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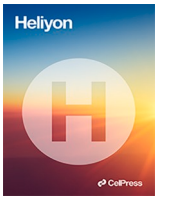

Child restraint systems: Understanding confidence in proper use and addressing the need for education

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ABSTRACT

Objective: To quantify the extent of proper local child restraint system (CRS) use and to better understand changes to the level of self-reported confidence with increased CRS installations. With the goal being to improve safety for children travelling in personal vehicles across London, ON and the region.

Methods: Public CRS clinics were initiated by Injury Prevention staff after they obtained the Child Passenger Safety Technician certification. Additionally, an online survey was commissioned targeting Ontario parents who had installed at least one CRS in the last five years.

Results: From September 2018 to September 2019, 96 comprehensive CRS checks were performed, with 29% of systems found to be installed correctly. Survey results showed a high level of reported confidence with CRS installation (N = 514, 70% female, 43% one child). Parents who had installed only one CRS reported higher confidence in their first install, compared to parents who had installed two or more systems.

Conclusions: The error rate with CRS installation and use seen in London, Ontario and the region, is similar to that reported in previous research. Survey results showed high levels of self-reported confidence in CRS use, especially for parents who have installed only one CRS. There presents a need to better understand the root cause of the discrepancy between level of confidence and proper CRS use and to expand our understanding of CRS knowledge retention and transferability to subsequent systems.

1. Introduction

Motor vehicle crashes (MVCs) cause the greatest number of injury-related deaths in children, 0–14 years of age [1]. For infants and children to ride safely in vehicles, an appropriately sized, fitted, and secured Child Restraint System (CRS) is required. Transport Canada, under the Motor Vehicle Safety Act, subsection Motor Vehicle Restraint Systems and Booster Seats Safety Regulations (SOR/2010–90), outlines the requirements for each category of CRS [2]. The National Safety Mark, displayed on the side of the CRS, demonstrates that the device meets the Canadian Motor Vehicle Safety Standard (CMVSS). It is widely understood that CRS use reduces the risk of injury in the event of an MVC. In developed countries, where awareness of CRS use is high, issues remain with sub-standard

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CRS use and are recognized as important contributors to MVC injuries and casualties [3–7].

Sub-standard restraint use includes both (1) inappropriate CRS, which are restraints that are not applicable for a child's size or age, and (2) incorrect CRS, which are restraints not installed to the vehicle as directed or where the child is not secured accurately [8]. In the National Highway Traffic Safety Administration's Child Restraint Use Special Study in the United States, the overall incorrect use rate was 46% for all types of CRS [9]. More recently in New South Wales, Australia, only 1% were inappropriately restrained based on age, but 60% were incorrectly restrained [10]. In Canada, the most recent observational study, completed in 2010, found that nationally, 46–70% of CRS were used inappropriately, based on age, for children four to eight years [11]. In addition, results revealed that compared to provinces without booster seat legislation or provinces with recent booster seat legislation, provinces with booster seat legislation enacted before 2006, had the highest (70%) observed inappropriate CRS use, for children four to eight years [11].

As past Canadian observational studies have primarily focused on appropriate CRS use, this study concentrated on both appropriateness and correctness of CRS use. With the overarching goal to improve safety for children travelling in personal vehicles across London, ON and the area, we sought to quantify the extent of improper CRS use locally and to understand parents' level of confidence with their CRS installations in Ontario, Canada.

2. Materials and methods

2.1. Phase one – community CRS checks

Injury Prevention staff at London Health Sciences Centre (LHSC) obtained the Child Passenger Safety Technician certification from the Child Passenger Safety Association of Canada in June 2018. With this certification, phase one of the project began, whereby staff initiated holding CRS clinics for the public to inspect the installation and fit of CRS. Each CRS was inspected by two technicians. Child restraint systems were assessed for correct installation (tightness, recline angle, use of tether strap if applicable, and adherence to CRS manual), appropriateness of seat based on height/weight of child, and fit for child in terms of harness strap or seat belt when CRS is in use (CRS inspection form provided in Appendix A). The CRS was determined to be "correct" if all criteria listed on the CRS inspection form were met and "incorrect" if at least one criterion was not (See Appendix A). If the clinic appointment was completed prenatally or the child was not present, a demonstration was given on how to adjust harness straps and buckles using a doll to show indicators to assess appropriate fit.

Clinics were advertised on multiple units throughout the hospital (i.e., Emergency Department, Family Resources Centre, Mother Baby Care Unit, Neonatal Intensive Care Unit, Women's Care, and Preadmit), and through community networks (i.e., health unit, family resource centres, daycares, etc.), inviting interested families to book a free appointment for service.

2.2. Phase two – online survey

Phase two began in January 2019 when an online survey was commissioned with Qualtrics to better understand Ontario parents' knowledge and perception of their CRS use. Level of confidence was selected as the primary outcome in an effort to identify the gaps, in terms of proper CRS installation and use. Qualtrics is a global survey technology enterprise that manages and provides customers with online samples. Qualtrics's methodology uses traditional, actively managed market research panels [12]. Survey questions were developed based on a review of a previously conducted survey by a health unit in Southwestern Ontario (See Appendix B). The draft survey was focus tested with a convenience sample of parents, hospital staff, and community partners that work with parents and families of young children. A target sample of 500 respondents was selected based on available funding. The following participant inclusion criteria were used; must be an Ontario resident, have children, have installed at least one CRS in the last five years, and be over 18 years of age. Quotas were set for age and education level that were aligned to 2016 census data (quotas provided in Appendix C). A cap was set at 45%, for the number of respondents with only one child to allow a comparison with individuals who had more CRS installation experience (survey questions provided in Appendix B). Potential respondents were sent an email invite that did not include specific details on the survey topic, but instead the length of the survey and offered incentive. Incentives varied but could have included cash, air miles, gift cards and vouchers. Being a commissioned survey, the authors did not know the number of persons contacted which resulted in a sample size of 514 respondents. All values are reported as frequency and proportion of respondents.

To test for an association between the number of CRS installed and confidence with their first installation, the Cochran-Mantel-Haenzsel test was used. This test determines if the proportion of respondents are the same among the ordered categories. The change in confidence between the first and most recent CRS installation was tested using respondents who had installed more than one CRS. Level of agreement with the statement *'I felt confident that I installed my car seat correctly'* was assigned a numerical value as follows; -2 = strongly disagree, -1 = somewhat disagree, 0 = neutral, 1 = somewhat agree, and 2 = strongly agree. The Wilcoxon Signed-Rank test was then used to test if the change in confidence level between the most recent and first installation was equal to 0. Statistical significance was considered when $p < 0.05$. The data were collapsed into three categories for the graph analysis but statistical analysis was completed using the five-category scoring system.

The commissioned online survey was used for quality improvement and program evaluation. Following the direction of the Interagency Advisory Panel on Research Ethics, "Quality improvement studies and program evaluation activities when used exclusively for management or improvement purposes do not fall within the scope of REB review." [13] All survey data were collected anonymously and reported in aggregate.

3. Results

3.1. Phase one – community CRS checks

From September 2018 to September 2019, 96 comprehensive CRS checks were performed during 17 clinic days. All clinics took place in an urban centre, in London, ON, with 15 being held in an outdoor parking lot at the hospital and two in a mall parking garage. Of the 96 CRS checked, only 29% were observed to be correct and appropriately used. Table 1 reports the list of CRS errors and the frequency of each error. Twenty-three (24%) CRS were observed to have multiple errors. The child was present for 30 (31%) of the appointments. Weight of the child was the indicator used to assess the appropriateness of CRS type, as this follows best practice guidelines. The weight range seen in the 30 appointments where a child was present was 5–45 lbs. The remaining appointments were mostly prenatal (N = 42) or done by reviewing indicators for fit with a doll, if the child was not present.

Table 2 details the number of each type of CRS that were inspected. All inspected CRS were in the back seat or the middle row of minivans.

3.2. Phase two – online survey

Of the 514 parents who responded to the Qualtrics survey, 43% had only one child. A further breakdown of demographic data is shown in Table 3.

The survey included questions about resources used and challenges faced by parents in Ontario regarding proper CRS use. Table 4 reports the percentage of respondents who used each specified resource to assist in their CRS installation. The most commonly used resource was the CRS manual, selected by 68% of respondents. Only 2% of respondents said they used no resources at all.

Table 5 reports the greatest challenge experienced by respondents while installing a CRS. Most people (45%) felt that getting the car seat tight was the most difficult aspect of installation. This finding was corroborated by the results from the car seat clinics where getting the car seat tight was also the most frequently observed error.

The self-reported confidence levels were high for the majority of survey respondents. The results showed that parents who had installed only one CRS reported higher confidence in their installation compared to parents who had installed two or more CRS. By limiting the analyses to confidence with their first/only CRS, the impact of installing only one versus those who had installed multiple CRS on reported confidence with the first CRS is investigated (Fig. 1). For this analysis, the data were collapsed to three categories; disagree (strongly disagree/somewhat disagree), neutral, and agree (somewhat agree/strongly agree) due to the very low number of respondents who answered 'strongly disagree'. Generally, respondents who had installed more CRS felt less confident with how their first CRS was installed. However, this difference in confidence with their first install for the three groups (1 CRS, 2 CRS and 3+ CRS) was not statistically significant (CMH statistic = 11.47, $p = 0.177$).

To further understand how increased CRS installations changed the recalled confidence level for first CRS installed, an additional analysis was done on respondents who had installed two or more CRS. For those respondents who had installed two CRS, their self-reported confidence was greater for the most recent install (96% reported high confidence) compared to their first (84% reported high confidence) (Fig. 2). For respondents who had installed three or more CRS, 74% reported a high level of confidence with their first install compared to 97% for their most recent install.

The change in confidence level was analyzed for all respondents who installed more than one CRS (N = 323). The mean change in reported confidence between the first and most recent CRS was determined, $x = 0.54 \pm 0.96$, $p < 0.0001$; thus, demonstrating a significant increase in confidence between the first and most recent CRS install. As shown in Fig. 2 and demonstrated through statistical analysis there is a larger reported change in confidence with the more CRS installed. This was finding was consistent across both groups

Table 1
Frequency of CRS clinic observed errors, N = 96.

Installation	N
CRS moves more than 1-inch side to side	24
CRS not installed	12
CRS not at the proper angle	11
Seat belt and Universal Anchor System (UAS) used	9
CRS touching front seat	7
CRS installed in the middle seat using UAS anchors from outside positions	3
Using UAS when seatbelt needed to be used to support child's weight	3
Not tethered when needed	2
Used wrong belt path slots	1
Twisted UAS straps	1
Inappropriate Type of CRS	
CRS not appropriate for child size (weight)	2
CRS not approved for use in Canada	1
Fit/Adjustment for Child	
Harness strap or crotch buckle in wrong position for size of child	9
Harness not tight enough and/or chest clip in wrong position on child's body	9
Twisted harness straps	3

Table 2
Type of CRS inspected and their frequencies, N = 96.

CRS Type	N	(%)
Infant	56	(58%)
Convertible- rear	16	(17%)
Convertible – forward	6	(6%)
3 in 1 – rear	12	(13%)
3 in 1 - forward	4	(4%)
Booster	2	(2%)

Table 3
Demographic characteristics of survey respondents, N = 514.

Age Range	N	(%)
18-24	84	(16.3%)
25-34	245	(47.7%)
35-44	185	(36.0%)
Number of Children		
1	222	(43.2%)
2	193	(37.6%)
3	73	(14.2%)
4	22	(4.3%)
5	4	(0.8%)
Education Level		
Less than secondary school diploma or equivalency certificate	31	(6.0%)
Secondary school diploma or equivalency certificate	112	(21.8%)
College or other non-university certificate or diploma	139	(27.0%)
Apprenticeship or trades certificate or diploma	18	(21.0%)
University certificate or diploma below a Bachelor level	51	(9.9%)
University certificate, diploma or degree at a Bachelor level or above	163	(31.7%)

Table 4
Resources used for CRS install, N = 514.

Resources Used – select all that apply	N	(%)
Car seat manual	351	(68.3%)
YouTube	180	(35.0%)
Friend/family member	152	(29.6%)
Car seat manufacturers' website	124	(24.1%)
Local health unit	114	(22.2%)
Transport Canada website	73	(14.2%)
Car seat clinic	55	(10.7%)
Other – police, hospital, fire station, etc.	16	(3.1%)
None	11	(2.1%)

Table 5
Greatest challenge faced with proper installation, N = 514.

Challenge Faced	N	(%)
Getting the car seat tight	229	(44.6%)
Getting the car seat at the right angle in car	102	(19.8%)
None	81	(15.8%)
Car seat manual is difficult to understand	43	(8.4%)
Not knowing which location in the car to install seat	28	(5.5%)
Conflicting information	27	(5.3%)
Other	4	(0.85%)

and most prominent in those who had installed 3 or more CRS. For two installs (N = 213), $x = 0.46 \pm 0.90$, $p < 0.0001$. For three or more installs (N = 110), $x = 0.72 \pm 1.05$, $p < 0.0001$.

Table 6 reports facilitators to improve confidence with CRS installation. Many parents (52%) felt that a video tutorial would be beneficial to support proper installation. Additionally, 42% reported simplified manual instructions would have increased their confidence with CRS installation.

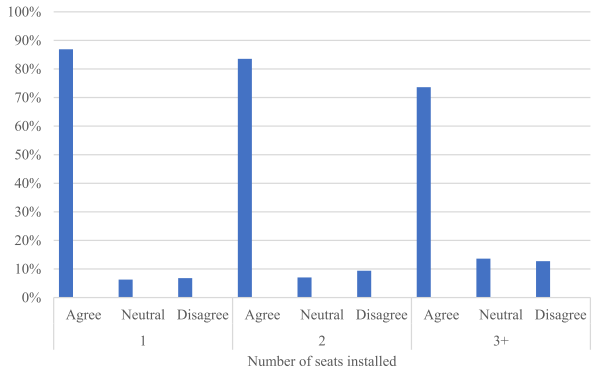

Fig. 1. Level of agreement with the statement *"I felt confident that I installed my first/only car seat correctly"*, by number of CRS installed, N = 514.

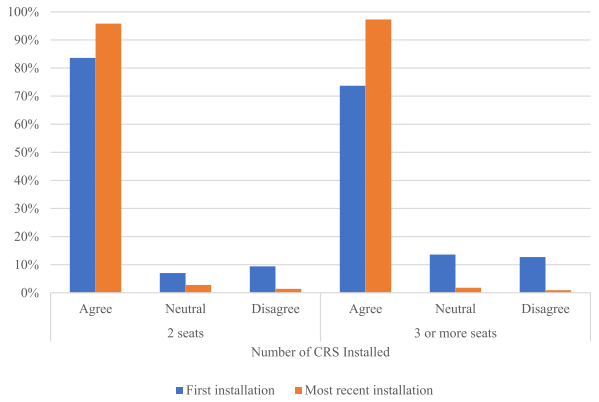

Fig. 2. Confidence level of installation with first CRS compared to most recent CRS, by total number of CRS installed, N = 323.

Table 6
Methods for improving confidence with installation, N = 514.

Facilitators	N	(%)
Video tutorial	267	(52.0%)
Simplified instructions	218	(42.4%)
Support from a car seat technician	153	(29.8%)
Help from a partner	121	(23.5%)
Nothing	59	(11.5%)
Other	3	(0.6%)

4. Discussion

For children's motor vehicle safety, it is predicted that parents and caregivers would want to follow best practice guidelines and take advantage of free education opportunities within their communities. In Nova Scotia (2015), during consented roadside checks, 53% of CRS were found to be inappropriate and/or incorrectly used.14 Most recently in New South Wales, Australia (2022), more than half (60%) of CRS observed were incorrectly used.10 Our results of overall incorrect use were higher at 71%. This is not surprising considering that all three aspects that define correct CRS use (appropriateness, installation, and fit) were evaluated. In addition, our data were from clinic appointments, where it is expected that individuals who book an appointment, have experienced difficulty or suspect an error in their CRS use.

Although CRS clinics are resource intensive, requiring a minimum of 1 h of staff time per appointment, there was never a waitlist for the service or a need to turn clients away. Despite this service being available in most regions of Ontario, only 11% of the survey respondents reported using a CRS clinic. Lack of awareness of these services is one plausible explanation for this, since 30% of survey respondents suggested having CRS technician support would improve their confidence. Alternatively, individuals may not realize there is an issue, possibly having an inflated sense of confidence in their installation and use of their CRS. This rationale is supported by Mirman et al. who found that even experienced parents/caregivers did not self-identify when they installed the CRS incorrectly [14].

As every vehicle and CRS is different, it is important to refer to the CRS manual, alongside the vehicle manual, to properly install the

device. Certified technicians regularly refer to the CRS manual because of the substantial variability between systems. As shown by our survey results, 68% of parents are aware of and utilized, the CRS manual. However, there exists the possibility that the manuals are not easily understood by the majority of the population. This possibility is supported by the survey results, as 42% of respondents expressed that having simplified instructions would improve their confidence with their CRS install. The reading level for health education is recommended to be at a grade six level or lower; yet, past research has shown manuals are typically written at a grade 10 level [15].

Previous studies have suggested barriers to proper CRS use to be; lack of knowledge, misperceptions of risk of injury, inconvenience, and cost. [16,17] More generally, in a recent systematic review of CRS interventions, many articles noted that parents/caregivers can learn proper CRS installation through education but this does not translate into behaviour change [18]. Our results support a lack of knowledge or understanding being a probable root cause of improper CRS use. As shown by the survey results, parents who had only installed one CRS reported the highest level of confidence with their installation, compared to parents who had installed two or more systems, when looking at the first install. Our survey found a significant difference in self-reported confidence in comparing their first CRS installed to their most recent, demonstrating the need for experience or practice to gain a sound understanding of the complexity of these systems. It can be speculated that as individuals move through the stages of CRS use (infant to convertible to booster), reviewing new manuals and gaining practice, they realize errors made during the use of their first system. Although updates have been made to improve the ease of CRS installation (e.g., Universal Anchor Systems), new systems with new features and greater convertibility continue to be added to the market, adding new challenges.

Parents that seek out support from a car seat technician may be more unsure of their CRS installation and use; thus, a limitation that needs to be considered when applying the error rate to the larger population. Even if this number represents an overestimation of the error rate for all CRS users, it implies there are likely thousands of children on Southwestern Ontario roads, riding in an improperly installed or used CRS. The low uptake of this free educational service also warrants questioning how well the program is being circulated and marketed. A previous study in the United States (2017) found that primary care providers are in a powerful position to promote the use of car seat technicians and parents/caregivers were more likely to install a CRS correctly when tested if they visited a technician previously [19]. With no standardization of where to go for CRS support and service, even between cities in Ontario, it is not surprising incorrect CRS use continues. A comprehensive educational campaign, targeted towards care providers and families is warranted to address this uncertainty of where to access service. Additionally, future studies should look to better understand the influence that social determinants of health have on CRS use and the initiative needed to take advantage of clinic offerings. A standardized approach to education likely does not meet the varied needs of individuals.

Future education initiatives should focus on ensuring parents and caregivers have retained basic installation knowledge for ongoing consistent use. Tessier looked at this, finding that individuals who had hands-on education compared to those who watched an educational video, were four times more likely to have a correct installation approximately four months following the education session [20]. Our study did not include any follow-up or return visits to look at the consistency of use. Without follow-up, we can only be certain that the CRS is being used appropriately in the moment. Once the vehicle leaves the parking lot there are confounding factors that could impact the safety of the device if knowledge has not been retained. Specifically, CRS moved to a new position in the vehicle or moved to a different vehicle entirely, it may be reinstalled incorrectly if installation knowledge is not maintained. Future studies should include a longer-term follow-up. As surveying to assess sustained knowledge may not be a strong predictor of proper CRS use, alternate methods need to be considered to assess consistency and retention of information.

Parents will need to install multiple devices as children graduate through the stages of CRS use. There is limited understanding of knowledge transferability to future stages of CRS use. For example, if parents receive hands-on education on the proper use and installation of an infant CRS, will this result in the proper use of a forward-facing system or booster seat? Subsequent stages of CRS use are touched on at our CRS clinic appointment, but no demonstration is given. The CRS clinic appointment takes approximately 1 h; this allows only enough time to review the basics of CRS use and work on the installation and fit of the system brought in. Offering any more than 1 h of individualized service for a family would be very taxing from a resource standpoint. Also, covering all stages of use at the appointment would likely be overwhelming for families and there is no indication this information would be well preserved until the time it is needed.

4.1. Strengths and limitations

A strength of this study is the use of comprehensive checks to assess correct use, looking at the appropriateness, installation, and fit of CRS for the child. Only a small number of studies have opted to use a comprehensive method for assessment, instead of roadside observation [8,10,21,22,23]. Additionally, every check was completed by two certified technicians for accuracy. As stated by Brown et al., gold-standard CRS studies should include observed restraint practices over self-reported practices and randomly selected samples over self-selected samples [10]. Although we focused on observed restraint practices, our study does not fully meet the determined gold standard, as our sample was self-selected.

A limitation of this study was that all the CRS checks were completed in one urban centre in Southwestern Ontario and as such, the results may not be generalizable to other populations. Also, sample size calculations were not completed. With a relatively small sample of CRS checks, population estimates cannot be made. In addition, clinic attendee demographics were not obtained; therefore, we cannot comment if the sample is representative of the local population. For the online survey, funding restraints determined the sample size. Some inferential statistics may not have been sufficiently powered. Quotas were used to obtain a sample that was aligned with provincial population data in terms of age and education level; however, many other factors should be considered to have a representative sample.

Previous research has analyzed levels of confidence in CRS knowledge and usage and parents consistently report high levels of confidence, which we also found [23–25]. However, to the best of our knowledge, this is the first CRS study to analyze how self-reported confidence levels change with the number of CRS installed. This is a method for demonstrating how practice and experience affect knowledge base.

5. Conclusion

This study has shown the rate of error with CRS installations, considering both appropriate and correct use, in London, Ontario and the region. Our results from clinic checks are similar to those reported in other check-point observation studies in Canada, the United States, and Australia. Additionally, survey results show high levels of self-reported confidence in CRS use, yet we know there is a high likelihood of misuse supported by our clinic check data and past research. This may be the result of misperceived risk related to improper system use or a mistranslation of knowledge of CRS to the actual use of CRS. Further research is needed to better understand effective methods for addressing this discrepancy and to identify interventions that are successful for maintaining appropriate and correct CRS use, not only for the current system but also as it relates to the use of future restraints.

Author contribution statement

Jennifer Britton: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Kaitlyn Jacobs: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Tania Haidar: Conceived and designed the experiments; Performed the experiments.

Christopher Stolworthy: Performed the experiments; Analyzed and interpreted the data.

Alison Armstrong; Dr. Neil Merritt; Dr. Neil Parry; Dr. Kelly Vogt: Analyzed and interpreted the data.

Fran Priestap: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Jennifer Britton reports was provided by London Health Sciences Centre.

Appendices and Supplemental Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e17409.

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