place on 4-point tiedown and automated docking systems. While the standards state that they apply to all types of WTORS, they specify the use of two primary forms of wheelchair securement; 4-point strap type tiedowns and those that use docking –type systems. Since our research shows that these two types of wheelchair securement devices are the most widely used by this sample population, in all transportation modes (see figure 3), these results support further research and standards development focused on 4-point strap type tiedowns and automated docking systems.

APPENDIX A

Screening Questions

Hello, _[name of potential subject]_____. This is, _[name of investigator]_____, from the University of Pittsburgh working on the project 'Wheelchair Transportation Accident Incident Study'. I would first like to explain to you about the project and would like to ask you some questions to determine if you qualify for the study and to gather some descriptive data regarding your transportation habits. This should take about 15 minutes. Is this a good time for you to talk? _____[answer – if yes, proceed; if no ---- when would be a good time to talk to you? [get information] ' thank you for your time, I will call you back then, goodbye']

This study is interested in identifying and describing injury to wheelchair users during motor vehicle transport. The questions that we will ask you today will determine whether you meet the criteria to take part of our study. Do you have any questions? _____[answer]_____ Great, then let's begin:

1. Are you responding to this study as someone who personally has a disability and makes your own decisions regarding motor vehicle transportation?

   ❑ Yes **If yes, skip to question #2**
   ❑ No

   a. If no, are you the parent or legal guardian, making transportation decisions, for an individual with a disability?

      ❑ Yes
      ❑ No **If no, can we speak with this person?** ❑ **Yes** ❑ **No**

   b. If yes, is the individual you care for under 18 years of age?

      ❑ Yes **If yes, skip to Child Survey.**
      ❑ No **If no, skip to Dependent Adult Survey.**

In the following questions, we would like to gain information about you, your experience in riding in motor vehicles and how frequently you use a wheelchair or scooter as a seat in a motor vehicle. This information will help us to determine if you are eligible for an in-depth study of transportation issues among wheelchair and scooter users.

2. Do you use a wheelchair or scooter for primary means of mobility?
   - ❑ Yes
   - ❑ No
   - ❑ Don't know

   a. If yes, do you use a powered or manual wheelchair or scooter?
      - ❑ Manual
      - ❑ Powered
      - ❑ Scooter

3. How long have you used a wheelchair or scooter? _____

4. What type(s) of medical conditions currently limit your mobility and require you to use a wheelchair or scooter?
   _____

5. Gender: ❑ Male ❑ Female

6. In what year were you born? _____

7. On average, about how many days per week do you leave the home for any reason?

   _____ days

8. In general, do you have any difficulties in getting the motor vehicle transportation that is needed?
   - ❑ Yes
   - ❑ No
   - ❑ don't know

   a. If yes, what are these difficulties? _____
      _____

9. About how frequently do you **drive** a car or van or other motor vehicle?

   - ❑ Everyday or almost everyday
   - ❑ Once a week
   - ❑ Occasionally (e.g. less than once a week)
   - ❑ Seldom (e.g. less than once a month)
   - ❑ Never (skip to question # 10)

   a. Approximately how many miles have you **driven** in the past week?

      _____ miles

b. When you **drive**, do you transfer into a motor vehicle seat, or do you use your wheelchair/scooter as the seat? (please refer to the activity you do the majority of the time)

- ❑ I transfer to vehicle seat
- ❑ I use my wheelchair or scooter

c. In the last three years, about how many motor vehicle accidents have you been involved in where you were the **driver**?

_____ accidents

d. In the last three years, about how many times have you been injured in a motor vehicle, where you were the **driver**, and the vehicle did not crash into another motor vehicle or object? (examples: quick braking, sudden turning or rapid acceleration)

_____ injuries

10. About how frequently do you **ride as a passenger** in a **private car or van**?

- ❑ Everyday or almost everyday
- ❑ Once a week
- ❑ Occasionally (e.g. less than once a week)
- ❑ Seldom (e.g. less than once a month)
- ❑ Never (skip to question # 11)

a. About how many miles have you ridden as a passenger in a car or van in the past week?

_____ miles

b. When you ride as a passenger, do you transfer into a motor vehicle seat, or do you use your wheelchair/scooter as the seat? (please refer to the activity you do the majority of the time)

- ❑ I transfer to vehicle seat
- ❑ I use my wheelchair or scooter

c. In the last three years, about how many motor vehicle accidents have you been involved in where you were a passenger in the car or van that crashed?

_____ accidents

d. In the last three years, about how many times have you been injured while you were a **passenger** in a private vehicle, and the vehicle did not crash into another motor vehicle or object? (examples: quick braking, sudden turning or rapid acceleration)

_____ injuries

11. About how frequently do you **ride as a passenger** while using **local public transportation**, such as a public bus line, rapid transit, subway, or street car?

- ❑ Everyday or almost everyday
- ❑ Once a week
- ❑ Occasionally (e.g. less than once a week)
- ❑ Seldom (e.g. less than once a month)
- ❑ Never

a. Approximately, how many miles have you ridden as a passenger in public transportation in the past week?

_____ miles

b. When you ride as a passenger, do you transfer into a motor vehicle seat, or do you use your wheelchair/scooter as the seat? (please refer to the activity you do the majority of the time)

- ❑ I transfer to vehicle seat
- ❑ use my wheelchair or scooter

c. In the last three years, about how many motor vehicle accidents have you been involved in where you were a passenger in the public transportation vehicle that crashed?

_____ accidents

d. In the last three years, about how many times have you been injured while you were a **passenger** in a public transportation vehicle, and the vehicle did not crash into another motor vehicle or object? (examples: quick braking, sudden turning or rapid acceleration)

_____ injuries

APPENDIX B

Wheelchair Transportation Safety Survey

In the following survey, we would like to gain information about:

- The types of motor vehicle transportation that you use
- How often you use each form of transportation (as a driver or passenger)
- If you have been involved in any motor vehicle accidents
- If you have had any injuries related to transportation

Your answers will help us to learn more about transportation safety for wheelchair users.

I. Demographic Information

1. What is your gender? ❑ male ❑ female

2. In what year were you born? _____

3. Are you a United States Veteran? ❑ Yes ❑ No

4. Are you presently going to school? ❑ Yes, full time ❑ Yes, part time ❑ No

   If **yes**, please specify the type of school: _____

5. Are you presently working either full or part time, a homemaker, retired, etc.? (Mark all that apply)

   ❑ working full time
   ❑ working part time
   ❑ homemaker
   ❑ student
   ❑ retired
   ❑ unemployed or looking for work
   ❑ unable to work due to disability

6. If working, what is your current occupation? _____

7. Would you say your health in general is excellent, very good, good, fair, or poor?

   ❑ excellent
   ❑ very good
   ❑ good
   ❑ fair
   ❑ poor
   ❑ don't know

8. What type(s) of medical conditions currently limit your mobility and require you to use a wheelchair or scooter?

_____

_____

II. Your Wheelchair or Mobility Devices

9. What type of wheelchair do you use as your **primary** means of mobility?

- ❑ manual
- ❑ power
- ❑ scooter

10. Make (brand) of your primary wheelchair: _____(Please look for a label on your wheelchair if unsure)

11. Model of your primary wheelchair: _____(Please look for a label on your wheelchair if unsure)

12. Date of receipt of primary wheelchair: _____ (best guess if unknown)
Month / Year

‘

13. On average, how often do you use your wheelchair? _____ hours per day
_____ times per week

14. Overall, about how long have you used a wheelchair or scooter? _____ years.

III. Your Private Vehicle

In the next set of questions, we would like to ask you about the privately owned vehicle that you may use for transportation (whether you drive it or ride as a passenger). Check all that apply.

15. What type of vehicle do you use?

- ❑ car
- ❑ minivan
- ❑ sport utility vehicle
- ❑ motor home or RV
- ❑ pickup truck
- ❑ van
- ❑ heavy truck
- ❑ don’t use private vehicle

16. Do you have any adaptive or special equipment on your car or other motor vehicle?

- ❑ Yes
- ❑ No

a. If yes, what adaptive or special equipment do you have? (mark all that apply)

❑ manual hand controls ❑ foot controls
❑ powered hand controls ❑ lift/ramp
❑ automatic door opener ❑ raised roof / dropped floor
❑ other :

_____

IV. Transportation

In the next set of questions, we would like to ask how often you use various types of motor vehicle transportation. The first questions (#16-23) concern your use as a driver. Later questions (#24-29) ask about how often you ride as a passenger in a motor vehicle.

AS A DRIVER: (If you do not drive, check this box ❑ and skip to question #24)

17. Do you have a current driver's license? ❑ Yes ❑ No

18. Approximately how many miles do you **drive** in a typical month? _____ miles

19. About how long have you been **driving** (while also having a disability)? ____ years

20. When you **drive**, do you transfer to a vehicle seat, or do you use your wheelchair as the seat?

❑ I transfer to vehicle seat ❑ I use my wheelchair

21. On average, about what percentage of the time that you **drive** a motor vehicle, do you remain seated in your wheelchair?

❑ 0% ❑ 30% ❑ 60% ❑ 90%
❑ 10% ❑ 40% ❑ 70% ❑ 100%
❑ 20% ❑ 50% ❑ 80%

22. When you **drive**, do you typically wear safety belts?

❑ Yes, lap and shoulder belt
❑ Yes, lap belt only
❑ Yes, shoulder belt only
❑ No, I don't use a safety belt

a. If you remain seated in a wheelchair, where is the safety belt typically attached?

❒ to the motor vehicle
❒ to your wheelchair
❒ does not apply (I transfer to vehicle seat)

23. When you **drive** and remain seated in a wheelchair, what type of wheelchair securement system do you use in your car or van? *[A wheelchair securement system (or tie-down system) is a system that secures your wheelchair to the vehicle floor during transit]*

- ❑ I don't use a securement system
- ❑ 4-point (strap type) securement system
- ❑ automated docking system
- ❑ wheel rim-pin securement system
- ❑ manual clamps to wheelchair frame
- ❑ other: (please specify) _____
- ❑ does not apply (I transfer to vehicle seat)

AS A PASSENGER:

24. In the past week, about how many times did you **ride as a passenger**:

a. in your car or van?	____ times	❑ none	❑ don't know
b. in a public bus?	____ times	❑ none	❑ don't know
c. in a taxi?	____ times	❑ none	❑ don't know
d. in a subway?	____ times	❑ none	❑ don't know
e. on some other rail system?	____ times	❑ none	❑ don't know
f. in a paratransit vehicle? *	____ times	❑ none	❑ don't know

*** Note:** Some communities have special bus, or van services for people. A paratransit vehicle is a van, minivan, or small bus that provides door-to-door service on request.

25. In the past week, about how many miles did you **ride as a passenger** in the following vehicles?

a. car or van?	____ miles	❑ don't know
b. a public bus?	____ miles	❑ don't know
c. a taxi?	____ miles	❑ don't know
d. a subway?	____ miles	❑ don't know
e. another rail system?	____ miles	❑ don't know
f. a paratransit vehicle?	____ miles	❑ don't know

26. In general, when you **ride as a passenger** in the following vehicles, do you transfer to a vehicle seat or remain seated in your wheelchair?

	transfer to vehicle seat	use my wheelchair	does not apply
a. while in private car or van?	❑	❑	❑
b. while in a public bus?	❑	❑	❑
c. while in a taxi?	❑	❑	❑
d. while on a subway?	❑	❑	❑
e. while on another rail system?	❑	❑	❑
f. while in a paratransit vehicle?	❑	❑	❑

27. When you ride as a passenger in a motor vehicle, about what percentage of the time do you remain seated in your wheelchair?

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	Does not apply
a. private car or van?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
b. public bus?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
c. taxi?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
d. subway?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
e. another rail system?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
f. a paratransit vehicle?	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

28. When you **ride as a passenger** in a vehicle, do you typically wear safety belts? (If yes, please mark the type of belts you use)

	I don't wear belts	lap belts only	shoulder belts only	lap and shoulder belts	no belt available	don't use vehicle
a. private car or van:	❑	❑	❑	❑	❑	❑
b. public bus:	❑	❑	❑	❑	❑	❑
c. taxi:	❑	❑	❑	❑	❑	❑
d. subway:	❑	❑	❑	❑	❑	❑
e. another rail system:	❑	❑	❑	❑	❑	❑
f. paratransit vehicle:	❑	❑	❑	❑	❑	❑

29. When you **ride as a passenger** in a vehicle, do you use a wheelchair securement system? (If yes, please mark the type of system you use)

	No	4-point (strap-type)	automated docking	wheel rim-pin	other system	does not apply
a. private car or van:	❑	❑	❑	❑	❑	❑
b. public bus:	❑	❑	❑	❑	❑	❑
c. taxi:	❑	❑	❑	❑	❑	❑
d. subway:	❑	❑	❑	❑	❑	❑
e. another rail system:	❑	❑	❑	❑	❑	❑
f. paratransit vehicle:	❑	❑	❑	❑	❑	❑

V. Accidents and Injuries in Motor Vehicle Transportation

To begin this section, we would like to ask you about any injuries that you may have gotten in your wheelchair, while loading onto or unloading from a vehicle.

30. In the last three years, have you ever been injured while loading onto or off of a motor vehicle?

❑ Yes a. If yes, how many times did this occur? _____ times
❑ No

If no, continue to question 33.

31. If you were injured while loading or unloading:

a. How did the injury (injuries) happen:

	Injury 1	Injury 2	Injury 3
-loading onto the vehicle on a lift	❑	❑	❑
-loading onto the vehicle on a ramp	❑	❑	❑
-unloading from the vehicle on a lift	❑	❑	❑
-unloading from the vehicle on a ramp	❑	❑	❑
-other:	❑	❑	❑

Please describe _____
_____

32. What type of vehicle was involved in this incident?

		Injury 1	Injury 2	Injury 3
a.	a family vehicle	❑	❑	❑
b.	a public or institution van	❑	❑	❑
c.	a city bus	❑	❑	❑
d.	a train, subway or other rail system	❑	❑	❑
e.	a paratransit vehicle	❑	❑	❑
f.	other: _____	❑	❑	❑

****Next, we would like to ask you about any accidents you may have been involved in while driving or riding as a passenger in a motor vehicle****

AS A DRIVER: (If you do not drive, check this box ❑ and skip to question #34)

33. In the last three years, were you involved in any motor vehicle accidents where you were the **driver** in a vehicle that crashed?

❑ Yes a. If yes, how many times did this occur? _____ times
❑ No

AS A PASSENGER:

34. In the last three years, were you involved in any motor vehicle accidents where you were a **passenger** in the vehicle that crashed?

- ❑ Yes a. If yes, how many times did this occur? _____ times
- ❑ No

****In the next question, we would like to ask you about any injuries that you may have gotten while in a motor vehicle, but the vehicle did not crash. This would include scenarios where you became injured because of quick braking, sudden turning, or rapid acceleration. You may have been either a driver of the vehicle or a passenger riding in the vehicle when this happened.****

35. In the last three years, have you been injured **while driving or riding as a passenger** in a motor vehicle (and the vehicle did not crash into another vehicle or object)?

- ❑ Yes a. If yes, how many times did this occur? _____ times
- ❑ No

<u>If you answered 'yes' to questions 33, 34 or 35</u>, please answer the questions on the attached INCIDENT FORM(S), on the next set of pages. If you were not involved in any accidents, or did not have any injuries while riding in a motor vehicle, then you are finished with this survey.

Incident Form A

The following questions pertain to the accidents and/or injuries that affected you within the last 3 years. We would like to ask you here about the specific details of these events.

In questions 33-35, you identified that you were involved in an accident or had an injury in a non-crash scenario. Please describe the details of the **first accident or incident** here.

A1. What type of incident were you involved in?

- ❑ a motor vehicle accident
- ❑ an injury occurring while seated in a motor vehicle (and the vehicle did not crash)

A2. What was the approximate date of this incident? _____ / _____ / _____
[Fill in any information you can remember] *Month* *Day* *Year*

A3. Were you driving or riding as a passenger in this incident?
- ❑ driver
- ❑ passenger

A4. What type of vehicle were you driving or riding in at the time of this incident?

- ❑ a family vehicle
- ❑ a public or institution van
- ❑ a city bus
- ❑ a train, subway or other rail system
- ❑ a paratransit vehicle
- ❑ other: _____

A5. In this incident were you seated in a vehicle seat or your wheelchair?

- ❑ vehicle seat
- ❑ wheelchair

A6. Which direction were you facing in the vehicle?

- ❑ I was facing forward
- ❑ I was facing sideways toward the aisle
- ❑ I was facing rearward

A7. What type of wheelchair were you using at the time of this incident?

- ❑ manual
- ❑ powered
- ❑ scooter
- ❑ not seated in wheelchair

A8. In this crash, were you wearing a seat belt?

- ❑ Yes, lap belt anchored to chair
- ❑ Yes, lap belt anchored to vehicle
- ❑ Yes, shoulder belt anchored to chair
- ❑ Yes, shoulder belt anchored to vehicle
- ❑ Yes, lap & shoulder belt, anchored to chair
- ❑ Yes, lap & shoulder belt, anchored to vehicle
- ❑ No seat belt worn

A9. If you were in your wheelchair, was the wheelchair tied-down (secured) to the vehicle?

- ❑ Not secured
- ❑ Secured with a 4-point system
- ❑ Secured with an automated docking system
- ❑ Secured with a wheel rim-pin system
- ❑ Secured with a manual clamp system
- ❑ I don't remember how my wheelchair was secured
- ❑ Does not apply

A10. Were you injured in this incident? ❑ Yes ❑ No

a. If yes, what part of your body was hurt? _____

b. What kind of injury was it? _____

c. Did you seek medical attention for your injuries? ❑ Yes ❑ No

d. About how many days did the accident keep you from attending work or school? _____ days

A11. If you were involved in an accident:

a. What type of crash was this? ❑ single vehicle
❑ 2 or more vehicles

b. Did the police record the details of the crash? ❑ Yes ❑ No

c. Was a vehicle towed from the scene of the crash? ❑ Yes ❑ No

d. How would you describe the general cause for the crash and which direction was the impact from (e.g. front of your car hit another object, another object hit back of your car)?

_____

_____

A12. If you were injured in an incident where the vehicle did not crash:

a. How did the injury happen: (mark all that apply)

- ❑ the wheelchair tipped
- ❑ seat belt failed
- ❑ the wheelchair securement failed
- ❑ the vehicle suddenly accelerated
- ❑ normal vehicle driving
- ❑ the vehicle stopped abruptly
- ❑ the vehicle turned suddenly
- ❑ I fell from the wheelchair
- ❑ other: _____

Medical and Police Records

In many incidents, the police often fill out a report that details the circumstances of the accident. If applicable, we would like to obtain a copy of the accident report to identify more details about the crash mentioned above. We would also like to obtain a copy of the medical records related to the treatment of the injuries listed above to identify the medical severity of the injury.

A13. May we obtain a copy of the accident report for the crash that you described here?

- ❑ Yes
- ❑ No
- ❑ Not involved in a crash

a. If yes, where did the crash occur? City: _____ State: _____

A14. May we obtain a copy of the medical records for the injuries you described here?

- ❑ Yes
- ❑ No
- ❑ Not injured

a. If yes, where were you seen for the treatment of the injury?

Place (where treated): _____
Address: _____
_____

Please remember to complete and sign the driving record and medical release forms at the end of this survey. These are the actual forms that we will send to the authorities to request the records. They will not release any information without your signed authorization.

If you were involved in more than one accident or incident, please complete Incident Form B to describe the circumstances of the second event.

Incident Form B

The following questions pertain to the accidents and/or injuries that affected you within the last 3 years. We would like to ask you here about the specific details of these accidents and injuries.

In questions 33-35, you identified that you were involved in more than one accident or injury. Please describe the details of the **second accident or incident** here.

B1. What type of incident were you involved in?

- ❑ a motor vehicle accident
- ❑ an injury occurring while seated in a motor vehicle (and the vehicle did not crash)

B2. What was the approximate date of this incident? _____ / _____ / _____
[Fill in any information you can remember] *Month* *Day* *Year*

B3. Were you driving or riding as a passenger in this incident?
- ❑ driver
- ❑ passenger

B4. What type of vehicle were you driving or riding in at the time of this incident?

- ❑ a family vehicle
- ❑ a public or institution van
- ❑ a city bus
- ❑ a train, subway or other rail system
- ❑ a paratransit vehicle
- ❑ other: _____

B5. In this incident were you seated in a vehicle seat or your wheelchair?

- ❑ vehicle seat
- ❑ wheelchair

B6. Which direction were you facing in the vehicle?

- ❑ I was facing forward
- ❑ I was facing sideways toward the aisle
- ❑ I was facing rearward

B7. What type of wheelchair were you using at the time of this incident?

- ❑ manual
- ❑ powered
- ❑ scooter
- ❑ not seated in wheelchair

B8. In this crash, were you wearing a seat belt?

- ❑ Yes, lap belt anchored to chair
- ❑ Yes, lap belt anchored to vehicle
- ❑ Yes, shoulder belt anchored to chair
- ❑ Yes, shoulder belt anchored to vehicle
- ❑ Yes, lap & shoulder belt, anchored to chair
- ❑ Yes, lap & shoulder belt, anchored to vehicle
- ❑ No seat belt worn

B9. If you were in your wheelchair, was the wheelchair tied-down (secured) to the vehicle?

- ❑ Not secured
- ❑ Secured with a 4-point system
- ❑ Secured with an automated docking system
- ❑ Secured with a wheel rim-pin system
- ❑ Secured with a manual clamp system
- ❑ I don't remember how my wheelchair was secured
- ❑ Does not apply

B10. Were you injured in this incident? ❑ Yes ❑ No

a. If yes, what part of your body was hurt? _____

b. What kind of injury was it? _____

c. Did you seek medical attention for your injuries? ❑ Yes ❑ No

d. About how many days did the accident keep you from attending work or school? _____ days

B11. If you were involved in an accident:

a. What type of crash was this? ❑ single vehicle ❑ 2 or more vehicles

b. Did the police record the details of the crash? ❑ Yes ❑ No

c. Was a vehicle towed from the scene of the crash? ❑ Yes ❑ No

d. How would you describe the general cause for the crash and which direction was the impact from (e.g. front of your car hit another object, another object hit back of your car)?

_____

_____

B12. If you were injured in an incident where the vehicle did not crash:

a. How did the injury happen: (mark all that apply)

- ❑ the wheelchair tipped
- ❑ seat belt failed
- ❑ the wheelchair securement failed
- ❑ the vehicle suddenly accelerated
- ❑ other:_____
- ❑ normal vehicle driving
- ❑ the vehicle stopped abruptly
- ❑ the vehicle turned suddenly
- ❑ I fell from the wheelchair

Medical and Police Records

In many incidents, the police often fill out a report that details the circumstances of the accident. If applicable, we would like to obtain a copy of the accident report to identify more details about the crash mentioned above. We would also like to obtain a copy of the medical records related to the treatment of the injuries listed above to identify the medical severity of the injury.

B13. May we obtain a copy of the accident report for the crash that you described here?

- ❑ Yes
- ❑ No
- ❑ Not involved in a crash

a. If yes, where did the crash occur? City: _____ State: _____

B14. May we obtain a copy of the medical records for the injuries you described here?

- ❑ Yes
- ❑ No
- ❑ Not injured

a. If yes, where were you seen for the treatment of the injury?

Place (where treated): _____

Address: _____

_____

Please remember to complete and sign the driving record and medical release forms at the end of this survey. These are the actual forms that we will send to the authorities to request the records. They will not release any information without your signed authorization.

If you have any questions on this or other parts of the survey, you may call Thomas Songer, PhD at (412) 648-9296 or Shirley Fitzgerald, PhD at (412) 383-6603. We would be happy to answer any of your questions. Thank you for your participation in this survey.

DRIVING RECORD RELEASE FORM

Your signature on the Driving Record Release Form is requested to obtain additional information relating to any reported crashes. This information will be used in the research study to gain a better understanding of the factors involved in the vehicle crashes reported. Please read the Driving Release Form and complete the Subject Identification portion.

AUTHORIZATION TO RELEASE DRIVING RECORDS

I hereby authorize the release of my driving records and/or the complete record of crash reports to the University of Pittsburgh Wheelchair Transportation Accident Incidence Study. This authorization includes obtaining photocopies and abstracting information from the driving record and related police accident reporting forms. I understand that the information obtained will be used only for the purposes of this research project and will be held in strict confidence.

I understand that furnishing all of the requested information on this form is voluntary. The principal purpose of requesting the information on this form is to legally comply with the request to obtain or send records. I request that this authorization remain in effect unless revoked by the undersigned.

I authorize (state licensing/transportation agency) _____

_____

to disclose to Thomas Songer, PhD, Shirley Fitzgerald, PhD, and the University of Pittsburgh Wheelchair Transportation Accident Incidence Study a complete record of my driving and crash reports. The information will be used for verification of reported crashes and their circumstances. A copy of this authorization will be returned to you.

SUBJECT IDENTIFICATION

The following information is needed to assure accurate identification for retrieving records.

_____ _____

Name (Print Name) Signature Date

_____

Date of Birth

_____

State (where the license was issued)

_____

Driver's License Number

MEDICAL RECORD RELEASE FORM

The attached Medical Release Form is requested to obtain additional information relating to the medical treatment of the injuries you received in motor vehicle transportation. This information will be used by the study to gain a better understanding of the injuries you experienced. Please read the Medical Release Form and complete the Subject Identification portion located at the bottom of this page.

AUTHORIZATION TO RELEASE PATIENT MEDICAL RECORDS

I hereby authorize the release of my medical records to the University of Pittsburgh Wheelchair Transportation Accident Incidence Study. This authorization includes obtaining photocopies and abstracting information from the face sheet, ambulance/EMT report, emergency department report, history and physical examination, progress notes, nursing notes, and laboratory records. I understand that the information obtained will be used only for the purposes of this research project and will be held in strict confidence.

I understand that furnishing all of the requested information on this form is voluntary. The principal purpose of requesting the information on this form is to legally comply with the request to obtain or send medical records. I request that this authorization remain in effect unless revoked by the undersigned.

I authorize (medical agency) _____

_____

to disclose to Thomas Songer, PhD, Shirley Fitzgerald, PhD, and the University of Pittsburgh Wheelchair Transportation Accident Incidence Study a complete record of my medical findings. The information will be used for verification of reported injuries and their circumstances. A copy of this authorization will be returned to you.

SUBJECT IDENTIFICATION

The following information is needed to assure accurate identification for retrieving records.

_____ _____

Name (Print Name) Signature Date

_____

Date of Birth

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