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Caregivers' Use of Child Passenger Safety Resources and Quality of Future Child Restraint System Installations

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Abstract: Objectives: Child Restraint System (CRS) misuse is common. We characterized caregivers' use of child passenger safety informational and instructional resources and determined whether there were differences in the quality of CRS installations associated with prior exposure to specific resources as evaluated in a standardized CRS installation environment. **Methods:** Caregivers completed self-report surveys and installed a forward-facing CRS in a controlled environment. Installations were evaluated for security (tightness) and accuracy (no errors) by a child passenger safety technician (CPST). **Results:** CRS manuals were the most common way caregivers learned to install a CRS. Primary care providers (PCP)s were the most frequently endorsed source of CRS safety information. There was no strong pattern of associations between prior exposure to resources and installation quality (security or accuracy), although some evidence supports protective effects of learning from CPSTs; 13% (19 out of 151) installations were secure and 57% (86 out of 151) installations were accurate. **Conclusions:** A focus on developing effective and lasting behavioral interventions is needed.

Keywords: child passenger safety; child restraints; parenting; injury; disparities

1. Introduction

Riding in an age-appropriate and properly installed Child Restraint System (CRS) can reduce the risk of death among 2 to 6 year-olds by 28% compared to riding in a seatbelt [1]. Drivers of children, most of whom are parents, are in a prime position to ensure that child occupants are properly restrained, but despite significant and important gains in the overall use of CRS, misuse remains prevalent at approximately 70% [2,3]. Therefore, enhancing proper CRS use is an important target of interventions [4,5]. While misuse of CRS is high across all groups, it is even more frequent among racial and ethnic minority groups and children from low socioeconomic status households [6–10].

Evidence-based prevention strategies to promote obtaining a CRS, using the CRS correctly (i.e., reduce errors in CRS attachment to the vehicle or of the child in the harness), and using the CRS appropriately (i.e., correct seat type for size and age of the child) are needed. These are different

behaviors, which may require different solutions. As a first step, families need to obtain a CRS. However, current research points to parents' lack of access to affordable CRSs coupled with insufficient knowledge on how to select and use a developmentally appropriate CRS [11,12]. Once the CRS is in hand, it needs to be used correctly, but prior research has shown that the literacy level of CRS manuals is greater than the reading comprehension ability of the majority of adults, which may contribute to the high rates of misuse [13].

To our knowledge, few studies have evaluated if exposure to CRS educational and instructional resources can have a lasting benefit. For example, free child CRS inspection stations staffed by trained child passenger safety seat technicians (CPST)s are one way for caregivers to get direct feedback on their currently installed CRS. Studies have suggested that inspection stations can be effective for preventing CRS misuse; but that benefits might weaken as children age and change seats and that the benefits might largely be driven by having an expert instead of a lay-installer [14,15]. Additionally, parents need to self-identify that they need assistance from a CPST, but research suggests that they are not good at doing so and CPSTs may be underutilized as a result [16,17].

To add to the limited evidence base on these topics, we analyzed data from the control group of a larger experimental study [18] to determine (1) if there were sociodemographic differences (e.g., education, race, age and current marital status) in how caregivers obtained information on child passenger safety and how caregivers learned to install a CRS; (2) if these two factors were associated with their ability to install a CRS; and (3) how caregivers perceived the role of the primary care provider (PCP) in providing anticipatory guidance on this topic and if they talked with their child's PCP about child passenger safety at their child's last well child visit.

2. Methods

2.1. Study Design and Sample

This study consisted of a one-time observational assessment of 151 caregivers who were asked to install a forward-facing CRS in a study vehicle and complete a psychosocial and socio-demographic survey. These participants completed this assessment as part of a larger study (n = 201) examining the effect of CRS technologies on the ability to effectively install a CRS among experienced (n = 151) and inexperienced (n = 50) installers [18]. Experienced participants were required to be regular caregivers to at least one child under 4 years of age, to transport this child in a personal vehicle at least two times a week, and to have installed any type of CRS, including booster seats, a minimum of five times within the previous six months. The inexperienced participants were not included in the current analysis, as they did not have prior exposure to any of the resources and were not parents.

As described in Mirman et al., 2015 [18], the sample was recruited from the community and from primary care practices affiliated with a large urban children's hospital in the northeastern United States. Flyers were posted in childcare centers and workplaces. Data collection occurred from June to August 2012. Study visits occurred in a hospital parking lot or at caregivers' homes depending on their preference. The study protocol was determined to be exempt by the institutional review board of The Children's Hospital of Philadelphia. Participants received $25 for their time and effort.

2.2. Materials

A commercially-available forward-facing CRS with a 5-point harness system designed for children who weigh between 11 and 38 kg and stand 76–145 cm was used for the observational assessment. Attachment to the vehicle could be achieved with the vehicle seat belt or Lower Anchors and Tethers for Children (LATCH), a dedicated attachment method for CRS installation. For the purpose of this study, installation instructions and graphics were initially created by the CRS manufacturer and revised by the study team to fit on one printed page following usability guidelines [19]. Final instructions consisted of 6 steps with complementary diagrams. The Flesch-Kincaid reading level of the instructions was 7.3 (7th grade reading level), slightly higher than the 5th- to 6th-grade reading level recommended

by the National Institutes of Health (NIH) for health communication materials [20], but lower than most CRS instructions, which range from 7th–12th grade, and have an average reading level of 9th or 10th grade [13,19].

2.3. Procedures

Surveys. Sociodemographic characteristics, perceptions about the primary care providers' role in promoting child passenger safety and the mechanisms by which caregivers learned about child passenger safety and how to install a CRS were collected via self-report paper surveys. We also assessed participants' current CRS usage and type of vehicle(s) they used for transporting their children. Paper surveys were reviewed for completeness and entered into a Research Electronic Data Capture (REDCap) software system [21], a secure, web-based data capture system.

Primary Care Provider's Role. Caregivers read the following item: "*How important is your primary care provider (for example, pediatrician) as a resource for child passenger safety information"*, for which response choices were on a 5-point scale from Very Unimportant (1) to Very Important (5); and "*Did your primary care provider discuss child safety seats at your child's last well child visit ("routine checkup")?*", for which response choices were "Yes" or "No".

Mechanisms for Learning about Child Passenger Safety. In response to: "*Where do you get information about child passenger safety?*", caregivers selected (i.e., checked all the responses that applied to them) from the following list: primary care provider, friend, relative, online, brochure/book, class, and other. Similarly, in response to: "*How did you learn how to install a child safety seat?*", caregivers selected from the following instructional resources: CRS manual, vehicle manual, CPST, friend, relative, brochure, class, online, and other.

2.4. Observational Assessment of Caregivers' CRS Installation Quality

Following completion of the surveys, participants were instructed to install the CRS in the second row of a contemporary minivan provided by the study team, use whichever CRS installation method (seat belt versus LATCH) felt more comfortable, not to use the top tether (because the parent trial was focused on improving lower attachments, top tether usage was not a focus of the current study), take as much time as needed to read the instructions, and to reference the instructions as many times as they wished. Installations began when the participant said he or she was ready, and concluded either when the participant said they were finished or when thirty minutes had elapsed.

Observational assessments were performed by a CPST who assessed both the security and accuracy of each installation. Installations were *accurate* if none of the following nine errors occurred: twisted seat belt; twisted LATCH anchor straps; non-approved position for use of LATCH anchors; attachment of LATCH anchor strap to non-anchor point in the vehicle; use of both LATCH and seatbelt; incorrect seatbelt routing; incorrect routing of LATCH anchor belt; inability to attach the CRS to the vehicle; or other error (e.g., did not buckle seat belt). Following accepted standards of measurement (see Greenwell, 2015), installations were *secure* if the lateral and forward movement of the CRS when pulled at the seat bight was less than 2.54 cm (1 inch). To obtain this measurement, masking tape was used to mark the initial location of the CRS on the vehicle seat and then the CRS was pulled in each direction at the belt or LATCH anchor points. The resulting amount of forward and lateral movement was assessed at the seat bight (where the seat cushion and seat back come together) using a standard measuring tape and recorded on the observation sheet.

Wald chi-square statistics were generated to assess for differences among the categorical outcome variables (i.e., proportion of installations that were accurate, secure) (alpha = 0.05) and responses to the survey items; exact tests were used as appropriate.

3. Results

3.1. Participant Characteristics

Participant characteristics are shown in Table 1. Most caregivers were female (91%) and ranged in age from 18 to 55 years, M(SD): 31(8). Over two-thirds identified their race as black or African-American (68%). One fourth reported a 4-year college degree or higher (26%); the remainder had at least some college education experience (30%) or at least some high school or high school diploma (44%). Caregivers with less than a 4-year college education were more likely to be black than other races ($p < 0.001$). Eleven caregivers (7%) were a caregiver to a child other than their own. Four participants (<3%) reported owning a CRS that was manufactured by the same company that manufactured the CRS we used in the observational assessment and one person (<1%) identified having prior experience driving the same minivan, although it was an earlier model year. Given this small amount of prior exposure to the experimental materials, these participants were retained in the evaluable sample. No participants took more than 30 min to complete the installation and no instances of missing data were observed.

Table 1. Participant characteristics (n = 151).

Characteristics	*n* (col %)
Gender (female)	138(91)
Age (years)	
18–24	32(21)
25–29	39(26)
30–39	39(26)
40–55	41(27)
Education	
≤High school diploma	66(44)
Some college/Associates degree	45(30)
College degree/Graduate degree	39(26)
Marital status	
Married/partnered	74(49)
Not married or partnered	69(46)
Refused	8(5)
Race	
White	24(16)
Black	103(68)
Mixed/other	21(14)
Refused	3(2)

3.2. Summary of Accuracy and Security Errors

The proportion of accuracy and security errors in this sub-sample of the parent trial has been previously reported, although in a different format (see Mirman et al., 2015 [18]). Thirteen percent (19 out of 151) of installations were secure, and 57% (86 out of 151) of installations were accurate.

3.3. Exposure to Informational and Instructional Resources and CRS Installation Quality

No statistically reliable associations were found between prior exposure to *informational* resources and caregivers' CRS installations ($p > 0.05$ for all comparisons). Caregivers who reported learning to install a CRS from a CPST were more likely to achieve an accurate installation than those who did not report learning from a CPST: 86% vs. 54%, $p = 0.03$. No statistically reliable associations were found for exposure to other *instructional* resources and CRS installations ($p > 0.05$ for all comparisons).

3.4. How do Caregivers Obtain Child Passenger Safety Information and Learn to Install a CRS?

More caregivers reported getting information about child passenger safety from their child's PCP (69%) than from any other source (Table 2). Most caregivers regarded their PCP as a very important (44%) or important (21%) resource for child passenger safety information. Slightly less than half of caregivers (45%) reported that their PCPs discussed CRS at the last well child visit. Black caregivers were more likely to report that they received information about child occupant protection from their PCP compared to white caregivers and caregivers from mixed/other racial groups (Table 2). Participants with less formal education were generally more likely to report getting information from their PCP, but the opposite pattern was found for getting information online. White caregivers (54%) were more likely to report getting information online compared with caregivers from other racial groups. We did not observe any evidence to suggest that how participants learned to install a CRS varied by sociodemographic characteristics (Table 3). CRS manuals were the most common way participants reported learning about how to install a CRS (62%).

Table 2. How do caregivers obtain information about child passenger safety? (n = 151).

Overall n(%)	PCP		Friend		Relative		Online		Brochure		Class	
	104(69)	***p***	**22(15)**	***p***	**33(22)**	***p***	**32(22)**	***p***	**38(25)**	***p***	**11(7)**	***p***
Age		0.09		0.41		0.63		0.16		0.69		0.48
18–24	26(81)		5(16)		8(25)		5(16)		7(22)		2(6)	
25–29	28(72)		5(13)		10(26)		6(15)		12(31)		5(13)	
30–39	38(68)		6(11)		9(16)		12(21)		12(21)		3(5)	
40–55	12(50)		6(25)		6(25)		9(38)		7(29)		1(4)	
Education		0.04		0.70		0.89		0.01		0.09		0.35
≤High school diploma	48(73)		8(12)		14(21)		7(11)		14(21)		6(9)	
Some college/Associates degree	35(78)		8(18)		11(24)		10(22)		9(20)		1(2)	
College degree/Graduate degree	21(54)		6(15)		8(21)		15(39)		15(39)		3(8)	
Marital status		0.15		1.0		0.32		0.02		1.0		0.52
Married/partnered	47(64)		11(15)		14(19)		23(32)		19(26)		4(5)	
Not married or partnered	52 (75)		11(16)		18(26)		9(13)		17(25)		6(8)	
Race		0.03		0.26		0.49		0.00		0.90		0.89
White	12(50)		1(4)		3(13)		13(54)		7(29)		2(8)	
Black	78(76)		17(17)		24(23)		16(16)		26(25)		7(7)	
Mixed/other	13(62)		4(19)		5(29)		3(14)		5(24)		1(5)	
Accurate (n = 86) ^	57	0.48	14	0.64	23	0.11	21	0.32	24	0.45	7	0.76
Secure (n = 19) ^	12	0.60	1	1.00	2	0.25	3	0.77	8	0.09	1	1.00

Note: In response to: "*Where do you get information about child passenger safety?*", caregivers selected (i.e., checked all the responses that applied to them) from the following list: primary care provider, friend, relative, online, brochure/book, class, and other. ^ Counts are provided of respondents who achieved an accurate or secure installation and identified using that informational resource. *p*-values were derived from exact tests as appropriate to evaluate the differences among characteristic categories.

Table 3. What resources do caregivers say they used to help them learn to install a CRS? (n = 151).

Overall n(%)	Manual		Vehicle Manual		CPST		Friend		Relative		Brochure		Class	
	93(62)	***p***	**13(9)**	***p***	**14(9)**	***P***	**32(22)**	***p***	**37(25)**	***p***	**9(6)**	***p***	**17(11)**	***p***
Age		0.17		0.29		0.27		0.71		0.77		0.35		0.39
18–24	19(59)		2(6)		1(3)		6(19)		10(31)		2(6)		4(13)	
25–29	23(59)		2(5)		5(13)		5(13)		9(23)		4(10)		7(18)	
30–39	40(71)		8(14)		4(7)		9(16)		12(21)		1(2)		4(7)	
40–55	11(46)		1(4)		4(17)		2(8)		6(25)		2(8)		2(8)	
Education		0.09		0.60		0.43		0.66		0.82		0.34		0.86
≤High school diploma	35(53)		4(6)		6(9)		11(17)		15(23)		6(9)		8(12)	
Some college/Associates degree	29(64)		5(11)		6(13)		7(16)		11(24)		2(4)		4(9)	
College degree/Graduate degree	29(74)		4(10)		2(5)		4(10)		11(28)		1(3)		4(10)	
Marital status		1.00		0.57		0.55		0.64		0.26		0.74		0.78
Married/partnered	47(64)		8(11)		5(7)		10(14)		16(22)		4(5)		8(11)	
Not married or partnered	44(64)		5(7)		7(10)		12(17)		21(30)		5(7)		6(8)	

Table 3. *Cont.*

Overall *n*(%)	Manual		Vehicle Manual		CPST		Friend		Relative		Brochure		Class	
	93(62)	***p***	**13(9)**	***p***	**14(9)**	***P***	**32(22)**	***p***	**37(25)**	***p***	**9(6)**	***p***	**17(11)**	***p***
Race		0.39		0.99		0.63		0.93		0.56		0.35		0.95
White	17(71)		2(8)		2(8)		3(13)		4(17)		0(0)		3(13)	
Black	61(59)		9(9)		8(8)		16(16)		28(27)		8(8)		11(11)	
Mixed/other	15(71)		2(10)		3(14)		3(14)		5(24)		1(5)		2(10)	
Accurate (*n* = 86) ^	57	0.18	9	0.34	12	0.03	1	0.49	22	0.84	3	0.17	12	0.30
Secure (*n* = 19) ^	13	0.62	1	1.00	3	0.69	11	0.31	5	0.78	2	0.32	1	0.70

Note: Too few participants (n = 3) selected online to calculate meaningful comparisons. ^ Counts are provided of respondents who achieved an accurate or secure installation and identified the resource as helping them learn; row and column percentages are omitted for readability. p-values were derived from exact tests as appropriate to evaluate the differences among characteristic categories.

4. Discussion

Surveillance studies have long noted persistent CRS misuse, along with racial and socioeconomic disparities in CRS use by caregivers of young children. While we did not observe strong evidence to suggest that the specific resources used to learn how to install CRS were associated with CRS installation quality, we did identify that PCPs may be in a uniquely powerful position. Providers can endorse or provide specific resources for families to encourage them to have their child's CRS evaluated by a local CPST, the one resource that demonstrated the most promise. This finding is consistent with the results from an evaluation of a large scale CPST network in Australia that indicated that parents' use of the network was associated with greater likelihood of correctly installed CRS [22]. This may be especially important for black families, 75% of whom identified their PCP as a key resource for information on this issue.

Strikingly, few caregivers of any racial group in our study identified the CPST as a resource for how they learned to install their child's CRS. This could be due to low exposure to CPSTs, although we did not measure exposure explicitly in this study—only parents' perception that they learned something from a CPST visit. This could have affected our results, because we may therefore have combined parents with no exposure to CPSTs and parents with exposure that they deemed unhelpful into the same group. Underutilization of the CPST has previously been reported in other studies [16]. Additional experimental research on this topic is needed to explore any causal relationships that might exist among resources, knowledge, attitudes, and behaviors as well as the contribution of geographic proximity of CPST inspection station events with populations of at-risk caregivers. A direct recommendation from the PCP might increase CPST utilization. However, patients may be presenting with more urgent medical needs during clinic visits making it difficult to allocate time and resources to provide guidance and tools for at-risk families in relation to occupant protection—a more distal health need.

Although web-based tools and online strategies are generally considered an inexpensive way to reach many families, we found that only 15% of the black caregivers in our study used online resources compared to 54% of white caregivers. Additionally, we found emerging evidence suggesting that caregivers with less formal education were less likely to use online resources compared to caregivers with more education. While making resources available on the web is a laudable goal, more may need to be done to connect families most at-risk for incorrect and inappropriate CRS use with effective interventions and resources. For example, promoting child passenger safety among racial and ethnic minority families, who are at greater likelihood of living in low SES households and face additional chronic stressors [23], requires dedicated attention [24]. While promising gains in child passenger safety knowledge and behaviors were found for an emergency department-based intervention via informational "kiosks", low-income participants demonstrated comparatively weaker gains compared to their higher-income counterparts [25]. In response to caregivers' difficulty using CRS, a 2002 Consensus Report from the National Medical Association recommended prioritizing the development of culturally appropriate health promotion programs and campaigns to reduce racial

disparities in traffic deaths [24]. However, recent analyses of national child occupant protection data still demonstrate striking disparities with children from racial and ethnic minority groups being less likely to be properly restrained in an age-appropriate child restraint compared with white children [7]. Data from a survey study of parents and children seeking emergency care found that racial disparities persisted after adjusting for education, income, source of general child passenger safety knowledge (e.g., online) and CRS-specific knowledge (e.g., their child's CRS instruction manual), with parents from minority racial groups reporting lower age-appropriate CRS use than white parents [9]. Our study was conducted in the United States, but racial and ethnic, cultural and socioeconomic disparities in child occupant protection knowledge, beliefs, and behaviors have been noted in other countries as well [26–30]. Qualitatively different models of intervention and outreach may be needed, especially for hard-to-reach and at-risk populations, although the factors that make certain populations hard-to-reach may vary globally.

4.1. Limitations

The caregivers who agreed to participate in our study may differ on unmeasured characteristics from those who did not participate (e.g., interest in safety); this limits the generalizability of the results. For example, one of the mechanisms used to recruit participants was a pediatric health care network, which may have led to a sample of parents with higher than average regard for their PCP than if we had recruited completely from the general community of parents. We did not experimentally assign exposure to CRS resources (e.g., brochures) and therefore cannot infer causality between exposure to these resources and performance on the observational installation assessment. For example, characteristics associated with caregivers who sought out a CPST visit prior to our study may have also enabled them to perform somewhat better on the installation assessment. Finally, while our study had strong internal validity by creating a uniform installation environment, the external validity of the study may have suffered—a common tradeoff. In our study, we focused on CRS installation and not on CRS choice, or on how to harness a child into a CRS; we did not examine use of the top tether. Future studies should examine these factors as well as evaluate a wider range of CRS makes, models and vehicle combinations.

4.2. Conclusions

CRS manuals were the most common way caregivers learned to install a CRS. Primary care providers (PCP)s were the most frequently endorsed provider of CRS safety information. Importantly, we did not see strong evidence that common educational resources (e.g., brochures, online information) or instructional resources (e.g., CRS manuals) offered any long-term advantages. Caregivers' prior utilization of a CPST demonstrated the most potential. Additional research is needed to understand the mechanisms by which sociocultural processes may affect CRS use and uptake of resources. Ideally, CRS psychoeducational materials and methods would be able to offer at least some lasting benefit across a variety of CRS-installation scenarios.

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Author Contributions: Jessica H. Mirman conceptualized and designed the study, coordinated and supervised data collection, drafted the initial manuscript, interpreted the data and approved the final manuscript as submitted. Kristy B. Arbogast, Mark R. Zonfrillo, Dennis R. Durbin and Sara J. Seifert contributed to study conceptualization and design (e.g., design of data collection instruments), reviewed and critically revised the manuscript, interpreted the data and approved the final manuscript as submitted. Kristi Metzger contributed towards the development of the analysis plan, managed, analyzed and interpreted the data, drafted the statistical sections, reviewed and critically revised the manuscript and approved the final manuscript as submitted.

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