Epidemiology of Booster Seat Misuse in Alberta

By

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

in

Epidemiology

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Abstract

Premature graduation from a booster seat to an adult seat belt places the child at increased risk of injury in the event of a collision, a practice that remains an important public health issue in Canada. Obtaining baseline information that describes the prevalence, nature and determinants of booster seat misuse, as well as the information utilization patterns of parents of booster eligible children is a required first step towards understanding this issue within the Alberta context. Between May 1st and August 31st, 2008 at 67 randomly selected childcare centers in both urban and rural locations, drivers exiting with their children were approached and asked to participate in a parking lot interview and simultaneous in-vehicle restraint inspection. Overall, 31.8% of booster eligible children were improperly restrained. Additionally, 11.4% of booster eligible children were improperly restrained even though they were in the correct seat. While the prevalence of improper seat choice was low as children first became eligible for booster seats (~15%), rates of premature graduation increased to ~50% and higher as the child neared the adult seatbelt transition point boundary of 80lbs. Children at low risk of being seated in the wrong seat included those riding with drivers that were able to successfully recall any child restraint transition point (OR: 0.27; 95%CI: 0.14-0.50; $p<0.0001$), while children at high risk of being seated in wrong seat included those riding in vehicles with three children (OR: 2.67; 95%CI: 1.2-6.06; $p=0.020$). Nearly half of all parents of booster eligible children had used a printed resource or a non-physician health professional to obtain information on child restraints, with the non-physician health professional being the most preferred source overall in the survey. By sex, males both utilized and preferred the use of non-health

professionals to obtain information while females both utilized and preferred the use of non-physician health professionals. The lowest rates of misuse were seen among drivers who had utilized a physician as an information source, who were also among the most underutilized sources in the survey. Drivers able to use their preferred information source exhibited lower rates of booster seat misuse, regardless of which source was used. Efforts must be made to increase awareness of booster seat transition points, of which, enactment of mandatory booster legislation is crucial. Additionally, avenues for parents to consult directly with non-physician health professionals must remain abundant and accessible as this was the most common pathway for obtaining information. Other less common sources must not however, be overlooked, as nearly all sources exhibited the potential to be correlated with proper use as long as it was also preferred by the parent.

Preface

This thesis is presented in a paper based format. An introduction to the project, overview of the subject area and description of the survey rational/objectives is presented in Chapter 1. Chapter 2 presents a literature review of important issues linked to booster seat misuse, trends in reported prevalence and determinants as well as reported patterns of information source utilization. The literature review focuses primarily on booster seats, but other types of motor vehicle child restraints are referenced where relevant. Chapters 3 and 4 were written with the intent that they be independently submitted for publication. Chapter 3 presents information on the prevalence, nature and determinants of booster seat misuse in Alberta, while Chapter 4 presents information on both the patterns of information source utilization and information source preferences of Alberta drivers with booster eligible children in the vehicle. Chapter 5 summarizes the results of the thesis and provides directions for future research and action. Chapter 6 provides supplemental information on sampling methodology and resources used in the survey. This thesis is an original work by Richard Golonka. No part of this thesis has been previously published. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board under the name 'Child Restraint Use Patterns Among Alberta School Children Under the Age of 13 (No. B-091007)', and was approved on Nov 6th, 2007.

Acknowledgements

I would like to express my sincerest thanks to my supervisor, Dr. Don Voaklander; without his expertise, guidance and unwavering patience, completion of this thesis would not have been possible. I would also like to thank committee member Dr. Brian Rowe and external reviewer Dr. Bonnie Dobbs for their invaluable insights and suggestions throughout the review process. This research was funded in its entirety by the Alberta Occupant Restraint Program and the Alberta Center for Injury Control and Research, and I extend my appreciation to these two organizations for providing me with this opportunity.

I would also like to thank my family for the unconditional support they have always given me, throughout my graduate degree and otherwise. Finally, I must express my deepest gratitude to my fiancée and best friend, Lindsay. You believed in me and stood by me with love and encouragement, through both the good times and bad. I could not have done this without you.

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Abbreviations

OR – Odds Ratio

RR – Rate Ratio

aRR – Adjusted Rate Ratio

RFS – Rear-Facing Seat

FFS – Forward-Facing Seat

BS – Booster Seat

SB – Seatbelt

CSS – Child Safety Seat (of any type)

Glossary of Terms

Error – Use of an approved child restraint device in a manner that does not comply with current Transport Canada guidelines and/or manufacturers instruction for the specific seat used. Actions of this type are likely to reduce the protection provided by the car seat in the event of a motor vehicle collision.

Seat choice error – Parent has chosen the wrong seat for the child's age/weight.

Seat installation error – Parent has secured the seat into the vehicle in error.

Seat use error – Parent has secured the child into the seat in error.

Chapter 1

1.0 Introduction

1.1. Overview

For many parents, travel in an automobile with young children is a daily reality. In Alberta, children under the age of nine years are either required or recommended (depending on age and/or weight) to be seated in an approved child restraint device during motor vehicle travel (1). Children transition from a rear-facing seat to a forward-facing seat at one year of age or at least 20lbs (2). Forward-facing seats may used up until 65lbs depending on manufacturer's instructions; however, by Alberta law they must be used until at least 40lbs (1, 2). Once outgrowing the forward-facing seat, children transition to a booster seat. While there is currently no law requiring the use of booster seats in Alberta, it is recommended that they not transition until at least 80lbs (1, 2). Unfortunately, these devices are often used improperly (3-5).Three recent Canadian surveys have investigated the prevalence of booster seat misuse through the use of observational methods; one municipal-level study in Manitoba utilizing in-vehicle roadside inspections and two national studies utilizing roadside observation conducted at numerous sites across Canada (3, 4, 6). While all surveys identified high misuse rates among booster eligible children, none collected detailed information on determinants of booster seat misuse or booster seat information utilization patterns and neither could be considered adequately representative of Alberta (3, 4). This thesis utilized a cross sectional survey design, complete with in-car restraint assessments and simultaneous driver interviews, to describe the prevalence, nature and determinants of booster seat misuse across the entire province of Alberta. Patterns of child restraint information utilization by drivers of booster eligible children will also be presented.

1.2. Statement of the Problem

Alberta exhibits the highest rate of potential years of life lost (PYLL) per 100,000 person years due to injury (both intentional and unintentional) of any province in Canada, and the second highest per-capita injury related health care costs (7). Motor vehicle collisions in Alberta were the leading cause of unintentional injury deaths and 3rd leading cause of unintentional injury hospitalization, accounting for

$306 million in total direct and indirect costs annually (7). Each year Canadian children aged 1-14 years have a 1 in 86,000 risk of death and a 1 in 6,600 risk of being seriously injured as a passenger in a motor vehicle collision (8). Furthermore, motor vehicle collision injuries to occupants have been shown to be more severe than that those resulting from other injury mechanisms (e.g., sport related injury) six months post injury (9). Motor vehicle collisions, and their associated physical and psychological trauma, have been shown to be a cause of chronic widespread pain and other abnormalities of the central nervous system (10). In regards to pediatric motor vehicle collision injures, evidence suggests that there is a high propensity for the development post-traumatic stress syndrome, occurring in 25-30% of children and 15% of their parents (11).

The conceptual model of the Haddon Matrix has been used for more than three decades as a tool for understanding, responding to, and mitigating patterns of injury (12, 13). The Haddon Matrix combines the concepts of Primary, Secondary and Tertiary prevention with the traditional epidemiologic triangle, providing a framework that can both guide injury research and assist with the practical identification of public health interventions (14). The matrix consists of three rows representing different phases in the progression of an injury event (i.e., pre-event, event, and post-event) and four columns representing different factors influencing the event (i.e., host, agent, physical environment, and social environment) (13). Each cell of the matrix then describes the personal, agent dependant, or environmental factors that are relevant within different phases of the injury event. Thoughtful examination of the factors present within each cell can assist in identifying potential strategies to prevent/reduce the occurrence of injury and/or minimize its impact. Of interest to this thesis are injuries to children cased by improper use of a booster seat during a motor vehicle collision. Given this orientation, pre-event includes the time prior to collision occurring, event includes only the instant of the collision itself, and post-event includes the time following the collision. The host in this matrix is the child riding in a motor vehicle and the agent is the vehicle and the energy created within the vehicle as a result of the collision. In terms of the environmental factors within this matrix, the physical environment refers to roadway infrastructure while the cultural norms and

legal landscape surrounding the use of booster seats constitute the social environment. Please see Table 1-1 for a full description of the Haddon matrix for injuries caused by improper booster seat use. The cells most pertinent to this thesis include the pre-event interactions with the host such as the prevalence of proper booster seat use prior to the crash and the pre-event social environment such as existing booster seat laws and norms.

Table 1-1 Haddon Matrix Applied to the Problem of Injuries Caused by Improper Booster Seat use During Motor Vehicle Collisions

Phase	*Host (child in vehicle)*	*Agent (force of collision in vehicle)*	*Physical Environment (roadway infrastructure)*	*Social Environment (laws and norms)*
Pre-event (before collision)	-Educate older children on the importance of using a booster seat, how to use them properly and what the restraint laws/recommendations are. -Educate parents on importance of using a booster seat, how to use them properly and what the restraint laws/recommendations are.	-Crash avoidance systems in vehicles. -Built-in latching systems to enable easy installation. -Vehicle warning signals to alert drivers of child in improper seating position based on weight. -Vehicle warning signals to alert driver of unrestrained passengers. -Vehicle warning signal to alert driver of lack of child restraint used based on weight of passenger. -Automatic deactivation of air bag if a small child is seated in the front seat.	-Proper signage and information to enable drivers to avoid collisions. -Minimal unnecessary roadside distractions. -Proper roadway design to minimize collisions with other vehicles and object. -Appropriate speed limits.	-Enforcement of existing booster seat laws/recommendations. -Strengthening of existing booster seat laws/recommendations. -Awareness campaigns focusing on booster seat recommendations and usage. -Incorporating the requirement for knowledge of all child restraints (including boosters) into existing driver training and healthcare education programs. -Enforcement of speed limits.

Table 1-1 Haddon Matrix Applied to the Problem of Injuries Caused by Improper Booster Seat use During Motor Vehicle Collisions (cont'd)

Phase	*Host (child in vehicle)*	*Agent (force of collision in vehicle)*	*Physical Environment (roadway infrastructure)*	*Social Environment (laws and norms)*
Event (during collision)	-Child seated in the safest location in the vehicle for their age. -Booster seat is used in an age appropriate manner. -Booster seat is used correctly. -Booster seat is not located in the front row, or located in the front row with airbag deactivated.	Safety features to maximize protection of children (both properly and improperly restrained) in the event of a collision. -Properly maintained vehicle components and safety features (i.e. window, brakes, tires etc).	-Presence of guardrails where appropriate. -Absence of unnecessary dangerous objects. -Properly maintained roadway surface.	-Policies to ensure adequate police, fire and emergency services response times in the event of a collision.
Post-event (after collision)	-Education and training for both parents and older children on what to do in the moments immediately following a collision. -Knowledge and familiarity with healthcare system. -Knowledge and familiarity with legal system. -Knowledge and familiarity with available support and rehabilitation programs.	-Automatic contacting of emergency services and law enforcement if a collision is detected.	-Automatic monitoring of roadways to detect collisions, with appropriate notifications to law enforcement and emergency services.	-Prompt fire, police and emergency services response to collisions. -Prompt access to adequate emergency care. -Availability of support and rehabilitation programs.

If properly restrained in a booster seat during a motor vehicle collision, booster eligible children are provided with significantly increased protection from injury and death as well as a reduction in injury severity (15-21). Despite these protective effects, recent Canadian studies suggest that booster seat misuse remains an issue across Canada, with misuse rates in older age groups reaching 60% or higher in some studies (3-6). Additionally, there is evidence of low knowledge of proper child restraint practices in addition to significant differences between self-rated practice and proper practice, a discrepancy which is highest among booster eligible children (5, 22). To date, there has been no provincial survey describing the patterns of booster seat use or booster seat information utilization patterns, and Alberta is the only remaining

province in Canada without booster seat legislation. If progress is to be made towards understanding and addressing this issue, baseline information on the prevalence of booster seat misuse, booster seat error patterns, risk factors of booster seat misuse and information utilization preferences by parents of booster eligible children must first be collected.

1.3. Objectives

The goals of this thesis are to: 1) estimate the prevalence of booster seat misuse among booster eligible children in Alberta; 2) describe the nature of observed booster seat errors; 3) identify significant determinants of booster seat misuse; and 4) identify the patterns and preferences related to information source utilization among parents of booster eligible children.

1.4. Significance

This is the first study of its kind in Alberta, and first in Canada to utilize driver interviews and simultaneous restraint inspections at both urban and rural locations across an entire province, factors which offer improvements over prior Canadian surveys (3, 4, 6, 23). Linking driver and vehicle factors collected during interview with the simultaneous booster seat inspection results enables direct comparisons of risk behaviours to restraint practices and produces prevalence estimates that are representative of all children in the vehicle rather than front seat occupants only. Additionally, the sampling methodology ensures that prevalence estimates are provincial in scope, rather than municipal or national. This information can be used to direct future research, guide implementation of awareness campaigns, enhance program delivery models and be used to support the rationale for enactment of booster seat legislation in Alberta.

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Chapter 2

2.0 Review of Literature

2.1. Methods

Literature was identified by searching Medline. Search terms used were booster seat, child restraint, child seat, car seat, premature graduation, seatbelt syndrome, occupant restraint, motor vehicle collision injury, automobile collision injury, motor vehicle crash injury, automobile crash injury, car crash injury, automobile safety and injury, vehicle safety and injury. Overall 1855 articles were identified and 137 met the following criteria: 1) published no earlier than 1997 and 2) article study population spans, in full or in part, children eligible for booster seats. Articles must also contain a discussion of: 1) prevalence of misuse, 2) determinants of misuse, 3) nature of misuse, 4) risk of not using a booster seat, 5) injury prevention capabilities of a booster seat, 6) burden of motor vehicle collision injuries on improperly restrained booster eligible children, 7) effect of booster seat legislation at increasing proper use, 8) program evaluation of successful interventions, 9) booster seat knowledge/awareness or 10) data on booster seat information utilization by parents. Where two articles provided nearly identical information for the purposes of this thesis, articles from the first publishing author were included only. Thus, this is not intended to be an exhaustive literature review on the topic, but rather intended to give a reasonable representation within each subject area of the progression of recent knowledge surrounding the misuse of booster seats. Overall, 41 articles were selected for inclusion into this review, with a preference given to those with data from Canada or the United States. Articles are summarized in text, with data presented table format at the end of each sub-section where indicated.

2.2. Canadian Child Restraint Recommendations

There are three primary categories of child restraints recommended and approved for use in Canada: rear-facing seats (RFS), forward-facing seats (FFS) and booster seats (BS) (1). Transition points (based on child age and weight) between child restraint devices will vary slightly depending manufacturer, leading to a range of

overlapping weight recommendations. For example, depending on the specific seat type, a rear-facing seat may be used for children upwards of 44lbs, a forward-facing seat for children between 22lbs and 65lbs and a booster seat for children between 45lbs and 79lbs (2). It is however not recommended for any child to be restrained in an adult seatbelt until they weigh at least 80lbs (2). Children that are small and/or light for their age are encouraged to remain in each stage as long as possible and to follow the manufacturer's instructions on their specific seat, as this is the safest practice (2).

2.3. Injury Prevention by Booster Seats

The biomechanics of injury prevention by booster seats during a motor vehicle collision follow similar principles as adult seatbelts; the device positions the straps over the areas of the body best able to absorb the forces in a collision (3). The strongest area of the body will vary depending on the age of the child, which necessitates the use of different seats for different age groups. Booster seats are the final stage prior to the adult seatbelt (2). Because of their anatomy, children are still at increased risk of injury if restrained in an adult seatbelt and booster seats are intended for children who have outgrown the forward-facing seat. Booster eligible children have a higher center of gravity and a significantly larger proportion of weight existing above the lap belt relative to adults (4). During a collision, this higher center of gravity causes the child to be inadequately secured to the seat-back, which can result in injures due to striking interior components of the vehicle (4). In children under the age of 10 years, the abdominal organs are also less protected by the rib cage, and the smaller bony pelvis less capable of serving as the seatbelt anchor point as it does in adults (5). In the event of a collision, the adult seatbelt can ride up over the abdomen causing the pelvis to submarine under the lap belt followed by a subsequent hyper-flexion of the spine (5, 6). This can result in abdominal compression injuries and/or spinal fracture, otherwise known as 'seatbelt syndrome' (5-7). Between September 2003 and August 2005, 28 children in Canada were reported to have sustained injuries consistent with seatbelt syndrome; seven of which remained paraplegic (8). Children also frequently place the shoulder strap of an adult seatbelt behind their back or under their arm, increasing the risk of head and neck injuries (9, 10). Booster seats reposition the

height and angle of the adult seatbelt more tightly across the chest and lower on the waist, increasing protection from injury and death as well as reducing injury severity (10-16).

2.4. Utilization of Injury Prevention Information Sources by Parents

Studies designed to investigate the relationship between a specific injury prevention imitative and subsequent improvement in parent knowledge are abundant in the literature, however there are very few studies which have directly approached parents and asked them which information sources work best for them and where they prefer to go to obtain information on child restraints, or injury prevention topics in general. In fact, only three such articles were identified in this search. The first very early study was published by Eichelberger *et al.* in 1990 who utilized telephone survey data to demonstrate that parents worry more about kidnapping and drug abuse than childhood safety (17). When parents did wish to obtain information on injury control or child safety, physicians were cited as the priority choice (17). Through the use of focus groups in 2001 Rivara *et al.* identified that parents believe messages from healthcare providers, emergency medical services or law enforcements were the most effective (18). And in a cross-sectional mail-out survey conducted across Canada designed to assess information support needs of parents of young children, Devoli *et al.* found that car seat safety was considered as 'somewhat important' or 'very important' by 95.8% of respondents, with informal sources such as the internet, drop-in programs, books, organized play groups, classes and information sessions seen as the most preferred modes to access information (19). In summary, data suggest that parents feel health professionals and law enforcement personnel are the most trusted source of child restraint information and may prefer to obtain information through local community programs and events. However, much more research is required in this area.

2.5. Prevalence of Booster Seat Misuse

Eight articles describing the prevalence of child restraint use were selected from the literature, with publication dates ranging from 1997-2014. Understanding

these trends in reported prevalance, along with any remaining knowledge gaps, enables identification of priority areas for future research and intervention. Decina *et al.* in 1997 stratified restraint misuse estimates by weight category and noted that restraint use was lowest (6.1%) among booster aged children, but when a booster seat was used proper use was high (50%) (20). Similar observations were found by Ramsey *et al.* in 2000 where 27.7% of children 4-8 years old attending childcare centers in the state of Washington were using a booster seat, but this dropped to only 10% among 6-8 year olds (21). A subsequent study by Ebel *et al.* conducted across Washington and Oregon published in 2003 demonstrated again low rates of proper use among booster eligible children, at 16.5% , compared to 80% proper use among those eligible for a forward-facing or rear-facing seat (22). More recent studies from the United States continue to confirm these findings. In Michigan in 2005 only 8.6% of booster eligible children were actually seated in a booster seat with the remaining were either seated in a child seat (37.5%), adult seatbelt (48.8%) or completely unrestrained (37.5%) (23). And in Indiana in 2009 at least one misuse was observed in 64.8% of children restrained in a booster seat (24).

An observational study of child restraint use conducted by Transport Canada occurred in 2006 at 182 randomly selected intersections across the country (published by Snowden *et al.* in 2009), showed that 89.9% of children under the age of nine were restrained in some type of restraint, however only 60.5% were deemed to be in an appropriate restraint (25). Among school age children (4-8 years) only 19.6% were correctly seated a booster seat with 63.1% instead seated in an adult seatbelt (25). A study published by Blair et al. in 2008 at 10 inspection sites across the city of Winnipeg, Manitoba showed that 70% of child restraints were installed incorrectly (26). Booster seats however, exhibited the lowest percentage of errors installation errors of all seat types, at 36% (26). And most recently, results from a national comparison of child seat misuse between provinces with different types of legislation showed that correct restraint use among booster eligible children was 52.0% in provinces that were without booster legislation at the time of the survey (i.e. AB, SK, MB, YK and NWT) (27). In summary, while progress has been made over the last fifteen years towards decreasing booster seat misuse, booster eligible children remain

chronically under-restrained compared to younger children in the vehicle. Please see Table 2-1 for a summary of literature pertaining to prevalence of misuse.

Table 2-1 Prevalence Estimates of Booster Seat Misuse

Study	Study Date	Design	Population	Target Group	Percent	Indicator
Decina *et al.* 1997(20)	1995	Child restraint observation and driver interview	15 Shopping centers and malls in Mississippi, Missouri, Pennsylvania and Washington DC	<9kg	96.6%	Restrained in CSS
					20.6%	Restrained properly
				9-18kg	67.5%	Restrained in CSS
					18.9%	Restrained properly
				18-27kg	6.1%	Restrained in CSS
					50%	Restrained properly
				Overall (<27kg)	50.6%	Restrained in CSS
					12.8%	Unrestrained
					36.6%	Restrained in seatbelt
					20.5%	Restrained properly
Ramsey *et al.* 2000(21)	not stated	Child restraint observation and driver interview	13 child-care centers in Washington	2-3years	29.4%	Restrained in booster
				4 years	32.6%	Restrained in booster
				5 years	32.6%	Restrained in booster
				6-8 years	10.0%	Restrained in booster
				Overall (4-9 years)	27.7%	Restrained in booster
Ebel *et al.* 2003(22)	2000	Child restraint observation and driver interview	83 child-care centers in Seattle, Spokane and Portland	eligible for child seat	80%	Restrained properly
				eligible for booster seat	16.5%	Restrained properly
				eligible for seatbelt	55%	Restrained properly
Eby *et al.* 2005(23)	2004	Child restraint observation	Statewide survey at 176 McDonalds, grocery stores and child-care centers in Michigan	4-8 years	5.1%	Restrained in a CSS
					8.6%	Restrained in a booster
					48.8%	Restrained in a seatbelt
					37.5%	Unrestrained

Table 2-1 Prevalence Estimates of Booster Seat Misuse (cont'd)

Study	Study Date	Design	Population	Target Group	Percent	Indicator
Blair *et al* .2008(26)	2004	Child restraint observation	10 roadside observation locations in Winnipeg	Children in booster seats Overall (all seats)	36% 70%	Incorrectly installed Incorrectly installed
O'Neil *et al.* 2009(24)	2006-2007	Child restraint observation and driver interview	25 fast food restaurants and department stores in Indiana	<16 years	64.8%	Restraint errors observed
Snowdon 2009(25)	2006	Child restraint observation	182 randomly chosen sites across Canada	<12 months 1-3 years 4-8 years 9+ years	61.2% 37% 67% 13.3% 13.4% 19.6% 63.1% 90%	Correct seat choice (RFCS) Incorrect seat choice (FFCS) Correct seat choice (FFCS) Incorrect seat choice (booster) Incorrect seat choice (seatbelt) Correct seat choice (booster) Incorrect seat choice (seatbelt) Correct seat choice (seatbelt)
Simniceanu *et al.* 2014(27)	2006/2010	Child restraint observation	196 randomly chosen intersections	4-8 years	54.1% 29.5% 52.0%	New legislation (2006+) Old legislation (pre 2006) No legislation

2.6. Effect of Legislation on the Prevalence of Booster Seat Misuse

In many prevalence studies it is possible to quantitatively assess the impact that laws have had on the prevalence of misuse by either comparing jurisdictions having different legislation or by conducting surveys prior to, and then following, the enactment of legislation. Three articles, published between 2007 and 2012, were selected from the literature that highlighted the impact of legislation on child restraint usage rates. Winston *et al.* in 2007 interviewed parents of children under the age of 16 who were involved in motor vehicle collisions between December 1998 and December 2004 in an attempt to determine the effect of booster seat laws on booster seat usage (28). Children 4-7 years of age involved in collisions were 39% more likely to be reported as appropriately restrained in the states with booster seat legislation (28). In another study investigating the effectiveness of legislation at increasing child restraint use, Sun *et al.* in 2010 identified children 4-6 years of age present in the New York State Accident Information System who were involved in motor vehicle collisions as passengers between 2003 (prior to upgraded child restraint legislation for 4-6 year olds) and 2007 (post legislation) (29). The rate of restraint use among 4-6 year olds increased by 31 percentage points (29% to 50%) following legislation, compared to only 6 percentage points (76% to 84%) for 0-3 years olds who would not have been directly affected by legislation (29). Additionally, the rate of traffic injuries among 4-6 year olds decreased by 18% following implementation of legislation, compared to no significant decrease for children aged 0-3 years (29). Data on the reduction of fatalities was provided by Mannix *et al.* in 2012, who demonstrated that states with booster seat laws exhibited a lower risk of motor vehicle collision fatalities among children 4-7 years of age, with the largest impact seen in 6 year olds and 7 year olds (30). In summary, information suggests that booster seat legislation can significantly increase the proper use of booster seats, along with affecting decreases in pediatric morbidity and mortality. See Table 2-2 for a summary of the presented literature describing the effect of legislation on booster seat misuse motor vehicle collision injuries.

Table 2-2 Effect of Laws on Prevalence of Booster Seat Misuse

Study	Study Date	Design	Population	Intervention	Category	Value
Winston *et al.* 2007(28)	1998-2004	Longitudinal analysis of insurance claim data, validated by telephone survey	Sixteen states and Washington DC	Comparison of appropriately restrained children between states having differing restraint legislation for children under the age of 16.	Use: 4-7 years Use: 4-5 years Use: 6-7 years	RR: 1.39 [95%$_{CI}$: 1.1-1.7] RR: 1.23 [95%$_{CI}$: 0.8-1.4] RR: 2.09 [95%$_{CI}$: 1.5-3.0]
Sun *et al.* 2010(29)	2003-2007	Longitudinal analysis of New York State Accident Information System data pre and post legislation	New York State	Comparison of child restraint usage rates for children aged 0-3 years and 4-6 years before and after implementation of an upgraded child restraint law for children age 4-6 years	**0-3 years** Use: pre legislation Use: post legislation Injury **4-6 years** Use: pre legislation Use: post legislation Injury	 76% 84% aRR: 0.95 [95%$_{CI}$: 0.90-0.99] 29% 50% aRR: 0.82 [95%$_{CI}$: 0.79-0.85]
Mannix *et al.* 2012(30)	1999-2009	Analysis of Fatality Analysis Report System in selected US states	Selected US states	Motor Vehicle Collision fatality rates before and after legislation among states that enacted legislation during the study period.	4-5 years 6 years 7 years	RR: 0.89 [95%$_{CI}$: 0.81-0.99] RR: 0.77 [95%$_{CI}$: 0.65-0.91] RR: 0.75 [95%$_{CI}$: 0.62-0.91]

2.7. Nature of Booster Seat Misuse

In addition to the use of a booster seat where indicated, proper restraint use also requires parents to utilize the components of the seat correctly in accordance with manufacturers' instruction and jurisdictional regulations. Four articles describing the nature of booster seat misuse were selected from the literature to illustrate the common problems parents have with using a booster seat, with publication dates ranging from 1997-2011. A study published by Decina *et al.* in 1997 conducted across four states (Mississippi, Missouri, Pennsylvania and Washington DC) found that 67.6% of booster eligible children between 19kg and 27kg misused the locking clip and 21.7% misused the seatbelt (20). Canadian findings published by Blair *et al.* in 2008 show that most common errors among booster seats were incorrectly used shoulder belts (54%) (26). Additionally, seats requiring immediate replacement (16%) and a lack of head/neck restraints (10%) were also identified (26). Recent data from the United States published by O'Neil *et al.* following booster seat inspections outside of fast-food restaurants in Indiana suggested that common errors in belt positioning boosters seats include: shoulder belt placed over the booster seat armrest (35.8%), shoulder belt not at mid-shoulder position (28.5%), seatbelt loose (24.5%) and having the shoulder belt either behind the child's back or under their arm (10%) (24). Belt positioning problems were further confirmed by Macy *et al.* in 2011 who found that found that 78% of drivers reported improper belt fit for passengers 4-9 years of age, with improper lap belt position (62%) being more common than improper shoulder belt position (44%) (31). In summary, the most significant problem with the use and installation of a booster seat is incorrect positioning of the shoulder strap and lap belt. See Table 2-3 for a summary of the presented literature describing the nature of booster seats misuse.

Table 2-3 Nature of Booster Seat Misuse

Study	Study Date	Design	Population	Target Group	Misuse	Percent error
Decina *et al.* 1997(20)	1995	Child restraint observation and driver interview	15 Shopping centers and malls in Mississippi, Missouri, Pennsylvania and Washington DC	18-27kg	Seatbelt Locking clip	*OF TOTAL* 21.7% 67.6%
Blair *et al.* 2008(26)	2004	Child restraint observation	10 roadside observation locations in Winnipeg	Booster seat	Shoulder belt at wrong level Lack of head/neck protection Require replacement	*OF MISUSED* 54% 10% 16%
O'Neil *et al.* 2009(24)	2006-2007	Child restraint observation and driver interview	25 fast food restaurants and department stores in Indiana	<16 years in Booster seat	Shoulder belt high on shoulder Lap belt not low on hips Shoulder belt guide used wrong Lap belt not under armrest Shoulder belt at wrong level Seatbelt loose Shoulder belt behind back Shoulder belt under arm Inappropriate head support Only lap belt used	*OF TOTAL* 28.5% 13.7% 32.4% 14.2% 35.8% 24.5% 9.1% 10.0% 5.4% 8.2%
Macy *et al.* 2011(31)	2007	Telephone interview	Random digit dialing of 64,193 numbers across the United States	4-9 years in Booster seat	Improper belt fit Improper shoulder belt position Improper lap belt position	78% 44% 62%

2.8. Determinants of Booster Seat Misuse

Identification of risk factors for booster seat misuse is essential for guiding future research and targeted injury prevention programs. Sixteen articles were selected from the literature describing commonly identified determinants of misuse, with publication dates ranging from 1997 to 2012. The most common risk factors identified by this search strategy included: 1) driver seatbelt use (20, 22, 23, 32, 33), 2) level of booster seat awareness (e.g. transition points, laws and norms) (18, 21, 22, 34-37), 3) beliefs regarding the effectiveness of child restraints (18, 22, 34, 36, 38), 4) age of child (21, 22, 33, 39, 40) and 5) the number of children in the vehicle (18, 21, 33, 35, 41). Each of these factors was identified in at least five different studies. Other less commonly identified, but still equally important, determinants of booster seat misuse include perceived inconvenience of installation (34), child resistance (18), negotiability of child restraint use (34, 41), increased frequency of seat removal from the vehicle (20, 22), passenger cars and pickup trucks (23), lower level of driver education (37, 39, 41), drivers over the age of 60 years (23) and a language other than English spoken at home (41). Information on the five most common determinants indicated above are described in more detail in the following section, summarized by risk factor in Table 2-4 and by author/year in Table 2-5.

2.8.1. Driver Seatbelt Usage Behaviours

Decina *et al.* in 1997 found driver seatbelt use to be the strongest positive predictor of child restraint use among children under 60lbs as only 5.4% of children with belted drivers were unrestrained compared to 47.3% of children with unbelted drivers (20). In 2001, Eby *et al.* focused on all children under 15 years of age and demonstrated that driver seatbelt use was identified a positive predictor for all three child restraint types (32). These conclusions were further supported by Ebel *et al.* in 2003, who observed that booster eligible children riding with belted drivers were three times (OR: 3.13; 95%CI: 1.8-5.4) as likely to be properly restrained than children riding with unbelted drivers (22). In 2005 Eby *et al.* published the results of a follow-up study which used similar methodology as their 2001 survey, but this time focusing only on children 4-8 years of age instead of 4-15 years (23). While the positive effect

of driver seatbelt use was still apparent, the prevalence of age appropriate restraint use in the 4-8 year age group in 2005 was much lower than within the expanded 4-15 year age group used in 2001, reaffirming the problems with booster seat use among children aged 4-8 years (23). And in 2012, Macy *et al.* reported that children under the age of 8 were at lower odds of child safety seat use when riding with unrestrained drivers (33). In summary, evidence from the literature indicates that drivers who do not practice regular seatbelt use often place their child occupants at increased risk of injury by failing to properly use child restraints.

2.8.2. Level of Booster Seat Awareness

Awareness of child restraint transition points, laws and norms is also frequently associated with use and misuse. This reason was stated in 45% of improperly restrained children by Ramsey *et al.* in 2000, 56% of errors observed by Ebel *et al.* in 2003¸ and at decreased odds (OR:0.24; p=0.003) among properly restrained children by Bingham *et al.* in 2006 (21, 22, 35). Transition point confusion was associated with improper use by Rivara *et al.* in 2001 and Simpson *et al.* in 2002 observed that parents having a good overall awareness of child passenger safety concepts were also more likely to be proper users (18, 34). Additionally, focus groups conducted by Simpson *et al.* in 2002 indicated that parents believe that some form of child seat education to improve their overall awareness would be useful to them (34). The belief that usage was either not required by law or not enforced was found to be associated with improper use by Bingham *et al.* in 2006 (35). And in 2012, Yanchar *et al.* found that having knowledge of when to graduate from a forward-facing seat to a booster seat was protective against child restraint misuse among children under the age of 12 years (37). In summary, parents that have high awareness of child restraint legislation as well as good general knowledge of booster seats and safety concepts appear less likely to misuse booster seats.

2.8.3. Beliefs Regarding the Effectiveness of Booster Seats

The importance of parent knowledge and education is further supported by studies examining the association between child restraint use and parent beliefs

regarding their effectiveness at preventing injury. Parents who felt that child restraints were ineffective at preventing injuries in the event of a collision were more likely to be using their restraints improperly, and evidenced by Rivara et al. in 2001 (18). Focus groups conducted by Simpson *et al.* indicated that parents who used booster seats were more likely to express concern over the risk of injury in the event of a collision (34). A study by Ebel *et al.* in 2003 presented similar data, that parents who viewed child restraints as safer were more likely to be using booster seats, as were those who expressed generalized concern for their children's safety (22). Results of focus groups conducted by Johnson *et al.* in 2009 indicated that while legislation is important to get parents using a booster seat, the promise of safety and protection was the primary reason families chose to use a booster seat (38). These attitudes towards booster seats as an injury prevention tool were also shown by Bruce *et al.* in 2012 to be the strongest predictor of intent among parents to use a booster seat (36). In summary, parents who recognized safety benefits of booster seats or expressed a higher level of concern regarding the risk of injury, were more likely to be proper users.

2.8.4. Age of Child

To restrain a child properly, parents must choose a seat that is appropriate for the child's age and weight, as well as continually adapt how they secure the child in the vehicle as the child continues to grow. Ramsey *et al.* in 2000 showed that 32.6% of children four years of age were observed in a booster seat compared to only 10% of children 6-8 years of age (21). A significant decrease in the odds of correct child seat choice with increasing age was also observed by Ebel *et al.* in 2003 when comparing eight year olds to four year olds (OR: 0.04; 95%CI: 0.1-0.2) and by Snowden *et al.* in 2008 when comparing 5-8 year olds to children under 6 months (OR: 0.13; 95%CI: 0.1-0.3) (22, 39). And most recently, the results of two separately studies by Macy *et al.* in 2012 both observed an association between younger age among children 4-8 years old and the use of a booster seat (33, 40). In summary, children are more likely to use a booster seat when they are young, with usage rates decreasing as they approach 80lbs and the transition point to an adult seatbelt.

2.8.5. *Number of Children in the Vehicle*

Ramsey *et al.* in 2000 observed that the prevalence of unrestrained children 4-8 years of age increased from 38.3% in two-children vehicles to 75.0% in four-children vehicles (21). While not quantitatively correlated with number of children/occupants, Rivara *et al.* in 2001 described that the presence of older children in the vehicle was associated with booster seat non-use for children 4-8 years old (18). While the presence of older children in the vehicle acted as a predictor of booster seat misuse by Rivara *et al*, the presence of additional booster age children acted to actually decrease the likelihood of misuse in a study by Bingham *et al.* in 2006 (18, 35). And while linked to family size instead of number of children in the vehicle, Bilston *et al.* in 2008 found that children under the age of eleven from families with more than two children were less likely to be properly restrained (OR:0.56; 95%CI: 0.4-0.9) (41). The relationship between multiple children in the vehicle and improper use was again confirmed in a recent study by Macy *et al.*2012, whereby having multiple child passengers in the vehicle increased the odds of being unrestrained (33). In summary, when multiple children are present in the vehicle, especially if these children are older and are not also using a booster seat, the risk of booster seat misuse appears to increase.

Table 2-4 Determinants of Child Restraint Use and Misuse by Type

Factor Category	Study	Factor sub-classification	Proper IMProper	Population
Driver seatbelt use	Decina *et al.* 1997(20)	Driver seatbelt use	P	< 27 kg
	Eby *et al.* 2001(32)	Driver seatbelt use	P	4-15 years
	Ebel *et al.* 2003(22)	Driver seatbelt use	P	Booster eligible children
	Eby *et al.* 2005(23)	Driver seatbelt use	P	4-8 years
	Macy *et al.* 2012(33)	Unrestrained drivers	IMP	<8 years
Child restraint awareness (e.g., transition points, laws and norms)	Ramsey *et al.* 2000(21)	Belief that child was too big for recommended seat	IMP	4-8 years
	Rivara *et al.* 2001(18)	Confusion regarding transition points	IMP	4-8 years
	Simpson *et al.* 2002(34)	High overall awareness	P	Children using boosters
		Child seat education would be useful to me	P	Children using boosters
	Ebel *et al.* 2003(22)	Belief that child was too big for recommended seat	IMP	Booster eligible children
		Had not heard of booster seats	IMP	Booster eligible children
	Bingham *et al.* 2006(35)	Belief that child restraint use is not enforced	IMP	4-8 years
	Yanchar *et al.* 2012(37)	Belief that child is too big for booster seat	IMP	4-8 years
		Belief that child restraint use is not required by law	IMP	4-8 years
		Good knowledge of transition points	IMP	<12 years
		Knowledge of forward-facing to booster transition		
Beliefs regarding the effectiveness and benefits of child restraints	Rivara *et al.* 2001(18)	Ineffective	IMP	4-8 years
	Simpson *et al.* 2002(34)	High concern for possibility of injury	P	4-9 years
	Ebel *et al.* 2003(22)	Thinks booster seats are safer	P	Booster eligible children
	Johnston *et al.* 2009(38)	Overall concern for children safety	P	Booster eligible children
	Bruce *et al.* 2012(36)	Thinks booster are a benefit	P	4-9 years
Age of Child	Ramsey *et al.* 2001(21)	Younger age of child	IP	4-8 years
	Ebel *et al.* 2003(22)	Older age of child	IMP	eligible for booster
	Snowdon *et al.* 2008(39)	Older	IMP	Grade 5 and under
	Macy *et al.* 2012(40)	Younger	P	4-8 years
	Macy *et al.* 2012(33)	Younger	P	<8 years

Table 2-4 Determinants of Child Restraint Use and Misuse by Type (cont'd)

Factor Category	Study	Factor sub-classification	Proper IMProper	Population
Number of children in vehicle	Ramsey *et al.* 2000(21)	More than two children in vehicle	IMP	4-8 years
	Rivara *et al.* 2001(18)	Need to accommodate older children in vehicle	IMP	4-8 years
	Bingham *et al.* 2006(35)	< 1 booster age child in vehicle	IMP	4-8 years
	Bilston *et al.* 2008(41)	More than 2 children in the home	IMP	< 11 years
	Macy *et al.* 2012(33)	Multiple child passengers	IMP	<8 years

Table 2-5 Determinants of Child Restraint Use and Misuse by Author

Study	Study Date	Design	Population	Target	Factors	Proper IMProper
Decina *et al.* 1997(20)	1995	Child restraint observation and driver interview	15 Shopping centers and malls in Mississippi, Missouri, Pennsylvania and Washington DC	<27kg	Driver using seatbelt Driver not using seatbelt Seat infrequently removed	P (5.4% unrestrained) IMP (47.3% unrestrained) P
Ramsey *et al.* 2000(21)	not stated	Child restraint observation and driver interview	13 child-care centers in Washington	4 – 8 years	Younger age (% 4y / % 6-8y) Thought child too big for seat Installation problems 2 children vs. 3 children 2 children vs. 4 children	P (BS use: 32.6% / 10%) IMP (45.7% of errors) IMP (11% of errors) P (unrest.: 38.3% / 58.3%) P (unrest.: 38.3% / 75.0%)
Eby *et al.* 2001(32)	1999	Child restraint observation	Schools, malls, fast-food restaurants, movie theatres, rink and recreation centers in Michigan	4-15 years	Driver belted Sport Utility Vehicles Vans/minivans Front right seating position	P (76.4% use) P (66.0% use) P (73.1% use) P (68.5% use)
Rivara *et al.* 2001(18)	not stated	Focus groups	30 parents in Seattle chosen by a survey research firm	4-8 years	Transition point confusion Legislation Cost Older child peer pressure Older children in vehicle Think lap belts are sufficient Child resistance	IMP P IMP IMP IMP IMP IMP

Table 2-5 Determinants of Child Restraint Use and Misuse by Author (cont'd)

Study	Study Date	Design	Population	Target	Factors	Proper IMProper
Simpson *et al.* 2002(34)	not stated	Focus groups	111 parents in Pennsylvania and New Jersey chosen from a market research database	Children using boosters	High perception of injury risk Good restraint knowledge Parenting education Make seat use required Inconvenient	P P P P IMP
Ebel *et al.* 2003(22)	2000	Child restraint observation and driver interview	83 child-care centers in Seattle, Spokane and Portland	eligible for booster	8 years vs. 4 years Driver belted Think boosters are safer Think seat is comfortable Think child too big Seat in another vehicle Have not heard of boosters	IMP(OR:0.04 [95%$_{CI}$:0.01-0.2]) P (OR: 3.13 [95%$_{CI}$: 1.8-5.4]) P (61% of proper users) P (12% of proper users) IMP (56% of errors) IMP (9% of errors) IMP (8% of errors)
Eby *et al.* 2005(23)	2004	Child restraint observation	Statewide survey at 176 McDonalds, grocery stores and child-care centers in Michigan	4-8 years	Sport utility vehicles Pickup trucks Passenger cars %60+ years / %30 – 59 years %60+ years / %16 – 29 years Driver seatbelt use Driver seatbelt non-use	P (booster seat: 14.1%) IMP (booster seat: 1.7%) IMP (booster seat: 7.9%) IMP (0.6% use/9.1% use) IMP (0.6% use/7.0% use) P (57.7% use) IMP (1.9% use)
Bingham *et al.* 2006(35)	not stated	Randomized household telephone survey	350 households in Michigan	4-8 years	>1 booster age child Think there is no enforcement Belief that child is too big Not required by law	P (OR: 2.2) IMP (OR: 0.12 p=0.77) IMP (OR: 0.24 p=0.003) IMP (OR: 0.09 p=0.003)

Table 2-5 Determinants of Child Restraint Use and Misuse by Author (cont'd)

Study	Study Date	Design	Population	Target	Factors	Proper IMProper
Bilston *et al.* 2008(41)	not stated	Randomized household telephone survey	403 households in New South Wales, Australia	5-8 years	English spoken at home Knows seatbelt transition Child allowed to sit in front	P (OR: 7.59 [95%$_{CI}$: 1.0-56.6]) P (OR:5.55 [95%$_{CI}$: 2.3-13.3]) IMP (OR:0.34 [95%$_{CI}$: 0.2-0.7])
				<11 years	Lower level of education Knows seatbelt transition Knows booster seat transition Restraint use is negotiable More than 2 children in home Child allowed to sit in front	IMP(OR: 0.54[95%$_{CI}$: 0.4-0.8]) P (OR:1.68 [95%$_{CI}$: 1.1-2.6]) P (OR:1.68 [95%$_{CI}$: 1.1-2.6]) IMP (OR:0.47 [95%$_{CI}$: 0.2-0.9]) IMP (OR:0.56 [95%$_{CI}$: 0.4-0.9]) IMP (OR:0.62 [95%$_{CI}$: 0.4-0.9])
Snowdon *et al.* 2008(39)	not stated	Parent interview and driver mail-in questionnaire	1,262 parents and 2,199 children in Southwestern Ontario	pre-kindergarten to grade 5	More than 'some high-school' 5-8 years vs. 6mo.	P (OR:2.12 [95%$_{CI}$: 1.2-3.6]) IMP (OR: 0.13 [95%$_{CI}$: 0.1-0.3)
Johnston *et al.* 2009(38)	not stated	Focus groups	Low-income individuals and recent immigrants	Children using booster seats.	Concern for children's safety	P
Bruce *et al.* 2009(36)	2009	Survey administered in community settings	Day care centers, sporting events, dental offices	4-9 years	Subjective norms Behavioral attitudes	P (Cronbach's α=0.91) P (Cronhach's α=0.84)
Macy *et al.* 2012(40)	2010	Cross-sectional web survey	Nationally (US) representative panel	Parents of 4-8 years old children	Younger child age	P (F=13.68, p<0.01)

Table 2-5 Determinants of Child Restraint Use and Misuse by Author (cont'd)

Study	Study Date	Design	Population	Target	Factors	Proper IMProper
Macy *et al.* 2012(33)	2011	Secondary analysis of direct observed child passenger restraint practices	3 years combined national (US) data from 2007, 2008, 2009	Parents of children 4-8 years old	Older child age 4+ children in vehicle	IMP(OR: 4.1 [95%$_{CI}$: 2.7-6.1]) IMP(OR: 1.6 [95%$_{CI}$: 1.1-2.4])
Yanchar *et al.* 2012(37)	2003	Telephone survey	Households with at least one child in Nova Scotia	Households with at least one child under the age of 12	Knows booster seat transition	P (OR: 0.1 [95%$_{CI}$: 0.04-0.2])

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Chapter 3

3.0 Epidemiology of Booster Seat Misuse in Alberta

3.1. Introduction

For children to travel safely in an automobile, specialized restraint devices are required. Children transition from a rear-facing seat to a forward-facing seat at one year of age or at least 20lbs (1). Forward-facing seats may used up until 65lbs depending on manufacturer's instructions; however, by Alberta law they must be used until at least 40lbs (1, 2). Once outgrowing the forward-facing seat, children transition to a booster seat. While there is currently no law requiring the use of booster seats in Alberta, it is recommended that they not transition until at least 80lbs (1, 2). Booster seats reposition the height and angle of the adult seatbelt more tightly across the chest and lower on the waist, increasing protection from injury and death as well as reducing injury severity (3-9). Using a booster seat properly will provide children with between 45% and 70% more protection in the event of a collision compared to an adult seat belt, a 3.5 fold decrease in the risk of serious head injuries, lower injury severity overall and a 28% reduction in the risk of death (3-9).

Current Canadian estimates suggest that only 19.6% of children 4-6 years of age are seated in a booster seat (10). By province and legislation type, booster seat use in Canadian provinces with no legislation (i.e., AB, SK, MB, NWT) exhibit usage rates of 52%, those with new legislation enacted in 2006 or later (i.e., NS, NB, PEI, NL, BC) exhibit usage rates of 54% and those with old legislation enacted prior to 2006 (ON, QC) has usage rates of 30% (i.e., ON, QC) (11). It must be noted that since this analysis was conducted Simniceanu *et al.*, both Saskatchewan and Manitoba have since enacted booster seat legislation. It is also likely that a significant proportion of booster eligible children seated in the correct seat are actually improperly restrained due to errors associated with securing the child into the booster seat and/or installing the booster seat into the vehicle (12). Among booster seats that are misused, the most common errors are placing the shoulder belt at the wrong level (74.3%) (i.e., under the arm, under the arm rest, or behind the back) or a loosely installed seat (54%) (12, 13).

While estimates of booster seat misuse display substantial variation across Canada, from 19.5% to 54.1% depending on jurisdiction and methodology, there is room for marked improvement in rates regardless of which metric is being considered (10, 11). Enactment of booster legislation has the ability to increase usage rates and decrease the rate of motor vehicle collision injures and death among children considered eligible for booster seats (14-16). In a study by Winston *et al.* in 2007 children 4-7 years of age involved in motor vehicle collisions were 39% more likely to be reported as appropriately restrained in the states with booster seat legislation, Sun *et al.* in 2010 described a 31 percentage point increase in booster seat use among 4-6 year olds (29% to 50%) following legislation, and Mannix *et al.* in 2012 found that sates with enacted booster seat legislation exhibited a lower risk of motor vehicle collision fatalities among children 4-7 years of age, with the largest impact seen in 6 year olds and 7 year olds (14-16).

Common factors influencing the use of booster seats include driver seatbelt non-use, child age, driver awareness of child passenger safety, risk-perceptions and number of children in the vehicle (17-27). Drivers who do not practice regular seatbelt use often place their child occupants at increased risk of injury in the even of a collision due to a higher prevalence of improper restraint practices (17-19). Children are more likely to use a booster seat when they are younger, with usage rates decreasing as they approach 80lbs and the transition point to an adult seatbelt (19-23). Parents that have high awareness of child restraint legislation as well as good general knowledge of booster seats and safety concepts are less likely to misuse booster seats (20, 21, 24-27). And when multiple children are present in the vehicle, especially if these children are older and are not also using a booster seat, the risk of booster seat misuse appears to increase (19, 20, 25).

Alberta is currently the only province in Canada without booster seat legislation. Recent surveys of booster seat use conducted in Canada have produced widely variable results, and none have presented estimates designed to be provincially representative of Alberta. While data suggests that booster seat misuse in Alberta may not be the lowest in the country there is still considerable room for improvement (10,

11). Additionally, the observation that provinces with booster seat legislation enacted prior to 2006 have a substantially lower rate of proper use (30%) than those with no legislation at all (52%) suggests that there are factors other than legislation influencing practice of booster seat use across Canada (11).

This study utilized cross sectional survey data to determine the prevalence of booster seat misuse within the province of Alberta, to describe the common ways booster seats are misused and identify risk factors of both improper seat choice and improper seat use or installation when a booster seat has been chosen correctly based on the child's age and/or weight. Using the correct seat for the child may indicate a higher baseline awareness of child restraint knowledge by the driver compared to drivers who choose the wrong seat. Therefore there may be differences in risk factors between those who chose the wrong seat and those who chose the right seat but used and/or installed it correctly, even though both children would still be considered improperly restrained. Determinants of these two practices have yet to be studied in Canada, and will be investigated in this article. Knowledge of prevalence of misuse in Alberta will help establish a baseline on which future progress can be measured as well as provide the required empirical data supporting the rationale for booster seat legislation in Alberta. Information on common booster seat errors can be incorporated into awareness campaigns and training programs in an attempt promote best practice and determinants of misuse can be leveraged to develop more targeted interventions and communication strategies targeted specifically for individuals at the highest risk.

3.2. Methods

A cross sectional survey design was used to investigate the prevalence, nature and determinants of booster seat misuse in Alberta. The study was approved by the University of Alberta Research Ethics Board (No. B-091007)"on Nov 6th, 2007. Childcare centers were selected as the survey population due to the predictable nature of transport at these locations, the availability of enrollment data and relative abundance within both urban and rural environments across Alberta. A list of active centers including address, contact information and enrolment numbers was obtained from the Government of Alberta. Childcare centers were weighted in order to achieve

a provincially representative urban/rural distribution and selected at random (without replacement) such that probability of selection was proportional to the number of eligible children enrolled in each location (28, 29). Urban and rural locations were defined according to community population, with those having greater than or equal to 25,000 residents were classified as urban while those with less than 25,000 residents were classified as rural. This criteria was chosen to remain consistent with prior seatbelt surveys that have been conducted in the province of Alberta. Excluded from the selection process were childcare centers located on First Nations communities as it was anticipated that the additional lead time that would be required to gain approval to conduct survey operations at these sites would conflict with the proposed survey start date. Additionally, only childcare centers with at least 20 children and located in an area where ample observation room was expected were eligible for inclusion into the study. All sites that had been randomly selected as potential survey locations were confirmed first for location suitability, based on address provided. For example, childcare centers located above the main-floor within high-rise buildings in congested urban environments were excluded. All locations deemed suitable based on this criteria were contacted, and their participation requested. Locations that agreed to participate were asked to withhold information from parents regarding specific dates and times of the study so as not to alter usual behaviour. Please see Appendix A: Sampling and Methodology *Supplement* for a detailed description of the sampling methods employed in this survey.

Surveys were conducted in teams of two, with inspectors being from two distinct backgrounds: 1) nurses who may have prior experience with child restraint inspections, and whose time was volunteered by their respective organizations, and 2) summer students with little to no experience conducting child restraint inspections. Regardless of background however, both groups were provided with similar instructions and training on how to conduct child restraint inspections for the purposes of this survey. While geographical limitations prevented measurement of inter-observer reliability, two trained professionals considered to be experts in restraint inspections were available as trainers to all inspectors, either in person or by

videoconference, in an attempt to enhance reliability. In addition, standardized training guides were provided to all.

Between May 1st and August 31st, 2008 at 67 randomly selected childcare centers across both urban and rural Alberta, drivers picking up their children between 3pm and 6pm were approached by a team of two inspectors while exiting the center and asked to participate in a five minute survey and restraint inspection. The child restraint inspection began only after the driver had provided verbal consent. Survey participants were provided with an information sheet summarizing study methods, objectives and contact information of study coordinators. Please see Appendix B – Information Sheet for a sample of the information sheet provided.

For those agreeing to participate in the survey, child restraint inspections were conducted on all children in the vehicle under the age of nine years, however only booster eligible children are considered in this analysis. A single adult (the driver) was interviewed within each vehicle. For each participating driver, the following information was collected: number of children in the vehicle under the age of nine, year/make/model of vehicle, driver sex, driver age in 10 year intervals, driver restraint use (regardless of participation decision), seating location of each child under the age of nine in the vehicle and the relationship(s) between the driver and children in the vehicle.

Additional behavioural information collected from the driver included: length of commute, self-reported speed of travel during commute, their suggestions of where parents should be able to obtain information, knowledge of fines for child restraint misuse and knowledge of child restraint transition points. Age, weight and restraint used were recorded for each child under the age of nine in the participating vehicle based on supplied information by drivers. The subsequent visual restraint inspection then assessed between five and seven aspects of child restraint use, depending on restraint used.

Misuses were categorized as: seat install error (i.e., incorrectly installing the seat into the vehicle), seat use error (i.e., incorrectly securing the child into the seat) or

seat choice error (i.e., choosing the wrong seat for the child). Seat install errors included: a loose seatbelt, not routing the seatbelt/UAS correctly, not using the tether strap correctly, or not facing the seat in the correct direction. Seat use errors included: non-use of the seatbelt, having the seatbelt low on the hips, having the shoulder harness at an incorrect height, a harness that was not snug, or a loose seatbelt. If restraints were found to be misused drivers were also provided with information on child restraint training sessions in the area. There were no specific criteria applied to driver selection during the survey. Once an inspection was completed, the next visible driver exiting the center with a child that appeared to be under the age of 9 years was approached. This interview/inspection method used was similar to the vehicle restraint use estimation procedure recommended by the American Automobile Association (30). Methods outlined in this guidebook have been recommended and validated by the American Automobile Association for the estimation of vehicle restraint use. Please see Appendix C – Data Collection *Form - Driver* and Appendix D – Data Collection *Form - Child* for samples of the data collection forms used.

All data were entered into a Microsoft Access (Redmond, Washington) by a summer student funded by the research project and audited for accuracy by the researcher. In cases where the investigators final decision regarding proper or improper use differed from what would have been expected considering the specific inspection results recorded for the child and the overall guiding restraint eligibility criteria, hardcopy records were re-evaluated and re-coded if necessary. Additionally, records having missing values for any individual inspection criteria were also reconciled from hardcopies where possible. If missing values persisted, the final decision regarding proper or improper use defaulted to the investigators final decision made at the time of survey, rather than an automated assessment. Please see Appendix E – Data Audits for a more detailed overview of the auditing methodology and results.

Data were analyzed using Stata 10 (Stata Corp., College Station, TX, USA). Significance between proportions were determined using a Chi-square test after adjusting for clustering by vehicle and site (significance level $\alpha=0.05$). Predictors were modeled using logistic regression, also adjusting for clustering by vehicle and site.

Child factors such as age and weight were used to determine eligibility categories as well as proper vs. improper use, but were excluded from the modeling procedure, where only driver factors were analyzed. All variables on the data collection form were tested for univariate significance. Those exhibiting a univariate p-value of less than 0.15 were included in the modeling procedure. Hierarchal stepwise regression was used to model predictors of: 1) improper seat choice, and 2) improper booster seat use and/or installation among children seated in a booster seat. Model fit was assessed through a survey adjusted goodness of fit test. Please see Appendix F – Ethics for a copy of the approval letter for this project.

3.3. Results

In the larger survey which incorporated children eligible for rear-facing and forward-facing seats, 747 drivers were approached at the 67 sites selected for analysis. Of these 747 drivers, 594 (79.5%) agreed to participate. Of the 153 drivers who chose not to participate, 58.6% (n=105) stated that they did not have enough time, 19.6% (n=30) did not give a reason for non-participation and 11.8% (n=18) gave another specified reason for non-participation. Drivers less likely to participate included those in passenger cars (78% vs. 86%, $p<0.0001$) and those who were not restrained (26% vs. 84%, $p<0.0001$).

In the 594 vehicles that agreed to participate, there were 330 children deemed eligible for a booster seat. Seventy percent of these booster eligible children lived in an urban area and 30% lived in a rural area. This ratio is consistent with the urban/rural population distribution of Alberta (28). The most common vehicles observed to be transporting booster eligible children were passenger cars (39.2%) followed by vans/minivans (26.1%) (Table 3-1). Drivers were most often in their 30's (54.7%) and were picking up their children in vehicles that were no more than 10 years old (Table 3-1). Parents comprised 93.6% of drivers and 98.5% of all drivers were restrained (Table 3-1). Only 20.4% of drivers would reach 80km/h on their way home and the majority (56.6%) had a one-way commute time of between 5 and 19 minutes (Table 3-1).

Table 3-1 Driver Population Characteristics (n=330)

Variable	N (330)	%
Urban Rural		
Urban	232	70.3
Rural	98	29.7
Sex		
Missing	5	
Male	93	28.6
Female	232	71.4
Children In Vehicle under 9 years		
One	128	38.8
Two	162	49.1
Three	34	10.3
Four	3	0.9
Five	3	0.9
Vehicle Type		
Missing	19	
Car	122	39.2
SUV	76	24.4
Van/Minivan	81	26.1
Pickup Truck	32	10.3
Driver Age		
Missing	3	
Under 20	2	0.6
20's	183	25.4
30's	179	54.7
40's	51	15.6
50's	9	2.8
60's	3	0.9
70's	0	0.0
Vehicle Year		
Missing	40	
1998 and older	30	10.3
1999 and newer	260	89.7
Driver Restrained		
Missing	113	
Yes	200	98.5
No	3	1.5
Driver Relationship		
Parent*	309	93.6
Grandparent*	25	7.7
Other Family Member*	6	1.8
Carpool*	7	2.2
Caregiver*	4	1.2
One-way Commute Time		
Missing	5	
Under 5 minutes	81	24.3
5-19 minutes	184	56.6
20-39 minutes	52	16.0
40+ minutes	8	2.5

Table 3-1 Driver Population Characteristics (n=330) (cont'd)

Variable		N (330)	%
Highway Speed (80+KM/H)			
	Missing	1	
	Yes	67	20.4
	No	262	79.6
Knowledge of Fines			
	Missing	5	
	Yes	253	77.8
	No	72	22.2
Knowledge of Forward-Facing to Booster Seat Transition			
	Missing	2	
	Yes	223	67.6
	No	105	31.8
Knowledge of Booster Seat to Seat Belt Transition			
	Missing	5	
	Yes	198	60.0
	No	127	38.5

Note: Missing values were excluded when calculating p values and category percentages.
** Categories are not mutually exclusive*

Ages for booster eligible children ranged from 2-8 years, with a median age of 4 years and a median weight of 40-44lbs. The survey population is skewed toward the younger end of the age-spectrum due to the age-based characteristics of childcare centers; only 7.9 % of booster eligible children were 7 years of age or older and only 7.7% were over 65lbs. There were wide weight variations observed within each 1-year age group, with the largest variation observed among children 6 years of age (40-44lbs to 85-90lbs). Similarly there wide age variations within each 5lbs weight group, with the largest variation observed among children 50-54lbs (2-7 years).

At least one misuse was observed in 31.8% (n=105) of all booster-eligible children surveyed. There was no significant difference by age in the prevalence of incorrect seat use or seat installation among children seated in a correct seat (Table 3-2). However, a significant difference in the prevalence of seat choice errors by age was observed (p=0.001) (Table 3-2). The lowest prevalence of improper seat choice occurred among booster eligible children 3 years (13.3%) and 4 years of age (17.3%), while the highest prevalence of improper seat choice occurred among children 7 years (47.8%) and 8 years of age (100.0%) (Table 3-2).

Table 3-2 Percentage Misuse by Age and Misuse Mode for Booster Eligible Children (n=330)

	% Misuse									
Age (years)	**<1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***P***
Seat Use Err. In Correct Seat			3.1	7.0	5.9	11.5				*0.444*
Seat Install Err. In Correct Seat			7.1	10.8	8.1	3.9	3.9			*0.547*
Seat Choice Errors			22.2	13.3	17.3	27.1	29.7	47.8	100	*0.001*

There was no significant difference by weight in the prevalence of incorrect seat use or seat installation among children seated in a correct seat (Table 3-3). However, a significant difference in the prevalence of seat choice errors by weight was observed ($p<0.001$) (Table 3-3). Prevalence of improper seat choice started to increase at 50lbs and reached a peak of 100.0% at 80-85lbs, although there were only 4 booster eligible children in this weight group (Table 3-3).

Table 3-3 Percentage Misuse by Weight and Misuse Mode Booster Eligible Children (n=330)

	% Misuse														
Weight (lbs)	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	P
Seat Use Err. In Correct Seat					5.7	1.9	3.1					33.3			*0.213*
Seat Install Err. In Correct Seat					9.5	3.9	3.1								*0.503*
Seat Choice Errors					10.3	14.8	33.3	31.8	52.0	50.0	33.3	25.0	100.0		*<0.0001*

The vast majority of the 330 children eligible for booster seats were seated in a booster seat (n=254; 77.0%). Of the remaining, 17.9% (n=59) were seated in an adult seatbelt, 4.9% (n=16) were seated in a forward-facing seat, and 0.3% (n=1) were seated in an 'other' child restraint of unknown type. There were no booster-eligible children observed in a rear-facing seat. Of the 254 booster-eligible children observed to be travelling in the correct seat, 5.5% (n=14) had at least one seat use error and 7.1% (n=18) had at least one seat installation error. Overall, 11.4% (n=29) of booster eligible children who were seated in a booster (i.e. representing a correct seat choice) were improperly restrained , with the most common problems were errors related to tightening the seatbelt (5.2%) running the belt across the chest (4.4%) (Table 3-4).

Table 3-4 Inspection Results Among Booster Eligible Children Seated in a Booster Seat (n=254)

		Missing	Yes	No
Seatbelt Used				
	#	2	252	0
	%		100.0	0.0
Seatbelt Tight				
	#	3	238	13
	%		94.8	5.2
Shoulder Belt Across Chest				
	#	4	239	11
	%		95.6	4.4
Lap Belt Low on Hips				
	#	6	242	6
	%		97.6	2.4

Note: Missing values were excluded when calculating p values and category percentages

Variables that exhibited a statistically significant ($p<0.05$) univariate relationship with seat choice errors among booster eligible children were: 1) seating location, 2) knowledge of transition points and 3) driver age (Table 3-5). Children eligible for booster seats that were seated in the front row (OR: 9.96; 95%CI: 2.9-3.2; $p<0.001$) or inside second row (OR: 2.39; 95%CI: 1.15-4.99; $p<0.001$) were more likely to be in the wrong seat compared to those seated in the outside second row (Table 3-5). Children with drivers that had knowledge of at least one transition point (OR: 0.027; 95%CI: 0.14-0.53; $p<0.001$) were more likely to be in the correct seat (Table 3-5). Drivers in their 20's exhibited the highest percentage of seat choice errors among booster-eligible children (33.4%) (Table 3-5). Among children eligible for, and seated in, booster seats, only 'having 5 or more children in the vehicle' (OR: 4.1; 95%CI: 2.10-7.98; $p<0.001$) exhibited a statistically significant univariate relationship with seat use and/or installation errors while in the correct seat (Table 3-5).

Table 3-5 Univariate Predictors of Incorrect Seat Choice and Incorrect Use/Installation While Seated in a Booster

(Note: Odds ratios greater than one suggest an association with improper use, while odds ratios less than one suggest an association with proper use).

Variable	Seat Choice Error				Seat Use/Installation Error While in a Booster			
	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P
Urban/Rural								
Urban	232	24.1	1.24 [0.65-2.37]	0.507	176	11.4	0.98 [0.45-2.13]	0.965
Rural	98	20.4	0.81 [0.42-1.54]	0.507	78	11.5	1.02 [0.47-2.21]	0.965
Driver Sex								
Male driver	93	30.1	1.74 [0.97-3.14]	0.064	65	13.9	1.33 [0.54-3.27]	0.524
Female driver	232	19.8	0.57 [0.32-1.03]	0.064	186	10.8	0.75 [0.31-1.84]	0.524
Number In Vehicle <9y								
One	128	21.1	ref		101	10.9	ref	
Two	162	20.4	0.96 [0.48-1.91]	0.899	129	10.9	1.0 [0.38-2.58]	0.993
Three	34	38.2	2.31 [0.87-6.17]	0.092	21	14.3	1.4 [0.25-7.49]	0.717
Four	3	100.0						
Five or More	3	0.0			3	33.3	4.1 [2.10-7.98]	<0.001
Vehicle Type								
Passenger Car	122	27.1	1.80 [0.74-4.38]	0.193	89	14.6	1.98 [0.55-7.12]	0.288
Van or Minivan	81	22.2	1.38 [0.60-3.13]	0.436	63	11.1	1.45 [0.36-5.78]	0.593
Pickup Truck	32	25.0	1.62 [0.58-4.46]	0.350	24	12.5	1.66 [0.33-8.31]	0.534
SUV	76	17.1	ref		63	7.9	ref	
Driver Age								
Under 20	2	0.0			2	50.0	10.00 [0.51-197.63]	0.128
20's	83	33.4	ref		55	9.1	ref	
30's	179	18.4	0.44 [0.22-0.89]	0.023	146	11.6	1.32 [0.46-3.74]	0.599

Table 3-5 Univariate Predictors of Incorrect Seat Choice and Incorrect Use/Installation While Seated in a Booster (cont'd)

Variable	Seat Choice Error				Seat Use/Installation Error While in a Booster			
	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P
40's	51	25.3	0.60 [0.24-1.50]	0.271	39	10.3	1.14 [0.25-5.14]	0.860
50's	9	22.2	0.56 [0.12-2.54]	0.448	7	14.3	1.67 [0.16-17.90]	0.669
60plus	3	0.0			3	0.0		
Vehicle Year								
1998 and older	30	23.3	0.99 [0.36-2.77]	0.989	23	8.7	0.69 [0.15-3.19]	0.634
Newer than 1998	260	23.5	1.00 [0.36-2.81]	0.989	199	12.1	1.44 [0.31-6.61]	0.634
Driver Relationship								
Driver is Parent	309	24.0	ref		235	11.5	ref	
Driver is Grandparent	25	20.0	4.00 [0.19-83.29]	0.365	20	5.0	0.70 [0.08-6.15]	0.744
Driver – 'other'	2	50.0	3.78 [0.51-28.01]	0.190	1	0.0	3.85 [0.32-46.32]	0.283
One-way commute time								
Under 5 minutes	81	30.9	ref		56	7.1	ref	
5m – 19 minutes	184	21.2	0.60 [0.28-1.28]	0.185	145	14.5	2.20 [0.71-6.79]	0.167
20-39 minutes	52	17.2	0.47 [0.18-1.24]	0.125	43	7.0	0.98 [0.20-4.69]	0.974
40+ minutes	8	25.0	0.75 [0.16-3.55]	0.710	6	0.0		
Highway Speed								
Reaches 80KM/h	67	20.9	0.85 [0.36-2.01]	0.711	53	7.6	0.57 [0.19-1.70]	0.310
Does not Reach 80KM/h	262	23.7	1.17 [0.50-2.77]	0.711	200	12.5	1.75 [0.59-5.21]	0.310
Fines								
Knowledge of fine	253	21.3	0.66 [0.33-1.31]	0.231	199	10.1	0.52 [0.21-1.29]	0.157
No Knowledge of fine	72	29.2	1.52 [0.76-3.02]	0.231	51	17.7	1.92 [0.77-4.76]	0.157

Table 3-5 Univariate Predictors of Incorrect Seat Choice and Incorrect Use/Installation While Seated in a Booster (cont'd)

Variable	Seat Choice Error				Seat Use/Installation Error While in a Booster			
	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P	N	% Seat Choice error	Survey Adjusted* Odds Ratio [95% CI]	P
Knowledge of Any Transition Point								
Knows at least one	265	17.7	0.27 [0.14-0.53]	<0.001	170	10.0	0.42 [0.14-1.25]	0.117
Does not know any	59	44.1	3.65 [1.89-7.07]	<0.001	81	13.6	2.40 [0.80-7.20]	0.117
Seating Location								
Front Row	13	69.2	9.96 [2.93-32.06]	<0.001	4	25.0	2.60 [0.25-27.20]	0.420
Outside Second Row	260	18.9	ref		211	11.4	ref	
Inside Second Row	28	35.7	2.39 [1.15-4.99]	0.021	18	22.2	2.22 [0.64-7.72]	0.203
Last Row	23	30.4	1.88 [0.56-6.31]	0.299	16	0.0		

*Adjusted for Clustering by Location and by Vehicle

A multiple regression analysis was conducted to model the relationship between survey variables and the odds of a booster eligible child being restrained in the wrong seat. After controlling for driver sex, driver age, commute time, and information sources used (i.e. variables included in the modeling procedure which exhibited univariate significance at $p<0.15$), knowledge of any transition point (OR: 0.27; 95%CI: 0.14-0.50; $p<0.001$) was found to be the strongest predictor of *correct* seat choice, while having a total of three children in the vehicle was found to be the strongest predictor of incorrect seat choice (OR: 2.67; 95%CI: 1.20-6.06; $p=0.020$) (Table 3-6). This model was found to have good fit (survey adjusted) ($p>=0.05$; 0.483).

Table 3-6 Multivariate Logistic Regression Model: Predictors of Seat Choice Patterns

Variable	OR	95% L	95% H	Std Err	t	P
Knowledge of Any Transition Point	0.27	0.14	0.50	0.084	-4.19	0.000
Three Children in the Vehicle	2.67	1.2	6.06	1.097	2.38	0.020

A multivariable model could not be built with more than one significant predictor of seat use/installation among booster eligible children seated in a booster seat. Low sample size for this group prohibited a robust analysis.

3.4. Discussion

There are multiple strategies for estimating the prevalence of child restraint misuse within a population. The most precise is to individually determine seat eligibility for each child based on an assessment of age, weight, height and manufactures' instructions for the seat used followed by a visual inspection for proper or improper use, which was the approach employed in this study. Overall, 31.8% of booster eligible children in this survey were improperly restrained, for which seat choice was the most common error at 23.3%. Seat choice errors also increased significantly with both increasing age and weight, providing further evidence outlining the extent of premature graduation among booster eligible children. Incorrect seat choice increased from 13% in booster eligible 3 year olds to 47% in booster eligible 7 year olds (Table 3-2). Similarly by weight, incorrect seat choice increased from 10.3% among booster eligible children weighing 40-44lbs to 52% among booster eligible children weighing 60-64lbs (Table 3-3).

The dangers of premature graduation are well documented (31-33). Due to their anatomical characteristics these young children are not yet able to be maximally protected by an adult seat belt (31, 33). In children under the age of 10 the smaller bony pelvis is less capable of serving as the seatbelt anchor point as it does in adults, and in the event of a collision the adult seatbelt can ride up over the abdomen causing the pelvis to submarine under the lap belt which can result in abdominal compression injuries and/or spinal fracture, otherwise known as 'seatbelt syndrome' (31). Booster seats reposition the height and angle of the adult seatbelt more tightly across the chest and lower on the waist, increasing protection from injury and death as well as reducing injury severity (3-9). Furthermore, due to the shorter and lower sitting heights, booster eligible children are also at risk of additional injury due to improper placement of the shoulder strap (either behind the back or under the arm), a practice which was observed in 70.4% of prematurely graduated children in this survey (3). Premature graduation to a seatbelt places booster eligible children at increased unnecessary risk of motor vehicle related morbidity and mortality, the majority of which could be prevented by proper use of a booster seat. It is unfortunate that this practice is still far too common in Alberta, and as such remains an important public health priority. A key first step in Alberta would be to follow in the footsteps of other Canadian provinces and enact legislation mandating the use of booster seats for children starting at 40lbs until at least 80lbs. Utilizing legislation to increase the rate of proper child restraint use has proven effective in other jurisdictions, and in some studies has been followed by subsequent decreases in the rate of motor vehicle collision injuries and fatalities in this age group (14-16).

Canadian data presented by Snowden et al. in 2006 from the last national child restraint observation survey estimated that 80.4% of children eligible for a booster seat by age (i.e. 4-8 years) were seated in the wrong seat (10). Alberta estimates generated in this study however were much lower, with only 23.3% of booster eligible children seated in the wrong seat. Compared to these national values, this is a 57 percentage point decrease in the prevalence of improper seat choice among booster eligible children. Potential reasons for this discrepancy include: 1) Alberta had the highest rate (63.9%) of proper child restraint use in the Country in the 2006 national survey

conducted by Snowden et al. (10), 2) differences in survey methods (i.e. interview and inspection vs. roadside observation) that allows a more detailed analysis of errors within our survey, 3) the fact that older booster eligible children who may be most at risk of improper seat choice were underrepresented in our survey and 4) children in all seating positions were included in our study and not just those in the front seat (as is common in other observation in other studies), which is an established predictor of improper use (18, 34) . Our survey did identify that the prevalence of improper seat choice among booster eligible children aged 7 and 8 years (47.8% and 100% respectively, albeit with a low number of observations) was much higher than the prevalence at 5 and 6 years of age (27.1% and 29.7% respectively), a pattern also observed by Snowden et al. in 2006 (10).

In this survey population, 76.6% of booster eligible children were seated in a booster seat (n=254/330), representing a correct practice. Of these correctly seated children 11.4% were observed with at least one seat use or seat installation error. While the prevalence of this error is low, it can still result in harmful effects in the event of a collision. Of the 28 children who were correctly seated in a booster seat but considered to be improperly restrained due to other errors, loose seat belts (n=13) and errors related to the placement of the shoulder belt across the chest (n=11) were the two most common. In this survey the reported rates of loose seatbelts or loose shoulder straps, two common errors identified in the literature, were each lower (<10%) than other estimates reported in the recent literature, where between 24% and 70% of children experience issues with seatbelt fit and/or positioning either across the waist or chest (12, 13, 35). This however, was an expected result, as seat installation or usage errors were only reported and analyzed if the child was first seated in the correct seat. Rationle for this approach is that when seated in the wrong seat, it may be impossible for the parent to use the seat, and thus errors in this situation may be more representative of choosing the wrong seat rather than knowledge gaps in installation practices. Despite the large discrepancies in absolute error rates, our survey aligns with others in that errors with using the lap and shoulder belts are most common (12, 13, 35). Messaging delivered through public health officials, researchers, front line care providers and others must continue to stress the importance of using a booster

seat until at least 80lbs with a specific emphasis on how to correctly use the lap and shoulder belts, as a supplement to booster legislation.

Of the variables examined in this survey, there appears to be some association (based on univariate relationships only) between the risk of not choosing a booster seat and seating location. Seating a booster-age child in a non-optimal location likely reflects lower overall knowledge of child restraint practices and thus the higher rate of incorrect seat choice. Other factors showing a univariate association with incorrect seat choice included drivers who couldn't accurately recite at least one child restraint transition point and drivers in their 20s (Table 3-5). While driver age, seating location and knowledge of transition points all exhibited statistically significant results in relation to seat choice errors in a univariate analysis, when all factors in the survey were modeled together (using a univariate significance of $p<0.15$ for inclusion into the model) only two factors remained: 1) knowledge of any transition point and 2) having three children in the vehicle. These two factors should be considered the most influential in relation to the risk of improper seat choice in this survey. Drivers that displayed knowledge of at least one transition point were at decreased odds (OR: 0.27 95%CI: 0.14-0.50; $p<0.0001$) of choosing the incorrect seat while drivers with three children in the vehicle were at increased odds (OR: 2.67 95%CI: 1.20-6.06; $p=0.020$) of choosing the incorrect seat. The association between knowledge of transition points and decreased risk of improper seat choice suggests a population that is receptive to the use of booster seats; however, more research is needed in order to further define the sub-populations at highest risk. This information can be incorporated into awareness campaigns that, unlike legislation, have the ability to act in a more targeted manner by providing customized information to specific risk groups utilizing their preferred communication methods.

When a booster eligible child is seated in a booster seat, errors relating to use and installation remain low (11.4%). Thus, results of this survey suggest that parents appear to have little trouble using boosters correctly when the correct seat is chosen. Only one variable in this survey, '5 or more children in the vehicle', exhibited statistical significance with the odds of improper use/installation while seated in a

booster seat and no predictive model with good fit could be constructed, due primarily to the lack of sample size (Table 3-5). Regardless of the inability to construct a model, this finding is partially validated as it was also identified as a misuse determinant for improper seat choice in this survey and remains consistent with other child restraint surveys in the literature that have linked a higher number of children in the vehicle, a higher number of occupants in the vehicle and the need to accommodate older children in the vehicle to an increased risk of misuse (20, 24, 25, 34).

The most significant limitation of this survey stemmed from modifications to the survey design as a result of unanticipated refusals from large school districts, which required all data collection to be done at childcare centers rather than at both childcare centers and elementary schools. As a result, the survey population was composed primarily of younger booster eligible children aged 4-6 years of age. Older booster age children, who are at a higher risk of misuse, were underrepresented in this survey. As such, our overall prevalence estimate of booster seat misuse within this study population of 31.8% is likely more representative of children aged 4-6 years eligible for a booster seat, rather than complete eligibility age range of 4-6 years. Other biases present in this survey that may cause our prevalence estimate to be underestimated include participation bias, observation bias and potentially outdated data. Approached individuals were free to refuse participation in the survey, and they may be more likely to do so if they felt their restraint practices may be sub-optimal. If agreeing to the survey, in-vehicle assessments of child restraint use are subject to observation bias as drivers may be more likely to take more care securing the child in the vehicle when under direct observation and assessment. Additionally, data collection occurred six years ago in 2008, and may not accurately represent the current state of booster seat misuse in the province. It is likely that the prevalence of booster seat use has increased over this time, owing to the parallel increase in adult seatbelt use in Alberta between 2007 (88.9%) and 2011 (95.1%) (36).

Other biases which introduce error into survey estimates include information bias, selection bias and self report bias. Inspections were performed by multiple teams across the province, and while all received identical training instructions and manuals,

due to geographical limitations it was not possible to conduct reliability estimates between inspectors operating concurrently at different locations. While consistency of information collected was assumed, we did not test for this in this survey, so the effect on the quality of information remain unknown. Selection of child care centers as the study population introduces selection bias, as we do not know how different those attending childcare centers are from those who do not attend, and what affect this may have had on our analysis other than the age based issues described above. And finally, data on child weight is based purely on parent report and recall, which parents may over or underestimate.

Analytical limitations include the absence of a Bonferonni correction during the data analysis, which because of the high number of simultaneously tested hypothesis increases the probability of Type 1 error (37). For this study specifically, it increases the probability of a risk-factor being significantly associated with booster seat misuse when in fact no relationships exist. Due to the exploratory nature of this analysis, the intent was to consider all information collected in this thesis equally within somewhat relaxed statistical constraints in an attempt to develop baseline information for the purposes of guiding future work in this area. Being overly restrictive through the application of the Bonferonni correction may have been detrimental to this goal. However, the potential for the lack of a Bonferonni correction to have a significant impact on our results cannot be discounted.

The strengths of this study lie in the provincial representativeness of prevalence estimates, which were based on individual eligibility decisions for every child in the vehicle under the age of nine rather than the percent misuse among children seated in a certain seat or those within a specific age group. Inspections were also performed on all children in the vehicle instead of only those seated in the front seat, as would be the case with purely observational surveys. In addition to overall misuse estimates within eligibility groups, they are also broken down by type of misuse and the specific errors observed. This is the only survey of its kind in Alberta and will provide valuable baseline information for researchers, health professionals and policy makers.

3.5. Conclusion

At least 1 in 3 booster eligible children travelling on Alberta roads were improperly restrained, and of these at least 1 in 4 were not in the correct seat and have most likely been graduated too early to an adult seat belt. Additionally, at least 1 in 10 booster eligible children were improperly restrained even though they were in the correct seat. Populations at high risk of improper use (most specifically incorrect seat choice) include drivers that are unable to recall any child restraint transition point, those with multiple children in the vehicle and may include young drivers in their 20s and vehicles with children in non-optimal seating positions for their age (Table 3-5,Table 3-6). There is a pressing need to improve awareness of the age and weight based transition points in Alberta and to continue to deliver information through the most desired and influential mediums. Other Canadian provinces have enacted booster seat legislation that mandates usage for children between 40lbs and 80lbs and this would be an essential step in Alberta to increase in the compliance with booster seat use. Once implemented, this legislation will only serve to enhance the effectiveness of existing awareness campaigns and public health programs. While these data may present baseline prevalence estimates that may be useful for future researchers or program planners, more robust information is required on older booster eligible children in the province as they were unrepresented in this survey. Obtaining more robust prevalence estimates from these older booster eligible children, aged 7-8 years, is a priority.

This survey indicated that booster eligible riding in vehicles with three or more child passengers, younger drivers or children in non-optional seating locations were at higher risk of misuse. This finding may lend itself towards more targeted enforcement programmes and/or spot checks of high risk vehicles fitting these criteria. Additionally, it was found that having knowledge of the correct transition points is correlated with an increase in booster seat use, and although it is not known if knowledge leads to practice or practice leads to knowledge in this specific scenario, it may be beneficial to consider running simple awareness campaigns that focus solely on reminding parents what the transition points are with no other information provided but direction to education centers or other sources where all other information can be

obtained. These information sources must then ensure that they highlight specific high risk practices, such as improper belt positioning, premature graduation, the importance of booster seat use for all booster-eligible children in the vehicle and perhaps even invest extra resources on the specific needs of younger drivers. However, for this type of awareness campaign to be maximally effective, messaging must first be tailored and information communicated in a unique way for each high risk group, depending on their unique characteristics and preferences. Additional research is required to identify the most effective means to communicate booster seat information to all relevant sub-populations in Alberta.

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Chapter 4

4.0 Booster Seat Information Sources Utilized by Parents of Booster Eligible Children

4.1. Introduction

Travel in an automobile with young children is a daily reality for many parents. Transporting children safely in the vehicle requires proper knowledge of approved child restraint devices; how to choose the correct one, how to use it properly and when to transition to the next. In Canada, children transition from a rear-facing seat to a forward-facing seat at one year of age or at least 20lbs (1). Forward-facing seats must by law be used up until at least 40lbs (1, 2). Once outgrowing the forward-facing seat, children transition to a booster seat. While there is currently no law requiring the use of booster seats in Alberta, it is recommended that they not transition until at least 80lbs (1, 2). Alberta is also the only province in Canada that has yet to enact booster seat legislation.

Proper use of a booster seat has been shown to provide children with significant protection from both injury and death in the event of a motor vehicle collision as well as reduce the severity of any injuries that do occur (3-9). Despite these protective benefits, booster seats are still underutilized in Canada (10-12). In the absence of legislation in Alberta that enforces the use of booster seats, population level changes in behaviour must be driven by awareness campaigns and public health programming. Studies designed to investigate the relationship between a specific injury prevention initiative and subsequent improvements in booster seat use and/or booster seat knowledge are abundant in the literature, however there are very few studies which describe where parents would like to get their information from. Evidence that does exist suggests that physicians, healthcare professionals, emergency medical services and law enforcement may be the most effective and that informal sources such as the internet, drop-in programs, books, organized play groups, classes and information sessions are venues that are highly preferred by parents (13-15). The purpose of this survey to identify where parents of booster eligible children in Alberta

are obtaining information on child restraints in addition to where they would prefer to obtain their information in the future. Information on booster-eligible children and their drivers was extracted from a larger survey designed to assess the prevalence of both booster seat and forward-facing seat misuse (see Chapter 3.0 Epidemiology of Booster Seat Misuse in Alberta). Rates of information source utilization and information source preferences will be analyzed as a whole and by driver sex. Additionally, misuse rates between drivers with different information source utilization patterns will be compared. This information can be used by public health researchers, public health officials and healthcare providers to tailor the medium through which booster seat information is disseminated, with the overall aim to improve communication to risk groups, enhance knowledge retention, influence behaviour and ultimately decrease the prevalence of booster seat misuse in Alberta.

4.2. Methods

A cross sectional survey design was used to investigate the prevalence, nature and determinants of booster seat misuse in Alberta. The study was approved by the University of Alberta Research Ethics Board (No. B-091007)"on Nov 6th, 2007. Childcare centers were selected as the survey population due to the predictable nature of transport at these locations, the availability of enrollment data and relative abundance within both urban and rural environments across Alberta. A list of active centers including address, contact information and enrolment numbers was obtained from the Government of Alberta. Childcare centers were weighted in order to achieve a provincially representative urban/rural distribution and selected at random (without replacement) such that probability of selection was proportional to the number of eligible children enrolled in each location (16, 17). Urban and rural locations were defined according to community population, with those having greater than or equal to 25,000 residents were classified as urban while those with less than 25,000 residents were classified as rural. This criterion was chosen to remain consistent with prior seatbelt surveys that have been conducted in the province of Alberta. Excluded from the selection process were childcare centers located on First Nations communities as it was anticipated that the additional lead time that would be required to gain approval to

conduct survey operations at these sites would conflict with the proposed survey start date. Additionally, only childcare centers with at least 20 children and located in an area where ample observation room was expected were eligible for inclusion into the study. All sites that had been randomly selected as potential survey locations were confirmed first for location suitability, based on address provided. For example, childcare centers located above the main-floor within high-rise buildings in congested urban environments were excluded. All locations deemed suitable based on this criteria were contacted, and their participation requested. Locations that agreed to participate were asked to withhold information from parents regarding specific dates and times of the study so as not to alter usual behaviour. Please see Appendix A: Sampling and Methodology *Supplement* for a detailed description of the sampling methods employed in this survey.

Surveys were conducted in teams of two, with inspectors being from two distinct backgrounds: 1) nurses who may have prior experience with child restraint inspections, and whose time was volunteered by their respective organizations, and 2) summer students with little to no experience conducting child restraint inspections. Regardless of background however, both groups were provided with similar instructions and training on how to conduct child restraint inspections for the purposes of this survey. While geographical limitations prevented measurement of inter-observer reliability, two trained professionals considered to be experts in restraint inspections were available as trainers to all inspectors, either in person or by videoconference, in an attempt to enhance reliability. In addition, standardized training guides were provided to all.

Between May 1st and August 31st, 2008 at 67 randomly selected childcare centers across both urban and rural Alberta, drivers picking up their children between 3pm and 6pm were approached by a team of two inspectors while exiting the center and asked to participate in a five minute survey and restraint inspection. The child restraint inspection began only after the driver had provided verbal consent. Survey participants were provided with an information sheet summarizing study methods, objectives and contact information of study coordinators. Please see Appendix B –

Information Sheet for a sample of the information sheet provided. For those agreeing to participate in the survey, child restraint inspections were conducted on all children in the vehicle under the age of nine years, however only booster eligible children are considered in this analysis. A single adult (the driver) was interviewed within each vehicle.

Each participating driver was asked to indicate which of the following information sources they used to obtain child restraint information from a list containing the following options: 1) physician, 2) public health nurse, 3) other parents, 4) vehicle owners manual, 5) child restraint instruction manual, 6) police or firefighter, 7) traffic safety website, 8) none or 9) other, specify. Additional categories were created from the 'Other, specify' category for commonly reported similar themes. Once utilized information sources had been recorded, drivers were then asked their opinions on where they thought parents should be obtaining information, which could be any source regardless of if they had utilized it or not. The survey also assessed seven other demographic and behavioural variables, as well as between five and seven aspects of child restraint use (depending on the child restraint used) during the in-vehicle visual assessment. Only children deemed eligible for a booster seat were included in the analysis. Please see Appendix C – Data Collection *Form - Driver* and Appendix D – Data Collection *Form - Child* for samples of the data collection forms used.

All data were entered into a Microsoft Access (Redmond, Washington) by a summer student funded by the research project and audited for accuracy by the researcher. In cases where the investigators final decision regarding proper or improper use differed from what would have been expected considering the specific inspection results recorded for the child and the overall guiding restraint eligibility criteria, hardcopy records were re-evaluated and re-coded if necessary. Additionally, records having missing values for any individual inspection criteria were also reconciled from hardcopies where possible. If missing values persisted, the final decision regarding proper or improper use defaulted to the investigators final decision made at the time of survey, rather than an automated assessment. Please see Appendix

E – Data Audits for a more detailed overview of the auditing methodology and results. Data was analyzed using Stata 10 (Stata Corp., College Station, TX, USA), with significance between proportions determined using a Chi-square test after adjusting for clustering by vehicle and site (significance level α=0.05). Please see Appendix F – Ethics for a copy of the approval letter for this project.

4.3. Results

In the larger survey which incorporated children eligible for rear-facing and forward-facing seats, 747 drivers were approached at the 67 sites selected for analysis. Of these 747 drivers, 594 (79.5%) agreed to participate. Of the 153 drivers who chose not to participate, 58.6% (n=105) stated that they did not have enough time, 19.6% (n=30) did not give a reason for non-participation, and 11.8% (n=18) gave another specified reason for non-participation. Drivers less likely to participate included those in passenger cars (78% vs. 86%, $p<0.0001$) and those who were not restrained (26% vs. 84%, $p<0.0001$).

Only children considered eligible for a booster seat were included in the following analysis. In the 594 vehicles that agreed to participate, there were 330 children deemed eligible for a booster seat. Seventy percent of these booster eligible children lived in an urban area and 30% lived in a rural area. This ratio is consistent with the urban/rural population distribution of Alberta (16).

Table 4-1 Information Source Utilization and Information Source Preferences for Drivers with Booster Eligible Children (n=268)

Information Source	Utilized (%)	Preferred (%)	Utilized Rank	Preferred Rank	Rank Diff
Manuals or pamphlets	43.8%	10.3%	1	4	-3
Non-physician health professional	40.4%	27.9%	2	1	1
Internet	19.1%	18.4%	3	2	1
Non-health professional	16.5%	12.1%	4	3	1
Friends, family or community	14.3%	2.6%	5	10	-5
Physician	3.7%	5.5%	6	6	0
News media	3.3%	3.6%	8	9	-1
Retailers or dealerships	3.3%	5.2%	8	8	0
Government regulations	0.7%	5.5%	10	7	3
School or daycare	0.7%	9.6%	10	5	5

Note: Information sources utilized was a multiple response item while preferred information source was a single response item.

The most common information sources utilized by drivers were manuals or pamphlets (43.8%) and non-physician health professionals (40.4%) (Table 4-1). Lesser utilized information sources included the internet (19.1%), non-health professionals (16.5%) and friends, family or community groups (14.3%) (Table 4-1). The most commonly preferred information sources were non-physician health professionals (27.9%) followed by the internet (18.4%) and non-health professionals (12.1%) (Table 4-1). Utilized information source was a multiple response item while suggested information source (referred to as 'preferred' in this analysis) was a single response item, which prevents the direct comparison of percentages. However, assessment of potential gaps between utilized and preferred can be approximated by comparing most-utilized and most-preferred by ranking. Here we see that there are two noticeable discrepancies, occurring within the information sources of 'friends, family or community' and 'school or daycare'. Drivers were very unlikely to suggest friends, family or community groups as a preferred source (rank: 10 of 10) but were much more likely to suggest that this is a source they have utilized (rank: 5 of 10) (Table 4-1). Conversely, drivers were somewhat likely to suggest schools or daycares (rank: 5 of 10) as a preferred source but were much less likely to suggest that this is a source they have utilized (rank: 10 of 10) (Table 4-1). Also of note was that manuals

or pamphlets were the most commonly utilized source but only the 4th most commonly preferred source (Table 4-1).

4.3.1. Information Source Utilization and Preferences by: Sex

Table 4-2 Information Source Utilization by Sex for Drivers with Booster-Eligible Children (n=268)

	F (n= 189)	M (n=79)	% Females (n=189) utilizing information source	% Males (n=79) utilizing information source	Diff (F-M)	P value
Manuals or pamphlets	81	36	42.9%	45.6%	-2.7%	0.711
Non-physician health professional	81	26	42.9%	32.9%	9.9%	0.125
Internet	30	21	15.9%	26.6%	-10.7%	*0.048
Non-health professional	28	17	14.8%	21.5%	-6.7%	0.142
Friends, family or community	29	10	15.3%	12.7%	2.7%	0.611
Physician	7	3	3.7%	3.8%	-0.1%	0.967
News media	8	4	4.2%	5.1%	-0.8%	0.774
Retailers or dealerships	7	2	3.7%	2.5%	1.2%	0.654
Government regulations	2	0	1.1%	0.0%	1.1%	NA
School or daycare	2	0	1.1%	0.0%	1.1%	NA

*Statistically significant at the α=0.05 level

Patterns of information source utilization by sex exhibited significant differences for 'internet' only. Utilization of the internet was significantly lower among female drivers (p=0.048) than male drivers, by a raw score of -10.7 percentage points (15.9% vs. 26.6%) (Table 4-2). While not statistically significant, females were more likely to have utilized a non-physician health professionals to obtain information while males were more likely to have utilized a non-health professional or the internet (Table 4-2).

Table 4-3 Information Source Preferences by Sex for Drivers with Booster-Eligible Children (n=268)

	F (n= 189)	M (n=79)	% Females (n=189) preferring information source	% Males (n=79) preferring information source	Diff (F-M)	P value
Manuals or pamphlets	16	10	8.5%	12.7%	-4.2%	0.299
Non-physician health professional	58	17	30.7%	21.5%	9.2%	0.155
Internet	35	15	18.5%	19.0%	-0.5%	0.928
Non-health professional	22	11	11.6%	13.9%	-2.3%	0.479
Friends, family or community	4	3	2.1%	3.8%	-1.7%	0.443
Physician	11	4	5.8%	5.1%	0.8%	0.812
News media	4	6	2.1%	7.6%	-5.5%	*0.042
Retailers or dealerships	9	5	4.8%	6.3%	-1.6%	0.640
Government regulations	10	5	5.3%	6.3%	-1.0%	0.764
School or daycare	17	9	9.0%	11.4%	-2.4%	0.539

*Statistically significant at the α=0.05 level

Information preferences represent a single source that participants felt would be best for parents to use to obtain information on child restraints, regardless of which sources they themselves have used. Patterns of information source preferences by sex exhibited significant differences for news media; however, the total number of responses was low (n=10) (Table 4-3). While not statistically significant, females were more likely to have a preference for using non-physician health professionals, which was 9.2% higher than among males (Table 4-3).

4.3.2. Booster Seat Misuse by Sex by Information Source

The prevalence of improper booster seat use in this survey was observed to be 31.8%. For more detailed information on prevalence observed in this survey please see Chapter 3.0 Epidemiology of Booster Seat Misuse in Alberta. Misuse was observed to be greater among males than females (39.8% vs. 28.4%) and approached statistical significance (p=0.057).

Table 4-4 Univariate Analysis of Information Source Utilization and Booster Seat Misuse

Information Source	# (%) Of Drivers Using Source	% Misuse Among Drivers Using Source	Unadjusted Odds Ratio [95% CI]	P
Other health professional	143 (43.3)	32.2	1.01 [0.56 - 1.91]	0.927
Manuals or pamphlets	141 (42.7)	32.6	1.17 [0.64 - 1.77]	0.799
Internet	62 (18.8)	29.0	0 .85 [0.41 - 1.75]	0.657
Non-health professional	53 (16.1)	26.4	0.73 [0.43 - 1.24]	0.245
Friends, family or community	47 (14.2)	12.8	0.27 [0.10 - 0.74]	*0.012*
Physician	47 (14.2)	22.2	0.60 [0.20 - 1.81]	0.357
News media	14 (4.2)	35.7	1.20 [0.37 - 3.88]	0.758
Retailers or dealerships	12 (3.6)	8.3	0.19 [0.02 - 1.60]	0.124
Government regulations	2 (0.6)	100.0	NA	NA
School or daycare	2 (0.61)	0.0	NA	NA

.

The rate of improper booster seat use can also be compared between drivers who have utilized different child restraint information sources. Overall the most utilized source was non-physician health professionals (43.3%) and manuals or pamphlets (42.7%) (Table 4-1,Table 4-4). Rate of booster seat misuse by utilized information source for which at least 20 observations were recorded ran from a high 32.6% among drivers who had utilized a manual or pamphlet to a low of 12.8% among drivers who had utilized friends, family or community groups (Table 4-4). Only one information source, 'friends, family or community' (p=0.012) exhibited as significant difference in misuse rate between drivers who did and did not utilize (Table 4-4). Drivers who consulted their friends, family members or community associations were at significantly reduced odds of booster seat misuse [OR: 0.27; 95%CI: 0.10-0.74; p=0.012] compared to those who did not utilize this source (Table 4-4). Additionally, the overall rate of misuse among drivers utilizing this information source (12.8%) was among the lowest observed in this survey (Table 4-4). Of note, is that the most utilized information sources also exhibited the highest rates of misuse (Table 4-4).

Table 4-5 Booster Seat Misuse Utilization or non-Utilization of Preferred Sources

	Did Not Utilize Preferred Source	Utilized Preferred Source	
Proper Use	139	86	
Improper Use	75	30	
Total	214	116	
			P-Value
% Improper Use	35.1	25.9	0.145

The rate of improper use among drivers who had utilized their preferred information source was lower than those who had not utilized their preferred source (25.9% vs. 35.1%), however this difference was not considered statistically significant (Table 4-5).

Table 4-6: Comparison of Misuse Percentage by Information Type between Drivers who Utilized their Preferred Source vs. Drivers who did not Utilize their Preferred Source

Information Source	**# of Drivers who Preferred Information Source**	**# of Drivers (% misuse) who Preferred <u>BUT DID NOT</u> Use**	**# of Drivers (% misuse) who Preferred <u>AND</u> Used**	**Survey Adjusted Pearson**	**P**
Non-physician health professional	95	34 (35.3)	61 (22.9)	0.865	0.358
Manuals or pamphlets	31	9 (33.3)	22 (45.5)	0.362	0.554
Internet	58	40 (27.5)	18 (27.8)	>0.001	0.983
Non-health professional	41	30 (43.3)	11 (9.1)	4.409	**0.047*
Friends, family or community	8	7 (28.6)	1 (0.0)	0.311	0.597
Physician	17	15 (26.7)	2 (0.0)	0.446	0.518
News media	12	9 (88.9)	3 (0.0)	6.711	**0.032*
Retailers or dealerships	16	16 (18.8)	0 (NA)	NA	NA
Government regulations	17	17 (23.5)	0 (NA)	NA	NA
School or daycare	31	30 (30.0)	1 (0.0)	0.433	0.518

**Statistically significant at the α=0.05 level*

The most commonly preferred information source in this survey was the non-physician health professional (n=95) and the least commonly preferred source were friends, family or community groups (n=8) (Table 4-6). The majority of drivers preferring a non-physician health professional (61/95) or a manual or pamphlet (22/31) were able to utilize these sources to obtain information (Table 4-6). However, for all others utilization of their preferred source was not the norm (Table 4-6). Among

drivers who had preferred each information source, the percentage misuse was compared between those who did and did not actually use it. Of the four primary preferred information sources specified (i.e. non-physician health professional, manuals/pamphlets, internet and non-health professional) the misuse rate dropped or stayed the same when a preferred source was used for all sources except manuals or pamphlets (Table 4-6).

4.4. Discussion

In a survey conducted across rural and urban Alberta, parents picking up their children at randomly selected daycares were approached and asked to identify child restraint information sources they had used as well as those they thought would be the best for parents to obtain information from. This was intended to represent their opinion on what they thought would be the best resource for drivers, regardless of their own personal utilization (referred to in this study as the 'preferred' source). The study identified that manuals/pamphlets and non-physician health professionals were the most commonly utilized sources with non-physician health professionals being the most preferred, at ~40% (Table 4-1). It is not surprising that non-physician health professionals are highly utilized as nurses are known to be one of the most trusted resources for obtaining health information and account for the vast majority of responses in this category (13, 14, 18). Additionally, consultation with health professionals regarding child restraints will often yield printed resources, and when considered with information in the booster seat instruction manuals and/or the vehicle owner's manual it is also not surprising that manuals or pamphlets are so widely used. However, while the use of manuals or pamphlets to obtain information was the most commonly utilized source, it was only the 4th most preferred option (Table 4-1), suggesting that they may not actually be the most desired method to obtain information, but simply remain commonly used because of their abundance and convenience. Only 19% of drivers utilized the internet to obtain child restraint information (Table 4-1), which is lower than estimates from other surveys on public utilization of healthcare information (18, 19). It is possible that child restraint information specifically is viewed differently by parents than other categories of

health information due to the often complex requirements for proper installation, and as such parents may simply prefer face-to-face consultation with a trained professional. Schools and daycares were the least utilized source, but jumped to the 5th most preferred source (Table 4-1). Parents may wish to obtain this information in the school setting, presumably because of convenience, but low utilization may suggest that opportunities for learning in this setting are limited. Efforts need to incorporate more child restraint information and learning opportunities into the elementary school environment, especially considering that evidence supports the use of in-school approaches with simultaneously parent and older child learning as one of the most effective mechanisms for improving child restraint usage rates within a community (20). Conversely, there appeared to be little desire to retrieve information from friends, family or community groups, however these sources are still being utilized relatively commonly, which may indicate they are being used as a last resort when other sources are either not sufficient or convenient(Table 4-1). Of note is the very low utilization of physicians as a child restraint information source, at only 4% (Table 4-1). This is somewhat surprising, considering that physicians are also consistently rated as a highly trusted information source (18).

In terms of ranking information source utilization and preferences between sexes, patterns remain similar to the overall trend, described above. Females were however more likely to both utilize and prefer a non-physician health professional compared to males, whereas males had stronger preference for non-health professionals (Table 4-2,Table 4-3). Males were also significantly more likely to have utilized the internet to obtain information compared to females (26.6% vs. 15.9%; p=0.048), although there was no significant difference in the preference for the internet between sexes (Table 4-2, Table 4-3). This is somewhat inconsistent with results of other surveys on internet utilization which have shown that females are actually more likely to use the internet to obtain health information (21). Overall, there appears to be a gap in information delivery to females via the internet and non-health professionals and to males via non-physician health professionals. Efforts must be two fold: 1) address these sex based under-utilizations and to modify existing methods of

delivery to make them equally attractive to all parents regardless of sex and 2) continue exploit these sex based preferences where possible to further enhance program delivery.

The highest misuse rates were observed among drivers who had utilized the most common sources, namely manuals or pamphlets and non-physician health professionals, whereas the lowest misuse rates were seen among drivers who had utilized less common sources such as physicians, non-health professionals, and unexpectedly friends, family or community groups (Table 4-4). Additionally, drivers preferring these less common sources were less likely to have actually used them (Table 4-4). Program delivery of child restraint information via manuals or pamphlets may need to be reassessed as it is the most commonly utilized source, but shows the poorest outcomes in this study. Results of this study indicate that more resources for training and awareness should be placed in the hands of non-physician health professional rather than physicians (as they are not a commonly utilized source), however this approach must be taken with caution as this survey also indicates that drivers that use a physician exhibit some of the lowest observed misuse rates (Table 4-4). While we must respect that the public may not wish to obtain information from these less commonly utilized sources, investing resources into strategies that may increase demand for these less utilized sources (i.e. physicians and non-health professionals) may be beneficial as they do appear to be quite effective.

For a source to be maximally effective results of this survey suggest that the individual must first wish to use it. Drivers who were able to utilize their preferred information source had the same or lower misuse rate than drivers who were not able to utilize their preferred source (Table 4-5). When analyzed by specific information source this trend remained the same for all except manuals or pamphlets, where misuse rates actually increased (Table 4-6). This demonstrates that there is not one specific source that is substantially better than any other, but rather that positive change in child restraint behaviour is likely to occur when a parent is able to access the information source they feel is best. One way public health can leverage this is to not only promote awareness of proper restraint use practices, but to ensure that there

are multiple different options and places to go to obtain information that are all equally promoted, along with a rationale as to why each is a trusted source of information.

The most significant limitation of this survey stemmed from modifications to the survey design as a result of unanticipated refusals from large school districts, which required all data collection to be done at childcare centers rather than at both childcare centers and elementary schools. As a result, the survey population was composed primarily of younger booster eligible children aged 4-6 years of age. It is not known if the information utilization parents of older booster age children differ from parents of younger booster age children. Also, due to differences in question design, percentages for utilization and preference of information sources could not be directly compared as utilization information was multiple response and preferences was a single response. While rankings in each group were instead compared, this means of comparison is not as powerful or statistically sound. Other biases present in this survey that may affect our results include participation bias, social desirability bias, self report bias, selection bias and potentially outdated data. Approached individuals were free to refuse participation in the survey, but it is not known how different non-participants were on their patterns of information source utilization. If agreeing to the survey, drivers are subject to self report bias in the recall of information sources used to gather information on child seats, which may not be correct. Additionally, drivers may have children eligible for other seats in the vehicle in addition to booster eligible children, thus stated information source utilization and preferences cannot be said to be directly related to the search for booster seat information specifically. Responses may also be subject to social desirability bias as respondents may succumb to perceived social pressure and offer that they have used a source to obtain information, when indeed they have not. Selection of child care centers as the study population introduces selection bias, as we do not know how different those attending childcare centers are regarding their patterns of information source utilization from those who do not attend, and what affect this may have had on our analysis. And finally, data collection occurred six years ago in 2008, and may not

accurately represent the current state of information utilization patterns in the province.

Analytical limitations include the absence of a Bonferonni correction during the data analysis, which, because of the high number of simultaneously tested hypothesis, increases the probability of Type 1 error (22). For this study specifically, it increases the probability of an information source showing a significant difference between males a females or exhibiting significantly lower misuse rates among those who have used it, when in fact no relationships exist. Due to the exploratory nature of this analysis, the intent was to consider all information collected in this thesis equally within somewhat relaxed statistical constraints in an attempt to develop baseline information for the purposes of guiding future work in this area. Being overly restrictive through the application of the Bonferonni correction for every comparison may have been detrimental to this goal. However, the potential for the lack of a Bonferonni correction to have a significant impact on our results cannot be discounted.

The strengths of this study include a description of information utilization patterns by both utilized source and preferred source (as they may not be the same) as well as comparisons of sex and urban/rural differences. In addition, drivers were asked to name any and all sources they have utilized instead of a single source, which provides a more representative picture of information use in the province. Because both information utilization and information preferences were collected, gaps can be identified that point towards potentially underutilized avenues for disseminating information. This is also the first study of its kind in Alberta thus provides crucial baseline information on how parents of booster eligible children obtain information on child restraints that will be used to guide future research and program enhancements in Alberta.

4.5. Conclusion

Nearly half of all drivers had used a printed resource or a non-physician health professional to obtain information on child restraints. While manuals or pamphlets were the most utilized source they were not well preferred, suggesting a preference for face-to-face communication with a trained professional. There is also evidence that

there is a need for additional information delivery in the school or daycare setting. While the preference and utilization of physicians to obtain child restraint information was low, those that did utilize were among the best restrained in the survey, as was the case for other less utilized resources such as the internet and non-health professionals. Conversely, those that utilized the most common information source of manuals or pamphlets exhibited the highest rate of misuse. However, when a driver was able to use their preferred information source, the rate of misuse either stayed the same or declined for all information sources except for manuals or pamphlets. This indicates that when parents are engaged in the process of learning and are accessing a source that they are wish to and/or are comfortable with, there is a higher probability of a positive behavioural change. Future work must focus on how to make child restraint manuals and pamphlets more effective at delivering messages that impart change as well as a strategy to deal with an abundance of varying information of this type. Strategies to incorporate more child restraint teaching and training into the school environment and to increase desire among parents to use non-health professionals and physicians, may also be of some benefit as these sources are all less commonly utilized but are shown in this survey to be the of the most effective.

4.6. References

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Chapter 5

5.0 Conclusion

5.1. Summary

The introductory chapter of this thesis outlined the rational and objectives of the project, chapter 2 presented a review of the relevant literature and the significance of the findings was described in chapters 3 and 4. The following section reiterates the results and implications of this thesis. The third chapter provides a descriptive analysis of the prevalence of booster seat misuse in Alberta, the nature of misuse and identified determinants. Overall in this survey nearly 1 in 3 booster eligible children were improperly restrained, and nearly 1 in 4 were in the wrong seat, for which the vast majority were prematurely graduated to an adult seat belt. The prevalence of seat choice errors increased significantly as child age and weight approached transition point boundaries. Additionally, even when a booster seat was correctly chosen, approximately 1 in 10 children were still improperly restrained, with the two most common reasons being an improperly positioned shoulder strap or a loose lap belt. The prevalence of booster seat misuse in this survey was much lower than recent Canadian estimates, with only 23.3% of booster eligible children seated in the wrong seat. Compared to these national values, this is a 57 percentage point decrease in the prevalence of improper seat choice among booster eligible children (1). What was similar was that both studies did observe an increase rate of booster seat misuse with age of child (1). The survey also identified predictors of booster seat misuse, the two strongest of which were not being able to recite any child restraint transition point when asked and having more than two children in the vehicle. Both of these risk factors have been previously identified in other jurisdictions (2).

The fourth chapter provided data on information sources that were the most commonly used by parents of booster eligible children, as well as their suggestions for where and how they would actually prefer to obtain child restraint information. Nearly half of all participants had used a printed resource or a non-physician health professional to obtain information on child restraints. While manuals or pamphlets

were the most utilized source they were not well preferred, suggesting a public preference for face-to-face communication with a trained professional. Males were more likely to consider obtaining information from non-health professionals or the internet, while females were more likely to consider and use non-physician health professionals. Drivers who utilized less commonly information sources such as physicians and non-health professionals exhibited the lowest rates of misuse. And finally, drivers who were able to utilize their preferred information source exhibited a lower rate of child restraint misuse, which was true overall, and for every source individually except for manuals or pamphlets.

5.2. Future Directions

Steps need to be taken in Alberta to increase the awareness of child restraint transition points, as knowledge of this is correlated with decreased odds of booster seat misuse. While is it debatable if knowledge of transition points leads to proper practice, or proper practice leads to better knowledge, there is a clear need for increased awareness within the population, as evidence suggests that at least 1 in 3 booster eligible children may be improperly restrained. In the absence of enacted legislation mandating the use of booster seat for children between 40lbs and 80lbs, there is an increased need for effective public health awareness campaigns. In addition to focusing on improving awareness of transition points, messaging also needs to be focused on describing the different ways in which parents can obtain information, and the rationale as to why it is a trusted source. There must also be an emphasis on more than one particular information source, as these data shows that if a preferred source is used of almost any type, it is able to result in a positive change. Sex based modifications to messaging guiding females to seek information from non-physician health professionals and males from non-health professionals may be also effective, as per differences in preference. While the both the preference for, and utilization of, physicians to obtain information on child restraints was very low, children of drivers who had utilized a physician were among the best restrained in the survey, and as such should not be left out of communication campaigns entirely.

Future prevalence studies should focus specifically on booster seat misuse among the oldest booster eligible children, as this group was underrepresented in this survey, and future work on risk groups should focus on those who have multiple children in the vehicle as well as younger drivers. There may also be an opportunity to enhance child restraint communication to parents within a school environment, as this was observed to be a preferred information source with very little utilization, suggesting limited availability. However, the essential first step in this province is the enactment of legislation mandating the use of booster seats between 40lbs and 80lbs, an intervention that has proven effective at decreasing the rate of booster seat misuse in other jurisdictions (3-6). When passed, legislation will only serve to enhance the existing efforts on the part of researchers, public health officials and front line care providers to change culture of booster seat use in Alberta.

5.3. Methodological Issues

The studies in chapters 3 and 4 were based on a survey of child restraint use among children eligible for forward-facing seats and booster seats; however, only booster eligible children were included in the analysis. While older booster age children are known to be at highest risk of premature graduation, they were unfortunately underrepresented in this survey.

In the initial sampling plan for this survey, separate estimates were to be obtained within both urban and rural stratums for both forward-facing seats and booster seats. Forward-facing seat data were to be obtained from childcare centers and booster seat data was to be obtained from elementary schools. Therefore, required samples sizes were required for four stratums: 1) urban childcare centers, 2) urban elementary schools, 3) rural childcare centers, and 4) rural elementary schools. Once selected, each location was to be visited by a team of two data collectors who approached drivers as they were leaving the location with their children to request participation in the survey. In the early stages of the survey, however, it was apparent to survey coordinators that sample size assumptions would not be met. Refusals from an unexpectedly high number of school districts, including a few large urban districts, resulted in the exclusion of many survey locations. The process of data collection was

not modified at this point in order to fully utilize resources that had already been secured, and an alternate analysis plan was developed following the completion of the survey.

Due to the substantial issues among elementary schools presented by district refusals, and the relative success among childcare centers, that the analysis was restricted to childcare center data of both forward-facing seats and booster seats. While the childcare center data were insufficiently powered to provide reliable prevalence estimates for both urban and rural Alberta, they did provide sufficient power to produce overall Alberta estimates for both forward-facing seats and booster seats by pooling all childcare centers. While doing so initially resulted in an imbalanced urban/rural ratio, all completed childcare centers at the end of the survey were categorized as urban or rural, pooled together and weighted according to the urban/rural population distribution of Alberta. All rural locations were given a 34.68% chance of being selected into the pooled sample while all urban locations were given a 65.32% chance. This new pooled sample would then be representative of the overall Alberta population terms urban/rural population distribution and serve at the final dataset for analysis for both forward-facing seats and booster seats. Prevalence outcomes from the survey were then expressed as a provincial estimate, rather than in separate urban and rural stratums as originally designed.

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Supplement

6.1. Appendix A: Sampling and Methodology Supplement

A cross sectional survey design was used to investigate the prevalence, nature and determinants of forward-facing seat and booster seat misuse in Alberta. In the initial sampling plan, separate estimates were to be obtained within both urban and rural stratums for both forward-facing seats and booster seats. Forward-facing seat data was to be obtained from childcare centers and booster seat data was to be obtained from elementary schools. Therefore, samples sizes were required for four stratums: 1) urban childcare centers, 2) urban elementary schools, 3) rural childcare centers, and 4) rural elementary schools. Once selected, each location would be visited by a team of two data collectors who approached drivers as they were leaving the location with their children and requested their participation in the survey.

6.1.1. Initial Sample Size Calculations

The number of childcare centers and schools required to obtain a provincial estimate of forward-facing seat misuse in separate urban and rural stratums depends on: 1) the background prevalence of misuse, 2) the choice of design effect and inter-cluster correlation, 3) required precision, 4) alpha (α), 5) the standard normal deviate and, 6) the number of subjects expected at each location. The following formula will be used to calculate the required number of clusters (1):

$$C = [P(1-P)D]/B * [Z^2_{1-\alpha}]/L^2$$

Where

C = number of clusters (i.e. survey locations)

P = anticipated background prevalence of misuse at childcare centers

D = design effect

α = size of the critical region (1 - α being the confidence level)

$Z_{1-\alpha}$ = standard normal deviate corresponding to the specified α

L = precision required

B = expected number of subjects per cluster

Reliable background prevalence estimates required for our sample size calculation were taken from a 2003 study conducted by Ebel *et al* in the state of Washington and Oregon as their methods, objectives, age group categories and restraint use definitions very similar to our research design (2). From this study, proper restraint use was estimated at 80% for children eligible for a rear-facing or forward-facing seat and 16.5% for children eligible for a booster seat. For the purposes of sample size calculation, it was assumed that this background prevalence applied to both urban and rural stratums within Alberta.

The efficiency of clustered sampling against simple random sampling can be quantified through the ratio their variances (varCLUS/varSRS), also known as the design effect (1). Every survey outcome has a distinct design effect which depends on the characteristics of the desired variable within the population to be studied (1). The design effect (D) can be calculated using the following formula:

$$(\text{varCLUS}/\text{varSRS}) = D = 1 + \rho(B - 1),$$

Where:
B = the number of individuals per cluster
ρ = the inter-cluster correlation

The variance of clustered sampling thus depends on the number of individuals sampled in each cluster and the inter-cluster correlation of the desired variable. While it is preferable that B and ρ remain constant for all clusters, reasonable approximations can still be achieved if otherwise. The inter-cluster correlation (ρ) is a statistical measure of the degree of homogeneity across population clusters, and will fall between 0 and 1. A higher ρ indicates that individuals within a cluster are in fact more similar to each other than to those of another cluster with respect to the desired variables, while a lower ρ indicates that individuals within a cluster are equally similar to those in other clusters as they are to themselves. Statistically, a high ρ suggests dependence within clusters, meaning that the total information supplied by a cluster may be no more than that supplied by a single member. A low ρ however, suggests

statistical independence within clusters, meaning that all individuals supply essentially equal information. For most measurements ρ will fall somewhere between 0 and 0.15. Taking a conservative approach, we assumed an inter-cluster correlation coefficient of 0.15 for this survey. We also require a 95% confidence interval with 10% precision (+/-5%) around each prevalence estimate. Thus the size of the critical region (α) is 0.05, precision required (L) is 0.05, and the corresponding standard normal deviate ($Z_{1-\alpha}$) is 1.96. We are expecting to recruit an average of 25 children per cluster, which with a ρ of 0.15 will correspond to a design effect of 4.5. Thus, the variance from our clustered sample will 4.5 times greater than if we had instead used a simple random sample. Previous studies have shown that consent from survey locations is given ~95% of the time (2), with the most common reasons for non-consent being dangerous parking situation, the area being prone to congestion and prohibitive corporate policy. These factors were taken into account during the location selection and contact process.

Applying these parameters for childcare centers (i.e. forward-facing eligible children) with a background prevalence of 80% yields a requirement of 45 sites, and assuming 25 observations per site, a total of 1,125 children. Since this sample must be collected within both urban and rural stratums, a total of 90 childcare centers and 2,250 forward-facing seat eligible children are required in order to obtain separate prevalence estimates for each strata.

Applying the same parameters for schools (i.e. booster eligible children) with a background prevalence of 16.5% yields a requirement of 38 sites, which equates to a total 950 children again assuming 25 observations per site. Since this sample must also be collected within both urban and rural stratums a total of 76 elementary schools and 1,900 booster seat eligible children are required in order to obtain separate prevalence estimates for each strata.

6.1.2. Contact Protocols

Once selected, locations were contacted to request permission to collect data on, or near, the property. For elementary schools, approval from the school district was first required, followed by approval by the school principal. Letters were sent to

the superintendent of each school district and manager of each childcare center that was selected into our sample, with a follow-up call placed the following week. Once approval was granted by the school district, the principal of each selected school was contacted by both phone and letter, and permission to conduct the survey on school property was requested. Only one level of permissions (obtained via phone contact) was required for childcare centers.

6.1.3. Pilot Testing and Early Indications

In the early stages of the survey it was apparent to survey coordinators that sample size assumptions would not be met. This was indicated by lower than expected location consent rates and a 'children surveyed per location' average of much less than 25 that was observed in both the initial pilot tests and in the first set of completed surveys. Due to weather-related limitations, pilot testing could not be conducted until immediately prior to the survey (i.e., after sample size had been calculated and locations selected/contacted) in order to accurately simulate weather conditions of the real survey. As a result, pilot tests were used primarily to test and refine the interview and inspection methodology and not used to inform sample size calculations. Pilot tests were conducted at an urban childcare center for 1.5 hours with a team of two data collectors and at three urban elementary schools (for 20 minutes each) with between 1 and 3 teams of data collectors.

6.1.3.1. Pilot Testing at the Urban Childcare Center

Nine drivers were approached during the 1.5 hours, five agreed to participate resulting in a total of seven children surveyed. Of the seven children surveyed, four were deemed eligible for a forward-facing seat. These results proposed a driver participation percentage of 55%, the potential for 14 children in three hours, an average of 1.5 children per vehicle but with only 0.8 children per vehicle of forward-facing seat age. These indicators suggested that our initial assumption of 25 children eligible for forward-facing seats per childcare center may be difficult to achieve.

6.1.3.2. Pilot Testing at the Urban Elementary School

Overall, 26 drivers were approached by a total of seven data collection teams at the three elementary schools. Twenty-one drivers agreed to participate resulting in 40 children surveyed. Of the 40 children surveyed, 24 were deemed eligible for a booster seat. These results proposed a participation percentage of 80.1%, an average of 1.5 children per vehicle, an average of 0.9 target children per vehicle (i.e., eligible for a booster seat), and the potential for only ~3.4 target-age children in the first 20 minutes. While this technically suggests that surveying 25 booster-eligible children per school three hours was possible, experience at these tests also suggested that very few, if any, drivers would be available to data collectors after the initial rush between 3pm and 4pm. Therefore it is realistic to expect that only ~5 booster seat eligible children could be surveyed at each school. Taken together, these indicators also suggested that it would be difficult, if not impossible, to fulfill our initial assumptions of 25 booster eligible children observed per elementary school.

6.1.4. Indications from the Early Surveys

During the first three weeks of the survey, results of the pilot test were confirmed by preliminary reports from data collectors; the number of target children surveyed at each location rarely exceeded 20 at childcare centers, 10 at elementary school, and also had not yet reached 25 at any one location. It is possible that the data collection methods of the study were more in-depth and took longer to complete than the comparison surveys from which our estimates had been calculated. Additionally, scheduling of data collection at rural sites was proving difficult due to competing priorities for the volunteer nursing time. Within the childcare centers, there were also difficulties making initial contact with site managers, resulting in a higher than expected refusal rate and increasing administrative time required to make multiple call-back attempts. While a pool of randomly selected replacement locations was selected to replace those that were deemed unable to contact (i.e., after three failed contact attempts with no messages received), consent still had not been received from the required number of locations on the study start date. At elementary schools, the primary issue was obtaining consent from the school districts to which the selected schools belonged. Refusals from an unexpectedly high number of school districts,

including a few large urban districts, resulted in the exclusion of a very large number of potential survey locations. As a result, smaller districts and charter schools were re-sampled in an attempt to recoup this loss. Surveys were also conducted at alternative locations where this age group could be expected (i.e., restaurants, summer programs, recreational centers etc.), although were not included in the analysis. Taken together, it became clear to study coordinators that surveying 90 childcare centers (45 urban and 45 rural) and 76 elementary schools (38 urban and 38 rural) with an average of 25 target children surveyed per site would not be achieved. The process of data collection was not modified as this point in order to fully utilize resources that had already been secured, however an alternate analysis plan was developed following the completion of the survey.

6.1.5. Operational Summary

In the summer of 2008 (May 1st – Aug 31st) surveys were conducted at 82 childcare centers (46 urban / 36 rural) and 36 elementary schools (25 urban / 11 rural). At childcare centers 939 drivers were approached, with 746 (79.5%) agreeing to participate, resulting in inspections conducted on 1,036 children under the age of nine years. Of these 1,036 children, 47 (4.5%) were deemed eligible for a rear-facing seat, 560 (54.1%) for a forward-facing seat, 409 (39.5%) were deemed eligible for a booster seat and 20 (1.9%) for an adult seatbelt. At elementary schools 164 drivers were approached, with 127 (77.4%) agreeing to participate, resulting in inspections conducted on 233 children under the age of 9 years. Of these 233 children, 5 (2.2%) were deemed eligible for a rear-facing seat, 60 (25.7%) for a forward-facing seat, 164 (70.4%) were deemed eligible for a booster seat and 4 (1.7%) for an adult seatbelt. Overall, 873 drivers and 1269 children under the age of nine were surveyed, which equates to a participation percentage of 79.2% (873/1,103) and an average number of children per participating vehicle of 1.5 (1,269/873).

6.1.6. Alternative Analysis Plan

When compared to the final survey statistics, the early predictions of low power proved accurate. While the number of childcare centers completed was close to the number required (82 completed vs. 90 required), the number of children surveyed

was very low (1,030 completed vs. 2,250 required). Within elementary schools, both the number of survey locations and number of children surveyed were low, with only 36 elementary schools surveyed (compared to 76 required) and 233 children (compared to 1900 required). Originally, the only data targeted for analysis was the booster seat data collected from elementary schools and the forward-facing data collected from childcare centers. When booster eligible children were present in a vehicle surveyed at a childcare center, or forward-facing eligible children were present in a vehicle surveyed at a childcare center, they would still receive a full inspection and interview, but were to be excluded from the analysis. However, due the major issues among elementary schools presented by district refusals, and the relative success among childcare centers, it was decided that childcare center data would be used for the analysis of both forward-facing seats and booster seats. While the childcare center data would not have enough power to provide reliable prevalence estimates for both urban and rural Alberta, it was expected that there would still be sufficient power to arrive at an overall Alberta estimate for both forward-facing seats and booster seats by pooling all childcare centers together at the conclusion of the survey. However, doing so would likely result in an imbalanced urban/rural ratio as initially half of the locations were rural and half were urban. To rectify this, all completed childcare centers at the end of the survey were categorized as urban or rural, pooled together and weighted according to the urban/rural population distribution of Alberta (3). All rural locations were given a 34.68% chance of being selected into the pooled sample while all urban locations were given a 65.32% chance. This new pooled sample would now be representative of the overall Alberta population terms urban/rural population distribution and serve at the final dataset for analysis for both forward-facing seats and booster seats. Prevalence outcomes from the survey would now be expressed as a provincial estimate, rather than in separate urban and rural stratums as originally designed.

6.1.6.1. Revised Sample Size for Forward-Facing Seats

The number of pooled locations required to obtain a representative provincial estimate of forward-facing seat misuse was calculated using the revised estimate of an average of seven children surveyed per location. This value was chosen after

considering information from the pilot test and preliminary data from the early surveys. As a result, the design effect for the survey dropped from 4.5 to 1.9, while the number of clusters required increased from 45 to 67. However only one strata of 67 locations was now required (urban and rural combined), instead of two strata of 45 (one for urban and one for rural). Assuming seven children per site, data on 469 children was required, down from the initial calculation of 2,250.

6.1.6.2. Revised Sample Size for Booster Seats

The number of pooled locations required to obtain a representative provincial prevalence estimate of booster seat misuse was calculated using the revised estimate of an average of five booster eligible children surveyed per location. This value was chosen after considering information from the pilot test and preliminary data from the early surveys. As a result, the design effect for the school phase of the survey dropped from 4.5 to 1.6, while the number of clusters required increased from 38 to also 67. However only one strata of 67 locations was now required (urban and rural combined), instead of two strata of 38 (one for urban and one for rural). Assuming five children per site, data on 335 children was required; down from the initial calculation of 1,900.

6.1.6.3. Suitability of the Alternative Analysis Plan

The alternative analysis plan involved a complete exclusion of data collected from at elementary schools due to low power. Instead, data collected at childcare centers would be used to estimate prevalence, nature and determinants for both forward-facing seats and booster seats as sufficient numbers are present within this stratum for both groups. Survey objectives were be modified to produce overall provincial estimates of misuse instead of separate misuse estimates for urban and rural, and weighted transformation was required in order to ensure a provincially representative urban/rural distribution (3). Revised sample sizes required 67 survey locations for both forward-facing seats and booster seats, with data on 469 forward-facing seat eligible children and 335 booster eligible children. The final childcare center sample comprised of 82 locations with 560 children eligible for a forward-

facing seat and 409 children eligible for a booster seat, sample sizes which were large enough to support the requirements of the alternative analysis plan as proposed.

6.1.7. Original Sample vs. Pooled Sample

In the pooled sample, 67 locations were randomly selected from the full list of 82, proportional to their urban/rural weighting. All 46 original urban locations and 21 of 36 original rural selections were selected, for an overall urban/rural distribution of 68.7% urban vs. 31.3% rural. True to the intention of our pooled sample, the urban/rural distribution is now reflective of the overall urban/rural distribution in the province of Alberta and can be used to accurately estimate outcome parameters on a provincial scale (3).

6.2. Appendix B – Information Sheet

UNIVERSITY OF ALBERTA
School of Public Health
Alberta Centre for Injury Control & Research

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Edmonton, Alberta, Canada T6G 2E1

www.acicr@ualberta.ca
acicr@ualberta.ca

Tel: 780.492.6019
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INFORMATION SHEET

Title of Project: Alberta Child Passenger Restraint Survey

Principal Investigator: Don Voaklander Ph.D.
Co-Investigator: Richard Golonka BSc.

Background: Many parents in Alberta are not properly restraining their children in cars.

Purpose: You are being asked to participate in a research study. The purpose of this study is to examine the patterns of child restraint use in Alberta.

Procedures: The survey will take about 5-10 minutes. You will be asked some questions and a certified technician will observe your child restraints.

Possible Benefits: There may not be any direct benefits to you. However, you will be given a child restraint information package. We will tell you if there are any errors in how you have used your child restraint. This study will help us develop better ways to increase the use of child restraints in Alberta.

Possible Risks: There are no risks involved in this study.

Confidentiality: No identifying personal information will be collected. Information will be kept in a locked office. Records will be destroyed in 7 years. Only the study team listed above will have access to this record.

You are free to withdraw at any time during the survey.

Questions or Concerns?

Contact:
Don Voaklander Ph.D
- Phone: (780) 492-0454 Fax: (780) 492-7154
- Email: don.voaklander@ualberta.ca

Richard Golonka BSc.
- Phone: (780) 492-9230 Fax: (780) 492-7154
- Email: rgolonka@ualberta.ca

Health Ethics Research Board
- Phone: (780) 492 0302 Fax: (780) 492 7808
- 213 Heritage Medical Research Centre
  University of Alberta, Edmonton, Alberta, T6G 2S2

6.3. Appendix C – Data Collection Form - Driver

Town/City:
Location Name:

Target Group:

ACRES Data Collection Form - Driver

1. OBSERVED VEHICLE #: ____

INTERVIEWER

2. Driver chooses to participate: yes no

Collect for all vehicles

3. # in vehicle under 9 yrs: (record) ____

4. Vehicle type: (circle one) Car SUV Van/Minivan Pick-up Truck

5. Location of children in vehicle: (circle all that apply)

Front of Vehicle

3	6	9	Cargo Area
2	5	8	
D (Driver)	4	7	

6. Driver gender: (circle one) M F

7. Driver age: (circle one) under 20 20's 30's 40's 50's 60's 70+

8. Driver properly restrained in seatbelt: (circle one) yes no don't know

Collect for non-participants if possible

9. Reason for non-participation? (circle and/or record)
- **a.** not enough time
- **b.** didn't say
- **c.** other

10. Comment on apparent restraint use (circle one)
- **a.** all children in vehicle restrained properly
- **b.** some improper restraint use was observed in this vehicle
- **c.** not sure

11. Additional information on non-participating driver (record)

12 .Year / make / model: (record) _____

13. Driver Relationship: (circle all that apply)
parent grandparent caregiver carpool other family member _____

14. What is the average length of time of your commute from here to home?
(record) ____ **min**

15: Will you be traveling at highway speed? yes no

16. How many hours per week, outside of the commute, are your children in a vehicle? ____ **hrs**

17. Where do you get your information on car seats? (circle all that apply)
a physician **b** public health nurse **c** other parents **d** vehicle owners manual
e CRS instruction manual **f** police officer or fire fighter **g** traffic safety website
h none **i** others _____

18. Where do you think parents should get information on transporting their child safely? (record) _____

19. Did you know there is a fine in Alberta for child restraint misuse?: yes no

20. Do you know what are the age and weight guidelines to move a child from a:
- **a. Rear-facing to forward facing?** ***Did they know 20-22lbs or at least 1y?:*** yes no
- **b. Forward facing to booster seat?** ***Did they know 40lbs or at least 6y?:*** yes no
- **c. Booster seat to seatbelt?** ***Did they know 80lbs or at least 9y?:*** yes no

Inspector will now inform driver of what they have found and point out any errors. Record any important and relevant drivers responses below

21.

22. Any other common problems or frustrations you have regarding the use of your child restraints. (record):

Need to be in a rear facing until they are at least 20-22 lbs (1)
Need to be in a forward facing seat between 20lbs until 40lbs (1-5)
Recommended they be in a booster between 40 and 80lbs (6-8)
Recommended they not use a seat belt until 80lbs (9 years)

6.4. Appendix D – Data Collection Form - Child

Town/City: Target Group:
Location Name:

ACRES Data Collection Form - Child

1. **OBSERVED VEHICLE #:** ____

INSPECTOR

2.	**Age / Weight** (specify months or years / lbs or kgs)	____ mo / yr ____lbs / kg	____ mo / yr ____lbs / kg	____ mo / yr ____lbs / kg
3.	**Restraint used** (refer to Restraint Types below)	A B C D E F	A B C D E F	A B C D E F
4.	**Seating Location** (refer to diagram)	_____	_____	_____
5.	**If UAS equipped, is it being used?**	YES NO	YES NO	YES NO
	Restraint Type: A (Seatbelt) **or D** (Booster Seat)			
6. →	**1** Is the seatbelt being used?	**1** Y N**	**1** Y N**	**1** Y N**
7.	**2** Does the seatbelt have a shoulder strap?	**2** Y N	**2** Y N	**2** Y N
8.	**3** Is the seatbelt tight?	**3** Y N	**3** Y N	**3** Y N
9. →	**4** Is the shoulder belt across the chest?	**4** Y N **	**4** Y N **	**4** Y N **
10.	**5** If **NO**, where is it?	**5** arm back	**5** arm back	**5** arm back
11. →	**6** Is the lap belt low on the hips?	**6** Y N **	**6** Y N **	**6** Y N **
	Restraint Type: B (FF Child Seat) **or C** (RF Child Seat)			
12.	**1** Is the shoulder harness at the correct height?	**1** Y N	**1** Y N	**1** Y N
13.	**2** Is the chest clip level with armpit?	**2** Y N NA	**2** Y N NA	**2** Y N NA
14. →	**3** Is the harness snug?	**3** Y N **	**3** Y N **	**3** Y N **
15. →	**4** Seat belt or UAS used?	**4** Y N **	**4** Y N **	**4** Y N **
16.	**5** Is the seat belt or UAS routed correctly?	**5** Y N	**5** Y N	**5** Y N
17. →	**6** Is the seat facing the correct direction?	**6** Y N **	**6** Y N **	**6** Y N **
	Restraint Type: B only (FF Child Seat)			
18.	**1** Tether anchor available?	**1** Y N unknown	**1** Y N unknown	**1** Y N unknown
19. →	**2** Tether anchor used?	**2** Y N **	**2** Y N **	**2** Y N **
20.	**Is this child properly restrained?**	YES NO	YES NO	YES NO
21.	**If NO, for what reasons?** (circle all that apply)	seat choice / seat install / seat use	seat choice / seat install / seat use	seat choice / seat install / seat use
22.	**Additional comments**			

Restraint Types

A: Seat Belt
B: Forward Facing CRS
C: Rear Facing CRS
D: Booster Seat
E: Unrestrained
F: Other

3	6	9	**Cargo Area**
2	5	8	
D (Driver)	4	7	

***** Identifies any misuse or using the wrong seat for the child's weight -- MUST be explained to the driver.***

6.5. Appendix E – Data Audits

At the 67 locations included in the pooled analysis a total of 747 drivers were approached and asked to participate in the survey. Of these 747 driver data collection forms, 210 (28.8%) received a full visual audit of all relevant fields, equating to a total of 8190 data entry decisions. Only 27 1-error forms, two 2-error forms and one 3-error form were found, for an overall total of 34 errors. This represents an exceptional data entry success rate of 99.6%. A similar process was then preformed on the child data entry forms, of which there were 841 in total. Overall, 603 (71.2%) child forms received a full audit of all 13 fields, representing a total of 7839 data entry decisions. Only 25 1-error forms, 10 two-errors forms and one three-error form were found, for an overall total of 48 errors. Again, this represents an exceptional data entry success rate of 99.4%. Partial audits were then conducted on the remaining forms (results not recorded) and selective data quality checks were completed where the automated decision regarding restraint eligibility based on age of child and restraint used did not coincide with the investigators evaluation. These records were pulled and re-evaluated in order to ensure the proper decision was recorded and utilized in the analysis.

6.6. Appendix F – Ethics

Health Research Ethics Board

213 Heritage Medical Research Centre
University of Alberta, Edmonton, Alberta T6G 2S2
p.780.492.9724 (Biomedical Panel)
p.780.492.0302 (Health Panel)
p.780.492.0459
p.780.492.0839
f.780.492.7808

HEALTH RESEARCH ETHICS APPROVAL FORM

Date of HREB meeting: **10/12/2007**

Name of Applicant: **Mr. Richard Golonka**

Organization: **U of A**

Department: **School of Public Health**

Project Title: **Child Restraint Use Patterns Among Alberta School Children Under the Age of 13**

The Health Research Ethics Board (HREB) has reviewed the protocol for this project and found it to be acceptable within the limitations of human experimentation. The HREB has also reviewed and approved the subject information letter and consent form.

The approval for the study as presented is valid for one year. It may be extended following completion of the yearly report form. Any proposed changes to the study must be submitted to the Health Research Ethics Board for approval. Written notification must be sent to the HREB when the project is complete or terminated.

Glenn G Griener

Dr. Glenn Griener, PhD
Chair of the Health Research Ethics Board
(B: Health Research)

NOV - 6 2007

Date of Approval Release

File Number: B-091007

UNIVERSITY OF ALBERTA

Capital Health
Edmonton and area

CARITAS HEALTH GROUP

6.7. References

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