Prevalence and predictors of booster seat use in Alberta, Canada

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ABSTRACT

OBJECTIVE: To determine the prevalence of booster seat misuse in a Canadian province and identify determinants of non-use.

METHODS: A cross-sectional study using parking lot interviews and in-vehicle restraint inspections by trained staff was conducted at 67 randomly selected childcare centres across Alberta. Only booster-eligible children were included in this analysis. Odds ratios (OR) and 95% confidence intervals (CI) are reported using unadjusted and adjusted logistic regression.

RESULTS: Overall, 23% of children were not in a booster seat, and in 31.8% of cases there was evidence of at least one misuse. Non-use increased significantly by age, from 22.2% for children 2 years of age to 47.8% for children 7 years of age ($p = 0.02$). Children who were at significantly increased risk of booster seat non-use were those in vehicles with drivers who could not recall the booster seat to seatbelt transition point (OR: 4.54; 95% CI: 2.05–10.06) or drivers who were under the age of 30 (OR: 3.54; 95% CI: 1.45–8.62). A front row seating position was also associated with significantly higher risk of non-use (OR: 18.00; 95% CI: 2.78–116.56). Children in vehicles with grandparent drivers exhibited significantly decreased risk of booster seat non-use (OR: 0.21; 95% CI: 0.05–0.85).

CONCLUSION: Messaging should continue to stress that the front seat is not a safe place for any child under the age of 9 as well as remind drivers of the booster seat to seatbelt transition point, with additional emphasis placed on appealing to parents under the age of 30. Future research should focus on the most effective means of communicating booster seat information to this group. Enacting mandatory booster seat legislation would be an important step to increase both awareness and proper use of booster seats in Alberta.

KEY WORDS: Child restraint systems; seatbelts; booster seats; car seats

La traduction du résumé se trouve à la fin de l'article.

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For children to travel safely in an automobile, specialized restraint devices are required. Canadian guidelines state that in order to keep children safe in the vehicle they must be in a rear-facing seat until they weigh at least 22 lbs (10 kg), a forward-facing seat until they weigh at least 40 lbs (18 kg) and a booster seat until they weigh at least 80 lbs (36 kg).¹ Parents are encouraged to keep children within each stage as long as possible, according to either these guidelines or the instructions specific to their seat.¹ In keeping with these national guidelines, all Canadian provinces with the exception of Alberta have enacted mandatory legislation addressing all three seat types and transition points. In Alberta, rear-facing and forward-facing seats are required by law, whereas booster seat use until at least 80 lbs (36 kg) carries a recommendation only.²

Booster seats reposition the height and angle of the seatbelt tightly across the chest and lower on the waist, increasing protection from injury and death in the event of a collision, as well as reducing injury severity.^{3–6} Unfortunately, these devices are often used improperly or not at all. Canadian estimates suggest that only 19.6% of children 4–8 years of age are properly restrained and that 63% graduate to a seatbelt too early.⁷ In addition to non-use, parents can misuse the seat even when it is used in an age-appropriate manner. Improper placement of the shoulder belt or loosely installed seats are two commonly reported errors.^{8,9} Using a booster seat with improperly positioned lap or

shoulder belts is dangerous and has been shown to increase the risk of serious injury.⁴

Enactment of booster seat legislation has commonly been followed by increased usage proportions and reductions in motor vehicle collision injuries and deaths among children.^{10–12} While recent observational surveys suggest that the proportion of correct child restraint use in Alberta among all children under the age of 9 may be among the highest in the country, there is still considerable room for improvement to both legislation and overall prevalence rates, given Canada's ongoing goal of reducing motor vehicle collision fatalities and serious injuries as part of Road Safety Strategy 2015, as well as the overarching goal of having the safest roads in the world.^{7,13–15} This study used cross-sectional survey data

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to determine the prevalence of booster seat misuse in Alberta and identify important determinants of non-use.

METHODS

Children in childcare centres were selected as the survey population because of the predictable nature of transport at these locations, the availability of enrolment data and the abundance within both urban and rural areas. Centres were weighted to achieve a provincially representative urban/rural distribution and selected for the survey at random (without replacement), such that the probability of selection was proportional to the number of eligible children enrolled at each location.^{16,17} Locations agreeing to participate were required to withhold information on study scheduling in order to avoid the Hawthorne effect. The required sample size was calculated at 68 clusters, and 67 were successfully surveyed.

During the months of May through September, a team of two inspectors approached drivers picking up their children as they exited the childcare centre and asked them to participate in a 5-minute survey and restraint inspection. For drivers agreeing to participate, inspections were conducted on all children in the vehicle under the age of 9; however, only booster-eligible children (as determined by age, weight or investigators' decision) are considered in this analysis. The inspection then assessed between five and seven aspects of child restraint use, depending on the restraint used. For booster seats, after the driver had secured the seat and restrained the child, investigators scored the following questions on the survey form as either "Yes" or "No": 1) Is the seatbelt being used? 2) Does the seatbelt have a shoulder strap? 3) Is the seatbelt tight? 4) Is the lap belt low on the hips? 5) Is the shoulder belt across the chest? and 6) If the shoulder belt is not across the chest, is it behind the back or under the arm? Misuses were then categorized as either booster seat non-use or booster seat use with errors. These observations, combined with the age/weight of the child supplied by the driver, were used to determine whether the child was properly or improperly restrained. Only one adult, the driver, was interviewed within each vehicle with regard to knowledge of child restraint laws/recommendations, travel patterns and other relevant demographic information. All predictor variables used in this analysis were present on the survey instrument as categorical variables with pre-identified options for selection, with the exception of vehicle year and commute length, which were collected as specific values provided by the driver. Where relevant, an "other" category was added to capture responses not included on the form.

The survey team comprised either nurses with prior experience conducting child restraint inspections or trained undergraduate summer students. Regardless of background, both groups attended a 2-hour information session outlining the study objectives, interview procedures, data collection processes and restraint assessment criteria, and were provided with a comprehensive training guide. A certified child restraint professional delivered training sessions face to face (or, if geographic considerations precluded this, by videoconference) to small groups.

Data were analyzed using Stata 10 (Stata Corp., College Station, TX). Significant differences in error proportions by age and weight, as well as by the 14 predictor variables assessed in our survey, were determined by univariate logistic regression after adjustment for clustering by vehicle and site. Predictors of booster

seat non-use were modeled with survey-adjusted logistic regression using a manual purposeful selection process. All variables with a univariate significance of $p < 0.25$ were entered into the full model and then removed if the p value of their Wald statistic was greater than 0.15. This reduced model was compared with the full model using the Wald test to assess the impact of multiple covariate removal. The reduced model was evaluated for confounding, defined as a 20% change in parameter estimate, with identified confounding variables returned to the model; the iterative process of model fitting was repeated until all excluded variables were deemed unimportant from the perspective of statistical significance or confounding. At this point, all variables that were excluded from the full model at $p < 0.25$ in step one were then added back, one at a time, to check for the presence of potentially overlooked important contributions, as measured by a Wald statistic p value, yielding the main effects model. The main effects model was tested for the presence of interaction terms and goodness of fit assessed by means of an F -adjusted mean residual test adjusted for survey effects, yielding the final model. This purposeful selection algorithm has been previously described and shown to be effective at retaining both significant covariates and meaningful confounders.^{18,19} The study was approved by the University of Alberta Health Research Ethics Board (No. B-091007).

RESULTS

Overall, 747 drivers were approached, and 594 (79.5%) agreed to participate. Drivers significantly less likely to participate ($p < 0.05$) were those in passenger cars (86% vs. 78%) and those whose children were unrestrained (84% vs. 26%). In the 594 participating vehicles, 330 children were deemed eligible for a booster seat. Ages ranged from 2 to 8 years (median of 4) and weight from 40–84 lbs (18–38 kg) (median of 40–44 lbs (18–20 kg)). The survey population is skewed towards younger children because of the age-based characteristics of childcare centres; only 7.9% of booster-eligible children were 7 years of age or older, and only 7.7% were over 65 lbs (29.5 kg).

Of booster-eligible children, 23% ($n = 76$) were not in a booster seat: 17.9% overall ($n = 59$) had been prematurely graduated to 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. Of the 254 children seated in booster seats, 11.4% ($n = 29$) were still considered improperly restrained, the most common problems relating to improper tightening of the seatbelt (44.8%; $n = 13/29$), running the shoulder belt under the arm or behind the back (37.9%; $n = 11/29$), or not having the lap belt low enough on the hips (20.7%; $n = 6/29$). At least one misuse of any type was observed in 31.8% ($n = 105$) of booster-eligible children.

Significant differences in the prevalence of non-use were observed by both age and weight. The lowest prevalence of non-use occurred among 3-year-olds (13.3%) and 4-year-olds (17.3%) and the highest prevalence among 7-year-olds (47.8%) and 8-year-olds (100.0%) (Table 1). Similarly by weight, the prevalence of non-use started to increase at 50 lbs (23 kg) and reached a peak of 100.0% at 80–84 lbs (36–38 kg; Table 2). Children riding with drivers who could successfully recall the booster seat to seatbelt transition point exhibited the second lowest non-use proportion of all groups analyzed in this survey (14.1%), second only to children riding with grandparent drivers (7.7%; Table 3). The highest proportion of non-use occurred among children seated

Table 1. Percentage misuse by age and misuse mode for booster-eligible children ($n = 330$)

Age (years)	% usage errors while in correct seat	% booster seat non-use
2	7.1	22.2
3	13.9	13.3
4	12.9	17.3
5	9.8	27.1
6	11.5	29.7
7	0.0	47.8
8+	—	100
	$p = 0.084$	$p = 0.020^*$

* Statistically significant at $p < 0.05$.**Table 2.** Percentage misuse by weight and misuse mode for booster-eligible children ($n = 296$)

Weight (lbs)	% usage errors while in correct seat	% booster seat non-use
40–44	15.2	10.3
45–49	5.8	14.8
50–54	6.3	33.3
55–59	0.0	31.8
60–64	0.0	52.0
65–69	0.0	50.0
70–74	0.0	33.3
75–79	33.3	25.0
80–84+	—	100
	$p = 0.128$	$p < 0.0001^*$

* Statistically significant at $p < 0.05$.

in the front row (69.2%; Table 3). It must be noted that sample sizes for grandparent drivers and front-row child occupants were small ($n = 13$ for both).

Variables retained in the final logistic regression model associated with an increased risk of booster seat non-use included children in vehicles with drivers who 1) could not recall the booster seat to seat belt transition point (OR: 4.54; 95% CI: 2.05–10.06) or 2) were under the age of 30 (OR: 3.54; 95% CI: 1.45–8.62) (Table 4). Being seated in the middle second row seating position was also associated with increased risk of non-use (OR: 2.61; 95% CI: 0.97–7.01), although this risk estimate was slightly above the level of statistical significance (Table 4). The OR for non-use in the front row seating position was also high and statistically significant (OR: 18.00; 95% CI: 2.78–116.56); however, this should be interpreted with caution because of the wide confidence intervals (Table 4). On the other hand, children in vehicles with grandparent drivers exhibited significantly decreased risk of booster seat non-use (OR: 0.21; 95% CI: 0.05–0.85) (Table 4).

Being in a vehicle with a total of three or more children under the age of 9 years (OR: 3.28; 95% CI: 0.89–12.02) was retained as a confounder as its presence increased the risk of non-use at the middle second row position seating position by more than 20%. The variable “children riding with male drivers” was also added as it made an important contribution to the final model (OR: 1.89; 95% CI: 0.90–3.93), even though initial univariate

significance was low ($p = 0.392$; Tables 3 and 4). An F -adjusted mean residual test statistic (adjusted for survey effects) of 0.344 ($p = 0.945$) for this final model demonstrated a good fit.

DISCUSSION

Using an observational on-site interview and inspection, this study examined booster seat use among children attending child-care centres across Alberta. Overall, 31.8% of booster-eligible children were improperly restrained, and 23% were in the wrong seat, with older children at higher risk. By comparison, the proportion of driver seatbelt non-use in Canada is estimated at only 5%.¹³ These results suggest that booster-eligible children are chronically under-restrained and are among the most vulnerable vehicle occupants on Alberta’s roads.

The most common error was not using a booster seat when indicated, present in 1 in 5 booster-eligible children overall. Booster seat non-use increased significantly with both age and weight, providing further evidence describing the extent of premature graduation (Tables 1 and 2). Overall, approximately half of booster-eligible children at least 7 years of age or weighing at least 70 lbs were not in a booster seat, the cause in every instance being premature graduation to a seatbelt. Additionally, 70% of prematurely graduated booster-eligible children of any age exhibited improperly fitting lap or shoulder belts, again demonstrating that using a seatbelt is not safe for any child under the age of 9. When booster-eligible children were instead seated in a booster seat, the presence of usage errors was low, at only 1 in 10, suggesting that when a booster seat is chosen correctly parents have little difficulty learning how to use it properly.

Drivers who were unable to accurately provide the booster seat to seat belt transition point or were under the age of 30 were considered to be the two factors most strongly associated with booster seat non-use in this survey (Table 4). These factors have also been identified in previous surveys as predictors of use/misuse.^{20–23} The association between knowledge of transition points and decreased risk of non-use suggests a population that is receptive to the use of booster seats, but awareness and incentives may be lacking on a wider scale. While it is recognized that using a booster seat properly is just as important from a safety perspective as choosing to use one, if a choice has to be made then social marketing campaigns in Alberta could consider a simplistic approach of communicating only a transition point reminder, this based on a high non-use prevalence (23.0%) compared with the lower prevalence of usage errors when boosters are used (11.4%). Additionally, it may be beneficial to target these reminders specifically to young parents, an identified high-risk group in this survey (Table 4). Delivery of this type of messaging would also be essential in the event of a change in booster seat legislation, as it has been shown that social marketing campaigns occurring concurrently with legislation changes can enhance the legislative effect.²⁴ This may also work to increase the speed at which booster seat use is accepted as a social norm, an identified predictor of an intention to use a booster seat.^{24,25}

National recommendations stress that no child under the age of 9 years should be seated in the front.¹ All children observed in the front seat in our survey who were not riding in a pickup truck ($n = 9$) could have been seated in the rear, as there was space

Table 3. Univariate predictors of incorrect seat choice ($n = 330$)

Variable	Seat choice error			
	<i>n</i> (children)	% booster seat non-use	Survey adjusted odds ratio [95% CI]	<i>p</i>
Urban/rural				
Urban	232	24.1	1.29 [0.60–2.75]	0.507
Rural	98	20.4	Ref.	
Driver sex				
Male driver	93	30.1	1.36 [0.67–2.74]	0.392
Female driver	232	19.8	Ref.	
Number in vehicle <9 years				
One	126	21.4	Ref.	
Two	159	19.5	1.02 [0.47–2.23]	0.951
Three or more	45	40.0	2.41 [0.76–7.58]	0.131
Vehicle type				
Passenger car	122	27.1	Ref.	
SUV	76	17.1	0.52 [0.14–1.17]	0.095
Van or minivan	81	22.2	0.73 [0.26–2.01]	0.535
Pickup truck	32	25.0	0.60 [0.19–1.92]	0.383
Driver age				
Under 30 years of age	85	32.9	2.78 [1.33–5.82]	0.008*
30 years of age and older	242	19.4	Ref.	
Vehicle year				
1998 and older	30	23.3	Ref.	
Newer than 1998	260	23.5	1.00 [0.37–3.07]	0.997
Driver relationship				
Driver is parent	309	24.0	Ref.	
Driver is grandparent	13	7.7	0.40 [0.05–2.95]	0.364
Driver – “other”	2	25.0	0.46 [0.41–5.12]	0.522
Commute time				
Under 5 min	81	30.9	2.21 [0.95–5.13]	0.064
5 min commute or longer	249	20.5	Ref.	
Maximum speed on commute				
Reaches 80 kph (50 mph)	67	20.9	Ref.	
Does not reach 80 kph (50 mph)	262	23.7	1.12 [0.53–2.73]	0.652
Fines				
Knowledge of fine	253	21.3	Ref.	
No knowledge of fine	72	29.2	1.42 [0.60–3.40]	0.412
RFS to FFS transition point knowledge				
Knew	183	16.9	Ref.	
Did not know	144	29.9	2.69 [1.26–5.73]	0.011*
FFS to BS transition point knowledge				
Knew	223	16.6	Ref.	
Did not know	105	36.2	3.43 [1.61–7.28]	0.002*
BS to SB transition point knowledge				
Knew	198	14.1	Ref.	
Did not know	127	36.2	4.84 [2.32–13.12]	<0.0001*
Seating location				
Front row	13	69.2	5.59 [1.45–21.46]	<0.013*
Outside second row	260	18.9	Ref.	
Inside second row	28	35.7	2.03 [0.73–5.64]	0.173
Last row	23	30.4	0.92 [0.16–0.36]	<0.0001*

* Univariate statistical significance at $p < 0.05$.

SUV, sport utility vehicle; RFS, rear-facing seat; FFS, forward-facing seats; BS, booster; SB, seat belt.

available. The risk of non-use among front seat occupants was high in our final model, but confidence intervals were wide because of the small sample ($n = 13$), so these results should be interpreted with caution. Regardless, it is a reminder that the message to parents that the rear seat is the only safe place for any child under the age of 9 must continue.

Being seated in the middle of the second row was identified as a factor that may contribute to non-use, although not reaching the level of statistical significance (Table 4). Identification of this variable differs from the results of other published studies on rear-facing and forward-facing seats in the middle seating position.²⁶ Additionally, Macy et al. found that second row child passengers who were not the lone occupant in the row exhibited better child restraint usage; however, this was not categorized by seating position or booster seats specifically.²⁷ Higher risk of non-use in the middle second row in our survey may be more related to having multiple children in the vehicle rather than to seating position on

its own, as the risk of non-use increased after accounting for multiple children as a confounder. It seems plausible that having two other young children in the vehicle, with both in the outside seating positions of the second row and requiring child restraints of their own, could act as a barrier to booster use in the middle seat. Having multiple children in the vehicle has been identified as a predictor of misuse in prior surveys; however, future research may need to further investigate the specific impact on non-use by seating position in vehicles that do not have a third row (i.e., passenger cars and some sport utility vehicles).^{20,22}

Children riding with grandparent drivers exhibited significantly lower risk of non-use compared with parent drivers; however, the sample was small in this subgroup. Previous research has found that grandparent drivers were slightly less likely to choose an optimal restraint for all children under 15 years, which is not in line with our results for booster seats.²⁸ Interestingly, while grandparents exhibited the lowest booster seat non-use

Table 4. Multivariate logistic regression model for seat choice errors ($n = 330$)

Variable	OR	95% CI	Standard error	p
Did not know BS to SB transition point	4.54	2.05–10.06	1.81	<0.0001
Seated in the front row	18.00	2.78–116.56	16.83	0.003*
Drivers under 30 years of age	3.54	1.45–8.62	1.58	0.006
Grandparent drivers	0.21	0.05–0.85	0.15	0.029
Seated in the middle second row [†]	2.61	0.97–7.01	1.29	0.057
3+ children under 9 years in vehicle [†]	3.28	0.89–12.02	2.14	0.074
Male drivers [†]	1.89	0.90–3.93	0.69	0.090

* Very high standard error, interpret with caution.

[†] Not statistically significant, but included in the final model because of meaningful effects on significant variables.

OR, odds ratio; CI, confidence interval; BS, booster seat; SB, seatbelt.

proportion (7.7%) in our survey (Table 3), only 31% could recall the booster seat to seat belt transition point, much lower than the parent driver recall proportion of 62.5%.

Snowdon et al. reported in 2009 that 77.5% of booster-eligible children in Canada were prematurely graduated, according to a roadside observational survey across Canada.⁷ Alberta estimates from the current survey, based on parking lot interviews, however, produced a much less severe picture, with only 23.3% of booster-eligible children seated in the wrong seat and 31.8% misuse overall. Potential reasons for this large discrepancy are that 1) Alberta had the highest proportion (63.9%) of proper child restraint use in the country in the 2006 National Roadside Observational Survey,⁷ 2) older booster-eligible children who are at the highest risk of improper seat choice were underrepresented in our survey, 3) those who suspected their restraint practices were erroneous may have been less likely to choose to participate, 4) seats were inspected after the child had been restrained by the driver under direct observation and 5) booster seat parking lot interviews have been proven to underestimate misuse compared with roadside observations.¹⁰ In fact, in a subsequent survey in 2010 Snowdon et al. reported Canadian estimates of booster seat misuse obtained from parking lot interviews using methodology similar to that of our survey to be much lower, at 29.1%, which is more closely aligned with our estimates.¹⁰

This survey has several additional limitations. First, only children attending childcare centres were included, and it is not known whether the prevalence of misuse in this group is different from that in the group not attending childcare centres. Second, inspections were performed by multiple teams across the province, and while all received identical training, because of geographical limitations it was not possible to conduct reliability estimates among teams. Because of this, we are not able to report on the potential for clustering by interviewer. And third, multiple statistical tests were performed, which increases the probability of Type 1 error.²⁹ In our defence, the analyses were restricted to the primary outcomes, and a multivariable regression equation was produced to adjust for confounders.

The strengths of this study lie in the provincial representativeness of the prevalence estimates, which were obtained proportionally from both urban and rural communities. Additionally, estimates were based on an individual eligibility decision for each child rather

than the percentage misuse among children seated in a certain seat or those within a specific age group. Refusals were also low (20.5%) compared with prior parking lot interviews in Canada.¹⁰ Our survey represents new data for Alberta, providing valuable baseline information for researchers, health professionals and policy-makers.

While the observed prevalence of proper booster seat use in Alberta may be high relative to other provinces, it still lags behind the rate of adult seatbelt use by a substantial margin. In order to narrow this gap, public awareness of the age- and weight-based booster seat transition points in Alberta must improve; this could be aided greatly by enactment of booster seat legislation similar to what is in place in other provinces in Canada.

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RÉSUMÉ

OBJECTIF : Déterminer la prévalence du mésusage des sièges d'appoint dans une province canadienne et repérer les déterminants de leur non-utilisation.

MÉTHODE : Dans 67 centres de la petite enfance sélectionnés au hasard en Alberta, nous avons mené une étude transversale comportant des entretiens dans les parcs de stationnement et des inspections des ensembles de retenue dans les véhicules par du personnel formé. Seuls les enfants ayant besoin d'un siège d'appoint ont été inclus dans l'analyse. Les rapports de cotes (RC) et les intervalles de confiance de 95 % (IC) obtenus par régression logistique ajustée et non ajustée sont indiqués.

RÉSULTATS : Globalement, 23 % des enfants n'étaient pas dans un siège d'appoint, et dans 31,8 % des cas, il y avait des signes d'au moins un mésusage du siège. La non-utilisation augmentait de façon significative avec l'âge, passant de 22,2 % pour les enfants de 2 ans à 47,8 % pour les enfants de 7 ans ($p = 0,02$). Les enfants qui étaient significativement plus à risque de non-utilisation d'un siège d'appoint étaient ceux dans les véhicules dont le conducteur ne se souvenait pas du point de passage du siège d'appoint à la ceinture de sécurité (RC : 4,54; IC de 95 % : 2,05–10,06) ou dont le conducteur avait moins de 30 ans (RC : 3,54; IC de 95 % : 1,45–8,62). La place de l'enfant sur le siège avant était aussi associée à un risque sensiblement plus élevé de non-utilisation (RC : 18,00; IC de 95 % : 2,78–116,56). Les enfants dans les véhicules conduits par un grand-parent présentaient un risque sensiblement moins élevé de non-utilisation du siège d'appoint (RC : 0,21; IC de 95 % : 0,05–0,85).

CONCLUSION : Dans les messages, il faut continuer à souligner que le siège avant n'est pas un endroit sûr pour les enfants de moins de 9 ans, rappeler aux conducteurs quel est le point de passage du siège d'appoint à la ceinture de sécurité, et s'adresser en particulier aux parents de moins de 30 ans. Les études futures devraient porter sur les moyens le plus efficaces de communiquer l'information sur les sièges d'appoint à ce groupe. L'adoption de mesures législatives obligatoires sur les sièges d'appoint serait un pas important pour accroître la sensibilisation et l'utilisation correcte des sièges d'appoint en Alberta.

MOTS CLÉS : systèmes de retenue pour enfant; ceintures de sécurité sièges d'appoint; sièges d'auto