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Child Passenger Safety State of Knowledge: A Literature Review

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This systematic literature review presents a synthesis of behavioral safety research on child passenger safety (CPS) published from 2000 to 2022 focused on children up to age 12 and that was conducted in the United States. A stakeholder meeting at the beginning of the project established important issues, gaps in available information, and stakeholder and audience needs. The review provides information about the current state of CPS; the history of CPS recommendations, regulations, and requirements; child restraint system (CRS) types; non-use and misuse of CRSs and their risk factors; and approaches for reducing child fatalities and injuries in motor vehicle crashes (MVC), including education, outreach, State legislation and enforcement, and programs for communities with lower CRS use.</td></tr>
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Executive Summary

This systematic literature review presents a synthesis of behavioral safety research on child passenger safety (CPS) published from 2000 to 2022, focused on children up to age 12, and conducted in the United States. A stakeholder meeting at the beginning of the project established important issues, gaps in available information, and stakeholder and audience needs. The review provides information about the current state of CPS; the history of CPS recommendations, regulations, and requirements; child restraint system (CRS) types; non-use and misuse of CRSs and their risk factors; and approaches for reducing child fatalities and injuries in motor vehicle crashes (MVC), including education, outreach, State legislation and enforcement, and programs for communities with lower CRS use.

Non-use

Non-use describes a lack of restraint use in any form. Non-use was rare for children younger than 1; as children aged, however, they were more likely to ride unrestrained. Drivers who had lower incomes, were Black, or lived in rural areas were more likely to travel with unrestrained children than those with higher incomes, who were White, or lived in urban areas. Non-use was also more likely for certain types of trips, including short trips and taxi or ride-share trips. Children in areas with stronger child restraint use laws were more likely to be restrained.

Misuse

Misuse describes restraint use that is incorrect according to current recommendations. Common misuses included inappropriate restraint selection, inadequate installation, and incorrect use of the restraint. The most common selection error was premature transition from a booster seat to seat belt. For rear-facing seats, common installation mistakes included an incorrect angle of recline and loose installation attaching the CRS to the vehicle. Installation errors were less common in forward-facing seats and booster seats. For forward-facing seats, the most common mistakes in restraint use were loose or incorrectly placed harness straps. For booster seats, the most frequently observed misuse was incorrect shoulder belt position or fit.

Misuse of child restraints was more likely among drivers who were Black, had lower incomes, had lower education levels, or lived in rural areas, compared to drivers who were White, had higher incomes, had higher education levels, or lived in urban areas. Children in pickup trucks were more likely to be incorrectly restrained than those in other vehicles. Misuse was also associated with a lack of knowledge about correct use, lack of experience, lack of confidence, and a low perception of risk. Misuse was associated with older age of vehicles, low ease of use of the CRS, caregivers using a different car than usual, and more passengers.

Education and Outreach

Research in this area included evaluation of educational programs that provided information directly to caregivers, the training of child passenger safety technicians (CPST), and the deployment of CPSTs to convey CPS information. Educational programs increased caregiver knowledge and improved child restraint use especially when a program had a variety of activities. Effective educational content included presentation of risk concepts and tailoring information to the child’s needs and caregiver’s existing level of knowledge.

The presentation of information in several contexts enhanced the effectiveness of CPS education and messaging; common contexts included health care settings, community events, and schools. CPSTs conveyed information and conducted interactive hands-on training. Information was also conveyed by health care workers, community leaders, and online resources. Additionally, multi-modal training including a hands-on component appeared to be more effective than passive education methods, and education alone was less effective than multifaceted interventions that included education along with enforcement and low-cost access to CRS.

Legislation and Enforcement

Enactment of State child restraint laws was associated with increases in use rates and decreases in child injuries and fatalities in MVCs. Laws were an important source of child restraint information for caregivers, and caregivers described the requirements as the reason for their restraint practices. Seat belt laws that increased adult restraint also increased child restraint use. Enforcement was described as a key component for CPS campaigns, with effectiveness greatest when combining law enforcement with education and messaging. CPS laws vary among States and jurisdictions, and laws tend to lag behind current recommendations and best practices.

Communities With Lower CRS Use

Some communities have lower child restraint use rates and more misuse of restraints. Barriers for child restraint in these communities included the cost of CRSs, knowledge and access to information, and misconceptions about CRSs, especially booster seats. Promising solutions were multifaceted and included low-cost CRS distribution, education, and aspects of enforcement. Community-led programs may be more effective than others, particularly those that include community ownership of the program, decision-making by community members, training that places expertise in the community, and visible activities led by community members.

Part I: Introduction and Background

Chapter 1: Introduction

This report is a comprehensive literature review of behavioral traffic safety research from the United States on CPS and includes research on children from birth through 12 years old. The report includes empirical studies published from 2000 to 2022; it does not include papers that comprise opinion, advocacy, calls for action, proposed legislation, and non-behavioral science topics like crash testing, engineering, or biomechanics. Appendix A discusses the methodology used for the literature search, review, and documentation.

Part I, Introduction and Background, offers grounding information that includes the current state of CPS; broad historical information on CPS recommendations, regulations, and requirements; child restraint system (CRS) types and current recommendations for their use. Part I then moves into behavioral safety research on non-use and misuse of CRS. Part II, Research on Reducing Child Fatalities and Injuries in Motor Vehicle Crashes, covers education and outreach, State legislation and enforcement, and communities with lower CRS use. Part III, Conclusions, describes limitations of existing work, gaps in knowledge, and conclusions.

Current State of Child Passenger Safety

Data confirms child occupants benefit from regulated safety products in motor vehicles involved in MVCs (Pai, 2020; Weber, 2000). The benefits of child restraint use (as well as restraints for occupants of all ages) have been well researched (Kahane, 1986, 2015; Partyka, 1988; Scherz, 1976; Shelness & Charles, 1975). As of 2021 observed restraint use for children infant to 7 years old was 93.4 percent, which was not significantly different from the 2020 rate of 93.6 percent. Restraint use for children 8 to 15 years old was 93.3 percent during the same time period, 3.2 percent higher than in 2020 (Boyle, 2022).[1] For children 4 to 7 years old, belt-positioning booster seat use in 2019 (the most recent year available at the time of this review) was 37 percent (Enriquez, 2021).

Broad History of Restraint for Child Vehicle Occupants Under Age 13

Among the agencies and jurisdictions that address child restraint in the United States, there are recommendations, regulations, and legal requirements for CPS. *Recommendations* are issued by NHTSA and by professional associations such as the American Academy of Pediatrics (AAP). For example, the American Academy of Pediatrics published specific best practices on how to restrain children appropriately for their weight, height, and age (Durbin et al., 2018). *Regulations* govern CRS devices: NHTSA, the appropriate regulatory agency, issues regulations that set standards, performance and otherwise, for devices to be marketed in the United States and conducts testing and inspection of the devices. *Requirements* for the restraint of children in motor vehicles (e.g., mandating CRS or seat belt use, seating positions of children, etc.) are determined by States and other jurisdictions such as tribal governing bodies on reservations. These requirements are established by statute (law) and vary among jurisdictions, and they may or may not conform to recommendations issued by organizations. Together, these elements affect

[1] This review only included research published from 2000 to 2022. Please see Werth (2025) for the most recent data about observed child restraint use.

the landscape of CPS in the United States and have operated in different ways to affect behavior over time.

Recommendations: History of Child Restraint Practices

Recommendations for child restraint have changed over time as technology has advanced. New restraint systems have been developed (e.g., belt-positioning booster seats), and criteria for the transitions between those systems (e.g., age, height, weight) have shifted.

Regulations: History of Child Restraint Systems

NHTSA is mandated under Title 49 of the United States Code, Chapter 301, Motor Vehicle Safety, to issue and enforce Federal Motor Vehicle Safety Standards (FMVSS) and Regulations to which manufacturers of motor vehicles and items of motor vehicle equipment must conform and certify compliance. The following timeline is an abridged view of key regulatory components most relevant to behavioral safety and CRS.

- **1971**: **Established FMVSS No. 213 CRS Safety Standard**. The first safety standard for any CRS in the United States applied to forward-facing car seats for children up to 40 pounds, secured to the vehicle with a lap-only seat belt with a harness to hold the child in the seat. At the time, no State laws in the United States required use of a CRS.
- **1981: Additional CRS Types**. This amendment to FMVSS No. 213 included all types of CRSs (rear-facing, forward-facing, infant carriers, harnesses,[2] car beds for children up to 50 pounds). It also provided performance standards and special labeling and instruction criteria. Manufacturers were required to provide a place for instructions on the CRS. This regulation also added two common child restraint misuses to the protocol for dynamic impact tests of applicable CRSs: tether non-use and misused harness straps.
- **1986: Tethers.** This amendment to FMVSS No. 213 required every CRS equipped with a tether to pass dynamic testing without the tether connected to a vehicle's tether anchor. This change attempted to minimize the consequences of tether non-use.
- **1989: Rear Seat Lap and Shoulder Belts.** This amendment to FMVSS No. 208 required lap and shoulder seat belts to be installed in forward-facing rear outboard seating positions. This change enabled use of booster seats for older, larger children in rear seats. This made booster seat use possible in rear seats for children who had outgrown CRSs with a harness. Shoulder belts were required for children in booster seats. At that time, vehicles were not yet required to have a lap and shoulder belt in the middle rear seat.
- **1994: Air Bags.** This amendment to FMVSS No. 213 required an air bag warning label for all rear-facing CRSs alerting consumers of the dangers posed to rear-facing infants in front seats of air-bag-equipped vehicles.
- **1994: Booster Seats**. This amendment to FMVSS No. 213 added performance, test criteria, and labeling requirements for belt-positioning booster (BPB) seats designed to be used with lap/shoulder belts (not shields[3]).

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[2] Unlike the (internal) harness on other child restraint system types, a harness is a combination pelvic and upper torso child restraint system that consists primarily of flexible material, such as straps, webbing or similar material, and that does not include a rigid seating structure for the child.

[3] Referred to as a backless child restraint system in FMVSS No. 213.

- **1999: Lower Anchors and Tethers for CHildren (LATCH)**. Vehicles were required to be equipped with tether anchors. Lower anchors were to be equipped through a phase-in by 2002. Child restraints were to be required to meet a reduced head excursion limit that would most likely require a tether to meet that requirement.
- **2005: Lap and Shoulder Belt for the Center Rear Seat.** This amendment to FMVSS No. 208 required vehicles to have lap/shoulder belts in the center rear seats.
- **2014: Higher Weight Limits**. The child weight limit in FMVSS No. 213 increased from 65 to 80 pounds. This amendment also required labeling for applicable CRSs that specified the maximum child weight (based on the known weight of the CRS) permitted for using the vehicle lower anchor/attachments for installation of the CRS.

Requirements: History of State Laws Governing Child Restraint

As of the time of this report, every State and the District of Columbia required children to travel in child restraints or seat belts up to the age, height, or weight determined by statute. Violators can be assessed fines or points for non-compliance. The first child passenger restraint law passed in Tennessee in 1977. By 1985, all States and the District of Columbia had passed legislation protecting very young children in vehicles, mostly to age 4. By 2004 there were 26 States that had upgraded their original laws to raise the ages or other conditions of the law. By 2023 there were 18 States and the District of Columbia that had upgraded laws to require children to travel rear-facing in a restraint until age 2 or more. In 1997 Delaware and Rhode Island enacted the first laws requiring children to ride in rear seats. By 2023 that number had grown to 25 States. In 2000 Washington State enacted the first booster seat law, and since then 47 States and the District of Columbia passed booster seat laws. States without booster seat laws required seat belt use from the time car seats were outgrown until 15 or 18. As of 2023 all 50 States and the District of Columbia have laws to fill the gap between when children outgrow booster seats or child restraints until adult seat belts are an option for them. In 2023 there were 46 States and the District of Columbia that required "proper" or "correct use" of car seats in the statutes.

Analyses of FARS data from 1975 to 1994 for 50 States estimated child restraint laws reduced fatalities of children up to 5 years old by an average of 18 percent, resulting in 1,840 fatalities averted during that time (Houston et al., 2001). Furthermore, the larger the age cohort covered by child seat laws, the more fatality rates dropped. For each additional year of age covered by statute, fatalities among children from birth to 5 years old lowered by 4.8 percent.

Research Information Sources and Methods

Behavioral safety studies on CPS acquire information from a broad base of sources and methods. This section briefly describes the major ways researchers obtain information about CPS.

National Observational Surveys

National surveys have collected child restraint data by directly observing vehicle occupants and their restraint status. These national surveys conducted by NHTSA include the National Occupant Protection Use Survey (NOPUS) Controlled Intersection Study, the National Survey of the Use of Booster Seats (NSUBS), and the National Child Restraint Use Special Survey (NCRUSS).

NOPUS

NOPUS has been a recurring national survey that estimates restraint use for all vehicle occupants on United States roads at a typical daylight moment. Data is collected by observers stationed at randomly selected roadways. During daylight hours the observer either stands at the side of a road or travels in a vehicle on expressways, allowing observation actual seat belt use. NOPUS collects an assortment of data, and only the fields most relevant for CPS are described here. In 2021 NOPUS observers classified children's restraint use as one of the following types: rear-facing seat, forward-facing seat, high-backed booster, seat belt alone or backless booster, or unrestrained. Observers estimated the age groups of occupants as follows: birth to 1 year old, 1 to 3 years old, 4 to 7 years old, 8 to 15 years old, 16 to 24 years old, 25 to 69 years old, and 70 and older. Observers also subjectively characterized occupants' perceived race as "Black," "White," or "Members of other races" (Boyle, 2022).[4]

NSUBS

NSUBS has been a recurring observational national survey of child restraint use (Enriquez, 2021; Glassbrenner, 2009). Observers were stationed at four types of collection sites (gas stations, recreation centers, daycare centers, and fast-food restaurants) in a nationally representative sample of sites across the United States. They then identified all vehicles at collection sites with child occupants appearing to be under the age of 13, recorded the restraint use of all occupants of each vehicle, and interviewed an adult vehicle occupant to obtain additional information such as the height, weight, and age of all child occupants, and the race and ethnicity of all occupants. The approximate ages and sexes of all other occupants were assessed by the data collectors. The result has been a probability-based estimate of national use rates (Enriquez, 2021).

NCRUSS

NCRUSS was a nationally representative survey that performed direct observations of child restraint of 4,167 children from birth to age 8 conducted in 2011. Researchers were stationed at five site types (large discount stores, fast food restaurants, daycares, public libraries, and recreation centers) in a nationally representative sample of sites across the United States. Two researchers approached each vehicle containing child occupants: one researcher interviewed the driver, and the other inspected and collected data on the child restraint system being used. Observations included not just the type of restraint but also specific details of the installation and use (Greenwell, 2015).

Other Observational Surveys

Not all observational surveys of CPS have been nationally representative. Researchers have conducted smaller-scale efforts to collect data to reveal current status, changes over time, or comparisons between groups or locations.

Self-Reported Behavior

Some research in this area has asked caregivers to report their restraint practices either verbally or in writing. This approach is far more economical than an observational survey, and it allows researchers to collect information that cannot be observed. However, as with any form of self-report, demand characteristics or other factors might limit the accuracy of the information. There

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[4] Note that Statistical Policy Directive No. 15: Standards for Maintaining, Collecting, and Presenting Federal Data on Race and Ethnicity (SPD 15) (www.federalregister.gov/d/2024-06469) revised the way race and ethnicity data are to be collected across the Federal Government, beginning March 2024.

has been mixed evidence on how closely self-report of child restraint by caregivers adheres to observed child restraint; general restraint use is fairly accurate when reported by caregivers, but self-report about whether restraint is age-appropriate may be less accurate (West et al., 2021).

Crash Data

The Fatality Analysis Reporting System (FARS) is a census of all fatal crashes on public roads. It contains data fields for restraint use of all occupants in the crash-involved vehicles, including children. Other crash datasets also contain elements that allow restraint use to be recorded by first responders such as law enforcement or emergency medical personnel. These data sources include data held by State or local jurisdictions, data held by private companies such as insurance companies, national datasets such as the Crash Report Sampling System (CRSS), National Emergency Medical Services Information System (NEMSIS), and the National Trauma Registry, and many other sources.

Data fields describing child restraint use at the time of crashes are not always populated in crash datasets. For example, the Minimum Reporting of Crash Data Elements guideline includes definitions or descriptions of data elements related to CRS for police to include on crash reports such as injury level, seating position, air bag deployment, CRS type, anatomical injury area, and injury severity. However, there are still challenges in obtaining consistent recordings of CRS information in crash reports, leading Barron (2018) to conclude, "NHTSA's crash investigation-based programs face challenges in obtaining a robust CRS dataset that will require attention going forward" (p. 15).

Restraint Types

This section includes descriptions of the most common currently available CRSs. The four basic restraint types are

- a rear-facing CRS with an internal harness;
- a forward-facing CRS with an internal harness;
- a BPB that lifts the child and guides the adult vehicle seat belt to rest appropriately on the shoulder and hips; and
- an adult seat belt.

Rear-Facing Seats

Rear-facing seats are installed in the rear seat, facing the rear of the vehicle. Three types of rear-facing seats are available (American Academy of Pediatrics, 2023):

- rear-facing only,
- convertible, and
- all-in-one.

All have 5-point harnesses that pass over the shoulders, at the hips, and between the legs. A rear-facing-only seat must only be installed facing the rear of the vehicle. Convertible seats can be installed facing the rear or facing the front of the vehicle. All-in-one seats can be used rear-facing, forward-facing, or as belt-positioning boosters. For the purposes of this report, use of the term "rear-facing seats" refers to the orientation of the seat and not the seat type.

Forward-Facing Seats

Forward-facing seats are installed in the rear seats, facing the front of the vehicle. These can include convertible seats, all-in-one seats, or combination seats with harnesses. Combination seats with harnesses can be used forward-facing with harnesses or, later, without the harnesses as BPBs (American Academy of Pediatrics, 2023).

Belt-Positioning Booster Seats

BPB seats include two types: high-back and backless booster seats**.** These do not come with harnesses but are used with lap and shoulder seat belts. A BPB is designed to raise a child up so that the lap and shoulder seat belt fits properly over the strongest parts of the child's body (shoulders and hips). At the time of this report, only a few vehicle manufacturers offer integrated (built-in) booster seats (American Academy of Pediatrics, 2023).

A booster seat is not secured to the vehicle seat with the seat belt or lower anchors and tether. However, some models of booster seats permit being secured to the vehicle seats by using the lower anchors and tether or with lap and shoulder belts while in use. Securing a booster seat to the vehicle while not in use prevents the booster seat from becoming a projectile in a crash (American Academy of Pediatrics, 2023).

Other CRS Devices

A child restraint harness (sometimes referred to as a vest) provides pelvic and upper torso restraint via webbing or other flexible material and does not include a rigid seating structure for the child. It can be worn by a child 22 to 168 pounds and can be an alternative to a traditional forward-facing seat. It is used when a vehicle has lap-only seat belts in the rear, for a child with certain special needs, or for a child whose weight has exceeded that allowed by other car safety seat types. Harnesses are required to be capable of installation using lap-only seat belts and usually require use of a top tether (American Academy of Pediatrics, 2023).

Seat Belts

A seat belt only protects a child properly when the child is large enough for the shoulder belt to lie across the middle of the chest and shoulder, the lap belt is low and snug across the upper thighs, and the child is tall enough to sit against the vehicle seat back with knees bent over the edge of the seat—conditions that often do not occur until a child is 10 to 12 years old (American Academy of Pediatrics, 2023).

Usage Rates Over Time

Since 2000 child restraint use rates in the United States have been mostly consistent. These rates may be partially due to the enactment of Federal standards from the 1970s through the 1990s or because of wider adoption of CPS requirements at the State legislative level. The following sections are high-level summaries of usage rates over the past 20 years from nationally representative surveys and crash data as reported by seat type.

Rear-Facing

In 2021 the children who were observed in rear-facing seats were in the rear row of vehicles 99 percent of the time (Boyle, 2022). This finding indicates very high levels of proper seat placement. Similarly, in the 2008 NOPUS children riding in rear-facing car seats were in the back rows 98 percent of the time (Pickrell & Ye, 2009). The 2002 NOPUS data, reporting by

child age instead of seat location, observed infants in rear-facing seats 32 percent of the time and toddlers, defined as ages 1 to 3, at 4 percent of the time (Glassbrenner, 2003). Children in rear-facing seats made up 3 percent of all child traffic fatalities in 2020. Of those 3 percent, 28 percent of the children were younger than 1, and 4 percent were 1 to 3. There was no documented use of rear-facing seats among child traffic fatalities for children 4 and older (National Center for Statistics and Analysis, 2022).[5]

Forward-Facing

Children observed in forward-facing car seats were in the correct back row position 100 percent of the time in the 2021 NOPUS and 99 percent of the time in the 2008 NOPUS (Boyle, 2022; Pickrell & Ye, 2009). In older NOPUS data where restraint type is reported by child age rather than seat position, forward-facing seat use was 66 percent for infants and 62 percent for toddlers (Glassbrenner, 2003). Children in forward-facing child seats accounted for 7 percent of all children killed in MVCs in 2020. Nine percent of those children were 1 or younger, 24 percent were 1 to 3, and 7 percent were children 4 to 7 (NCSA, 2022).

Booster Seats

Data from NSUBS, a specially designed observational survey of child restraint that also collects children's age as reported by caregivers, observed rates of 37 percent booster seat use for 4- to 7-year-olds in both the 2019 and 2008 observations (Enriquez, 2021; Pickrell & Ye, 2009). High-back booster seats, which are visible from the roadside and therefore reportable in NOPUS, were found to be mostly correctly placed in the back rows per observations over the past decade and a half: children in high-back booster seats were observed to be in the rear seats 99 percent of the time in both the 2021 and 2008 NOPUS (Boyle, 2022; Pickrell & Ye, 2009). In the 2002 NOPUS, infants were observed in high-back booster seats only 1 percent of the time, as were 16 percent of toddlers (Glassbrenner, 2003). Placement of those age groups in boosters would most likely be classified as misuse due to size or age violations. Of children killed in crashes in 2020 who were 4- to 7 years old, only 12 percent were restrained in booster seats (NCSA, 2022). Booster seat use among other ages of children killed in fatal crashes was very low: children younger than 1 made up 2 percent, children 1 to 3 years old made up 3 percent, and children 8 to 12 made up 1 percent (NCSA, 2022).

Belted

Any children restrained with seat belts but below the age, height, or weight requirements for seat belts would be instances of misuse. In the 2021 NOPUS, children in seat belts or backless boosters were in the rear rows 89 percent of the time, with the remaining belted children in the front seats (Boyle, 2022). Rates of rear seat belted children were similar in 2008 at 87 percent (Pickrell & Ye, 2009). Of children who died in fatal crashes in 2020, 50 percent of the 8- to 12-year-olds were wearing a seat belt (lap, shoulder, or both), and 36 percent were entirely unrestrained. The remainder had unknown restraint status or were in CRSs (NCSA, 2022).

Unrestrained

In the 2002 NOPUS, infant nonrestraint was at 1 percent, toddler nonrestraint at 6 percent, and 17 percent for children 4 to 7 years old (Glassbrenner, 2003). In 2009 the rates were 1 percent for

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[5] This review only included research published from 2000 to 2022. Please see NCSA (2025) for the most recent data about children in fatal crashes.

infants and toddlers, and 10 percent for children 4 to 7 years old (Pickrell & Ye, 2009). Finally, in 2021 the rates were less than 1 percent for infants, 4 percent for children 1 to 3 years old, and 10 percent for children 4 to 7 (Boyle, 2022). Most unrestrained children are observed riding in the rear seats, with rates at 93 percent in 2021 and 91 percent in 2009 (Boyle, 2022; Pickrell & Ye, 2009). Of children from birth through age 14 who were killed in 2020 MVCs, 38 percent were unrestrained. The rates of non-use varied from 25 percent for children under 1 to 51 percent for children 13 and 14 (NCSA, 2022).

Chapter 2: Non-Use

Introduction

This chapter focuses on research examining factors associated with CRS non-use. Primary data sources are observational studies, data on fatal and injury crashes and insurance claim information on crashes involving children, and surveys and focus groups of caretakers who transport children. The chapter is organized by factors pertaining to child, driver, vehicle, trip, and legal influences.

Summary of Findings

- High-level trends show very high rates of CRS usage for infants, followed by a quick deterioration of usage as the children age and outgrow their original car seats.
- Driver socioeconomic status, race, and location are predictive of child restraint non-use, with lower income families, Black and Hispanic drivers, and drivers in rural areas generally displaying lower use rates in observational studies and lower rates of self-reported use.
- Child restraint use is more common in larger vehicles like vans and SUVs, though the findings are not always consistent. Drivers report trip characteristics, especially short trips, decrease their perceived need to restrain their children.
- Uncommon trip types like rides in taxis and ride-shares have lower rates of restraint use for children.
- Stricter State legal requirements about CPS appear to lead to higher usage rates.

Definitions and Inclusion Criteria

"Non-use" means the child is riding completely unrestrained. Instances where a caregiver improperly restrains a child in the incorrect seat type or a child is prematurely using a lap belt are characterized as misuse and covered in Chapter 3: Misuse. The studies reviewed in this chapter focus on children up to age 13, though because age groups are bracketed differently between studies, some statistics about older child passengers are also reported.

Recent Trends

Child passenger restraint usage rates have been mostly static for the past decade. From 2012 to 2021 national observations of CRS usage rates were 98 percent or higher for children under 3 years old. The use rates for children 4 to 7 years old were in the low 90 percent to mid-80 percent range. Children older than 7 had usage rates in the mid-90 percent range during that time

(Boyle, 2022).[6] Restraint non-use of children killed in fatal crashes was 38 percent in 2020, which was only a slight decrease relative to the 41 percent a decade prior (NCSA, 2012, 2022).[7]

Factors Associated With Non-Use

Absence of CPS Laws

Research shows laws regarding CPS use are effective. A study examining State child seat laws that increased the age threshold for riding unrestrained found an increase in child safety seat use when examining children involved in fatal crashes (Jones & Ziebarth, 2017). A study of police-reported crashes involving children found that while State laws were not a significant predictor of overall usage rates, they did significantly predict use of the optimal type of restraint based on American Academy of Pediatrics and NHTSA recommendations (Benedetti et al., 2017).

Child Characteristics

Demographics – Child Age/Size

Observational studies of CRS usage found non-use to generally be very low for infants but to increase as children grow older and outgrow their original rear-facing car seats. National observations found restraint use for infants as high as 99.4 percent compared to 96.4 percent for children 1 to 3 years old, 90.3 percent for children 4 to 7 years old, and 93.3 percent for children 8 to 15 years old (Boyle, 2022). Similarly, a study of Iowa drivers transporting children found CRS use to be 100 percent for children younger than 2, with usage rates decreasing to 85.5 percent for children 14 to 17 years old (University of Iowa, 2020). A longitudinal observational study, also of Iowa drivers, found infant CRS use remained very high over the past 15 years and restraint use for all other child age groups was steadily increasing over time (Hamann et al., 2022). Observations from Tennessee saw usage rates from 87 percent to 76 percent for 4- to 10-year-olds, depending on driver-reported race of the children (Gunn et al., 2005). An observational study in five States with demographics similar to the entire country classified children by weight rather than age and had similar findings, with children under 20 pounds using restraints at a rate of 97.1 percent and usage rates dropping to 88.8 percent for children weighing 60 to 80 pounds (Decina & Lococo, 2005).

Studies examining fatal crash outcomes also found high restraint usage for infants and then gradual decreases as children get older. Children under 5 who died in car crashes were restrained 70 percent of the time, compared to 60 percent unrestrained fatalities in children 13 to 15 years old (Dunn et al., 2016). An analysis of children killed in fatal crashes from 1991 to 2001 found restraint non-use for children birth to 3 years old was varied from 68 percent when drivers were also unrestrained to 28 percent when drivers were restrained (Starnes, 2003). Moreover, as age increased, so did child non-use rates for both driver categories. For example, 8- to 15-year-olds killed in fatal crashes were unrestrained 46 percent of the time when drivers were restrained and 91 percent of the time when drivers were unrestrained. More recent analyses found that in 2011, about 40 percent of 8- to 12-year-olds who died in fatal crashes were unrestrained, compared to 33 percent for all children combined who died in fatal crashes (Sauber-Schatz et al., 2014). When looking at non-fatal injury crashes, similar patterns emerged throughout the literature, with

[6] This review only included research published from 2000 to 2022. Please see Werth (2025) for the most recent (2022) data about observed child restraint use.
[7] This review only included research published from 2000 to 2022. Please see NCSA (2025) for the most recent (2022) data about children in fatal crashes.

rates of restraint non-use higher among older age groups (Funk et al., 2003; Lee et al., 2008; Violano, 2015; Winston et al., 2004).

As noted, non-use for infants was generally extremely low. Therefore, researchers have made efforts to understand the thoughts and behaviors of caregivers of slightly older children using surveys and focus groups. This data sheds light on the reasoning behind observed non-use trends. A phone survey of caregivers found 4 percent of children under 4 years old were unrestrained at least some of the time, and that number jumped to 9 percent for children 8 to 12 years old (Greenspan et al., 2010). When asked about scenarios in which they would allow their children 4 to 10 years old to be "not fully buckled in," caregivers were most permissive of non-use when in a taxi or ride-share, in someone else's car, and when driving short distances (McDonald et al., 2018). The same study also found caregivers were generally more permissive of non-use if their children were in booster seats as opposed to car seats, which also points to increased child age as a significant factor for non-use.

Demographics – Male Versus Female Children

The review identified only two studies that investigated non-use by child sex, and neither study found these variables to be influential factors in prevalence of CRS non-use. There were no statistical differences in restraint use by sex for children presenting to emergency departments (EDs) after motor vehicle collisions (Lee et al., 2008) or in a roadside observational study of CPS use in Michigan (Eby, Kostyniuk, & Vivoda, 2001). As discussed later, however, whether a driver is male or female may influence use.

Child Behavior

Parents sometimes reported children's behavior as a barrier to restraint use. Parental focus group studies cited resistance from children as one of the reasons for riding unrestrained (Agran et al., 2004; Medoff-Cooper & Tulman, 2007). Children with certain neurodevelopmental conditions may also demonstrate resistance, as illustrated in medical records research that showed 74 percent of children with autism spectrum disorder (ASD) referred to a car seat program for children with adaptive transportation needs escaped their restraints, according to caregivers (Yonkman et al., 2013). Parents have also reported non-use of restraints as reward for children (Zonfrillo et al., 2015).

Driver Characteristics

Demographics – Driver Age

Driver age generally influenced usage rates, with both younger and older drivers using CRS less than middle-aged drivers. Nationally, as of 2022 child restraint use was observed to be 88.5 percent when the drivers were 16 to 25 years old, increased to 94 percent for drivers 25 to 69, and then fell again to 90.8 percent for drivers 70 or older (Boyle, 2022). An older study found a similar pattern, with drivers 30 to 59 years old being more likely to use child safety seats than those younger or older (Eby, Kostyniuk, Miller, & Vivoda, 2001). Fatal crash analyses (Huang et al., 2019) and surveys (Hernandez, 2008; Zonfrillo et al., 2015) also pointed to a trend of younger drivers being less likely to use child restraints. However, one study of roadside observations from 2011 did not find differences by age (Raymond, Searcy, Miller, & Redden, 2018).

Demographics – Male vs. Female Drivers

The research concerning rates of child restraint non-use by male or female drivers were mixed, with no difference found in observational studies, higher non-use rates for female drivers in injury involved crash data and higher non-use with male drivers in crashes involving an insurance claim (not necessarily involving an injury) and in self-reported data. Two national observational studies showed male and female drivers buckle up children at roughly the same rate (Boyle, 2022; Raymond, Searcy, Miller, & Redden, 2018). An observational study in Michigan found a similar lack of differences between male and female drivers (Eby, Kostyniuk, Miller, & Vivoda, 2001). By contrast, an analysis of police-reported crashes from Connecticut found female drivers were more likely to have children restrained in car seats (Violano, 2015), and a national study of insurance claim crash data found fathers were driving with unrestrained children in 35 percent of claims compared to mothers at 26 percent (Kallan et al., 2014). The results were also mixed when the data were based on self-report: males reported being more permissive when asked about a variety of situations when they might drive with a child unrestrained (Zonfrillo et al., 2015). In another study, males reported always restraining children at nearly the same rate as females (Hernandez, 2008). Finally, a study that surveyed parents bringing their children to doctors for well visits found no difference in self-reported restraint use between male and female parents (Cooper et al., 2002). Some of these mixed results may be due to the different types of data on which they are based. For example, while observational studies collect restraint use data for all child occupants, studies using crash data provide information only from the subset of vehicles involved in crashes.

Demographics – Driver Race/Ethnicity

A driver's race and Hispanic ethnicity were predictive of rates of non-use of child restraints. Generally, Black and Hispanic drivers had lower CRS usage rates in observational and crash data analysis than White and Asian drivers. This section presents data on driver race, but also includes studies that presented results on child race.

Observational studies found child restraint use for children under 8 was lowest with drivers who observers perceived to be Black, at 81.9 percent, compared to 95.2 percent for drivers perceived to be White and 91.4 percent for drivers of other races (i.e., drivers whose race observers did not perceive to be either Black or White) (Boyle, 2022). Another observational study that also involved interviews conducted in 2011 found drivers who self-identified as Black (any ethnicity) were statistically more likely than White (any ethnicity) or Asian (any ethnicity) drivers to not use child restraints (Raymond, Searcy, Miller, & Redden, 2018). People who self-identified as Hispanic (any race); non-Hispanic, other race (any race other than Black or White); or non-Hispanic Black all had greater odds of self-reporting non-adherence (e.g., not owning or using a car seat appropriately) to child safety seats than non-Hispanic White drivers (Heerman et al., 2016). Hispanic children admitted to emergency rooms after motor vehicle crashes were significantly less likely to have been restrained than non-Hispanic children (Ghetti et al., 2023). Finally, among children killed in crashes, Hispanic (any race) and non-Hispanic Black, Native American, and Asian/Pacific Islander children were more likely to be unrestrained than non-Hispanic White children (Voas et al., 2002).

Surveys and focus groups found Hispanic or Latino caregivers were more likely than non-Hispanic or Latino caregivers to allow or have permissive views about non-use of child restraints. This finding was the case in a national survey (Zonfrillo et al., 2015) and a survey of Arizona drivers only (Hernandez, 2008). In research primarily investigating maternal depression

and child safety, Black mothers were statistically more likely to report not using car seats than White mothers (Leiferman, 2002). By contrast, a survey of parents who brought their children to doctors for well visits found no apparent connection between race or ethnicity and non-use of child restraints (Cooper et al., 2002).

Rurality

There are differences in child restraint use depending on location: different regions of the country and rural versus urban areas demonstrated different use rates. The 2021 NOPUS found usage rates (for children perceived to be 8 or younger) were similar in urban (93.6%) and rural (93.2%) areas (Boyle, 2022). That same study found child restraint usage highest in the West[8] at 97.5 percent and lowest in the South[9] at 91.6 percent (Boyle, 2022). Rural areas in Iowa and Arizona had lower CRS usage rates than the same States' urban areas (University of Iowa , 2020; Hernandez, 2008). Another study from Iowa found that while both urban and rural CRS usage increased over time, rural usage consistently lagged behind usage rates in urban areas (Hamann et al., 2022).

Socioeconomic Factors

In the limited available data, socioeconomic status (SES) did not predict self-reported CRS use. However, other data sources (hospital visits after motor vehicle crashes, crash analyses, and behavioral intervention studies) suggest a link between lower SES and lower use rates. Survey and focus group research found mixed results, with high-income people found to be both most compliant (Hernandez, 2008) or least compliant (Zonfrillo et al., 2015) with CRS use. And, in a study looking at racial and ethnic differences in injury prevention behaviors, statistical models that included factors related to SES did not explain differences in CRS usage behaviors between racial and ethnic groups (Heerman et al., 2016). By contrast, data from MVC hospital visits showed lower CRS use rates in poorer areas, which is more consistent with general findings related to SES and traffic safety outcomes (e.g., Braver, 2003). Children under 18 who were admitted to emergency rooms for MVC-related injuries also were 21 percent more likely to be unrestrained if they were from the most socioeconomically disadvantaged neighborhoods[10] compared to those from the least disadvantaged (Ghetti et al., 2023).

Psychological Factors

Parental knowledge of child occupant protection issues and laws was not always predictive of non-use of child restraints (Agran et al., 2004; Cooper et al., 2002), and an analysis of data from the National Institutes of Health's Greenlight study showed health literacy (understanding health information to make appropriate health decisions) was not associated with regular car seat usage (Heerman et al., 2014). However, there was variability among caregivers in their knowledge of specific features of CPS laws, and caregivers often used seat belts rather than car seats to restrain their children. The impact of knowledge on this premature transition to inappropriate restraints (non-use of car seats, but use of seat belts) is discussed in the literature on misuse (see Chapter 3: Misuse).

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[8] Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, Wyoming

[9] Alabama, Arkansas, the District of Columbia, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia

[10] Neighborhoods were categorized based on Area Deprivation Index scores, a validated composite of economic, housing, social, and transportation socioeconomic indicators from the American Community Survey.

Other psychological factors are sometimes related to non-use and include a caregiver's attitude toward safety and risk. According to NCRUSS data, drivers with unrestrained children and drivers with restrained children reported they were both aware of the benefits of car seats for restraining children (Raymond, Searcy, Miller, & Redden, 2018). By contrast, participants in focus groups consisting of violators of CPS laws said they did not understand the risks associated with non-use (Agran et al., 2004). Similarly, a "short trip" was a common reason for non-use in NCRUSS data, suggesting there is a misconception that short trips are low risk, and that low-risk situations are an acceptable time to leave a child unrestrained (Raymond, Searcy, Miller, & Redden, 2018).

A few studies investigated the effect of maternal depressive symptoms on behaviors related to child safety, often including car seat use. In surveys of mothers experiencing post-partum depression, self-reported car seat use was 67 percent, compared to 84 percent among non-depressed mothers (Balbierz et al., 2015). Two studies examining the same longitudinal datasets came to a similar conclusion: increases in maternal depression were related to decreases in child safety restraint usage (Leiferman, 2002; McLennan & Kotelchuck, 2000).

Driver Restraint Use

A driver's own seat belt usage patterns are often reflected in the CRS usage of the children that the driver transports. Studies using different methodologies found drivers who do not use restraints tended to more frequently drive with unrestrained children. As described elsewhere in this report, the issue was exacerbated as the child ages.

Observations of people on-road consistently found unrestrained drivers were more likely to not use child safety restraints. For example, in 2021, 95 percent of children were restrained when the driver was also restrained compared to 76 percent child restraint use when the driver was unrestrained (Boyle, 2022). Observations of vehicles containing children in locations like parking lots, childcare facilities, and restaurants found drivers of unrestrained children were themselves unrestrained 66 percent of the time (Raymond, Searcy, Miller, & Redden, 2018). An observational study conducted in Iowa also found an 11 times greater likelihood of unrestrained children when the driver was unbelted (Missikpode et al., 2021); the risk increased to 33 times more likely when the unbelted driver was a teenager. A study conducted in 2001 at medical and childcare facilities found unbelted drivers used restraints for children under 4 about 19 percent less often than belted drivers (Eby, Kostyniuk, Miller, & Vivoda, 2001), while there was a 56 percent decrease in restraint use for children 4 to 15 between buckled and unbuckled drivers (Eby, Kostyniuk, & Vivoda, 2001).

The trend for children being unrestrained in the presence of unrestrained drivers was also present among analyses of child-involved MVCs. Children up to 14 killed in fatal crashes were unrestrained 65 percent of the time when drivers were also unrestrained, compared to 32 percent of the time when driver were restrained (NCSA, 2022). Older children were more likely to be unrestrained in fatal crashes when the driver was also unrestrained, with rates reaching 90 percent restraint non-use for children 13 to 15 years old (Dunn et al., 2016). Another analysis using FARS data found similar patterns: for vehicle occupants 3 and younger involved in fatal crashes, the child restraint use rate matched the driver restraint use rate at 68 percent (Starnes, 2003). As the age of children increased, the rate of restraint use among fatally-injured children decreased, with only 14 percent of fatally injured children 4 to 7 years old, and 7 percent of fatally injured children 8 to 15 being restrained when the drivers were unrestrained (Starnes,

2003). Of children under 2 involved in fatal MVCs, about 7 percent were completely unrestrained, and one of the strongest predictors of non-use use was driver non-use (Huang et al., 2019). Findings were similar in non-fatal crashes. In an analysis of injury crashes in Connecticut, 41 percent of children riding with unrestrained drivers were also unrestrained, compared to only 2 percent for children riding with restrained drivers (Sauber-Schatz et al., 2015). Another analysis of non-fatal crash data found driver non-restraint was the largest predictor of child restraint non-use (Benedetti et al., 2017).

Self-report data further shows driver belt use is strongly related to CRS use. A survey of caregiver/child pairs found caregivers who always wore seat belts were more likely to have children who sat in rear seats and wore seat belts (Ehrlich et al., 2004). In a telephone survey, drivers who transported 8- to 15-year-old children self-reported encouraging the children to buckle up 96 percent of the time if they themselves used seat belts compared to only 56 percent of drivers encouraging child restraint use if they did not use seat belts (Kidd & McCartt, 2014).

Driver Alcohol and Drug Use

Two studies of children involved in motor vehicle collisions found significantly higher rates of CRS non-use when the drivers had used alcohol, drugs, or both. One study of fatal MVCs found rates of non-use for children 2 and under to be more likely if the drivers tested positive for alcohol (i.e., if police reported alcohol or if drivers had blood alcohol concentrations [BACs] ≥ .01 grams/deciliter) (Huang et al., 2019). Another study of injury crashes found children were unrestrained 16 percent of the time when the drivers were suspected (by police) of alcohol or drug use compared to 3 percent for drivers not suspected of alcohol or drug use (Sauber-Schatz et al., 2015).

Vehicle Features

The type and size of vehicle, especially the access to seats, number of seats, and seat configurations, influenced usage rates of CRS.

Vehicle Type

Larger vehicles (e.g., vans and SUVs) tended to have higher restraint use among child occupants. From an observational/interview study, the highest levels of CRS non-use were found in passenger cars and pickups, with 3.7 percent and 2.0 percent, respectively (Raymond, Searcy, Miller, & Redden, 2018). There were similar findings in a more recent observational study, with vans and SUVs having higher rates of restraint use (95.8%) followed by cars (90.4%) and trucks (86.8%) (Boyle, 2022). Observations of older child passengers in Michigan also found higher restraint rates in vans, minivans, and SUVs (Eby, Kostyniuk, & Vivoda, 2001). Pickup trucks were found to have the lowest use rates of child restraint use in all reviewed studies, including one conducted on a tribal reservation in Washington State (Hoff et al., 2017). However, the findings were inconsistent when examining fatal crashes, with SUVs not always showing high levels of restraint. Children killed in fatal crashes were much more likely to be restrained if they rode in sedans and vans compared to SUVs and trucks (Lee et al., 2015). Children treated at hospitals after MVCs were three times more likely to have been unrestrained when riding in trucks than in other types of vehicles (Lee et al., 2008).

Seat Location

While young children sitting in the front seat was very uncommon, when it was observed, CRS non-use was high. Less than 2 percent of infants were observed riding in the front seat in 2021

(Boyle, 2022). When researchers observed children in Connecticut in the front seat, however, they were significantly less likely to be restrained (Violano, 2015). Similar findings came out of Iowa, where the rate of non-use was 50 percent for front seat child passengers (University of Iowa Injury, 2020). All agencies and manufacturers strongly recommend against children riding in front seats; speculatively, drivers who did not heed those warnings may also be more likely to disregard other safety precautions like restraint use.

There were also differences between CRS non-use when children were sitting in the rear seats/rows. The back-right seat of a vehicle was the most likely place for an unrestrained child to be sitting at 44 percent, followed by the back left at 23 percent and front-passenger seat at 22 percent (Raymond, Searcy, Miller, & Redden, 2018). Similarly, in Michigan, observed front-center and front-right seat usages rates were 58.8 percent and 42.2 percent for children under 4, respectively, compared to usage rates between 85 percent and 91 percent in the second row (Eby, Kostyniuk, Miller, & Vivoda, 2001). For older children 4 to 15 years old, however, observed restraint use was highest for the front-right seat (Eby, Kostyniuk, & Vivoda, 2001); note, however, current recommendations state children should remain in the rear seats at least through age 12 (NHTSA, n.d.-a).

Number of Passengers

It can be challenging for a family with a large number of children to correctly install three car seats in one row. This situation is known as the "three-across problem," and it has sometimes resulted in non-use of child restraints. For example, infant passengers were 1.5 times more likely to be unrestrained if positioned in the center-rear seat, where space is typically tightest (Huang et al., 2019). Moreover, as the number of occupants increased, so did the percentage of unrestrained children. The unrestrained rate climbed from 1.2 percent unrestrained when the total occupant count was three or less to 6.7 percent with four or more occupants (Raymond, Searcy, Miller, & Redden, 2018). In survey data, caregivers of children who rode in car seats or booster seats reported having permissive attitudes for going unrestrained because of factors related to the car being too small or too crowded, with from 25 percent and 30 percent not strongly disagreeing they would allow their children to go unrestrained in those situations (McDonald et al., 2018).

Situational Factors

The last major set of factors to consider for non-use are factors related to the trip distance, time of day, and weather. These factors can all affect rates of non-use, as can whether children are riding in less commonly used vehicles such as taxis, ride-shares, or ambulances.

Trip Length

Short trips were often given as a reason for permissibility of CRS non-use. Drivers who had driven with unrestrained children gave the drive being a short trip as the most common reason for non-use, at 51 percent (Raymond, Searcy, Miller, & Redden, 2018). Similarly, around 20 percent of caregivers said it would be at least somewhat acceptable for a child to ride unrestrained if they were on a short trip (Zonfrillo et al., 2015). Over 30 percent of booster seat and 20 percent of car seat users had permissible opinions of not using restraints if the trip was just around the corner (McDonald et al., 2018). The finding from observational research that restraint use was slightly lower in less traffic and slower speeds (Boyle, 2022) may also reflect these self-report findings and suggest use is lower in situations perceived to be lower risk (e.g., shorter trips, less traffic, slower speeds).

Time of Day/Day of the Week
The day of the week of a trip did not seem to influence observed rates of non-use of CRS (Boyle, 2022; Eby, Kostyniuk, & Vivoda, 2001). Time of day, however, was a factor. When examining crashes, non-use among children involved in all police-reported crashes was higher in the evening and night than during the day, by around 3 percent and 10 percent higher (Violano, 2015). A separate study of injury-related crashes found non-use to be statistically significantly more likely at night relative to the day (Huang et al., 2019).

Weather
In the 2021 NOPUS, there was no evidence non-use was different in clear versus not clear weather conditions (Boyle, 2022).

Trips in Taxis, Ride-shares, or Ambulances
An area of CRS non-use that has received attention in recent years is the usage patterns in ride-share services such as Lyft and Uber. These trips, along with taxi and ambulance trips, may have lower rates of CRS use than when children are transported in personal vehicles. A commonality between trips in taxis, ride-shares, and ambulances is they are generally out of the ordinary; additionally, for taxis and ride-shares, regulations for CPS often differ compared to normal passenger vehicles (McCourt et al., 2022). Parents who have used ride-shares with their children reported doing so on out-of-town travel like vacation or business trips (Owens et al., 2019), and ambulances are only ridden in during medical emergencies. Surveys showed permissive attitudes and behaviors regarding restraint use in ride-shares. Only half of caregivers reported always using CRS when riding in ride-shares, with rate use less for older children (Savage et al., 2021). Similarly, in another study, caregivers reported using car seats 59 percent of the time while using ride-share services (Owens et al., 2019). Similar to ridesharing, 80 percent of EMS providers reported regularly using CRSs when transporting children (Johnson et al., 2006). Although no studies of observed restraint use by children in taxis and ride-share vehicles were published in the review period (2000 – 2022), see De Leonardis et al. (2024) for such a study, in which child restraint use in ride-share vehicles was observed in two urban areas to be substantially lower than national estimates of child restraint use in private vehicles.

Chapter 3: Misuse

Introduction

This chapter discusses research identified related to misuse in CPS practices. The chapter provides a definition of misuse; however, citations throughout the chapter will note the definitions used in individual studies, as needed. The chapter continues with literature on the trends and prevalence of commonly identified misuses within selection, installation, and use, particularly those demonstrated with specific types of restraints. Finally, the chapter describes the factors associated with misuse discovered during the review.

The most common study types identified in this review were observational studies, nationally representative surveys, and user testing of CRSs. NHTSA's NCRUSS was a nationally representative survey conducted in 2011; NHTSA observed the use of car seats and booster seats for child passengers under 8 years old in 4,167 vehicles and interviewed drivers on their attitudes, beliefs, and confidence with CPS (Greenwell, 2015). NHTSA conducted its most recent NSUBS in 2017 and presented national estimates and characteristics of booster seat use

among children 4 to 7 years old (Li & Pickrell, 2018). CPSTs conducted other observational studies of participating vehicles, either through an inspection event or randomly recruited vehicles entering a study site. These studies investigated all types of misuse (selection, installation, and use). User testing allowed researchers to monitor participants installing CRSs and directly identify common errors in installation and use, as well as factors for misuse. Researchers also investigated factors associated with misuse through observation, self-reported data, and crash data.

Summary of Findings

- Across different seat types, caregivers often selected an inappropriate option.
- Common installation errors were incorrect recline, loose installation, and tether non-use. Incorrect installation was more common in rear-facing seats.
- Common errors in restraint use were loose or incorrectly placed harness straps for car seats and incorrect shoulder belt position or fit for booster seats.
- Misuse was more prevalent among Black and Hispanic children and caregivers, caregivers with lower education or income, drivers with risky driving behavior, and caregivers who were not knowledgeable about CPS.
- Misuse was also more common in pickup trucks and older vehicles and when the trip was short, there were more children in the vehicle, and the caregivers reported they were rushed.

Definition of Misuse

Consistent with the literature discovered by this review, this report considers misuse in three categories: inappropriate restraint selection, inadequate restraint installation, and incorrect restraint use.

- **Inappropriate restraint selection** refers to selecting the wrong seat for the child; the criteria for what constitutes the wrong seat varies by legislation and the recommendations of car seat manufacturers, but it is often defined by age or weight.
- **Inadequate restraint installation** refers to installing the seat incorrectly in a way that may reduce the protection of the child in the event of a crash.
- **Incorrect restraint use** covers characteristics of car seat use beyond selecting the correct seat and installing the seat correctly, such as placement of the child in the seat.

Inappropriate Restraint Selection

Inappropriate selection is a type of misuse the literature sometimes refers to as age-inappropriate use, premature transition, and improper restraint choice. Older literature may have referred to this as “premature graduation,” but this term became less common as there may be a positive connotation with “graduation.” A qualitative study of parental perspectives on CPS found a barrier for proper restraint selection was that first-time parents were more focused on installation (Kendi, Howard, et al., 2021), suggesting inappropriate selection is common because parents may pay more attention to correctly installing the systems.

The literature defines appropriate restraint selection by whether the child's characteristics are aligned with the appropriate metrics for transitioning between types of restraint. The recognized progress for a child's transition between seats is rear-facing to forward-facing to booster. Then, children transition to seat belts in the rear seat and, finally, seat belts in the front seat. The transition from one restraint type to another depends on the child's age, height, or weight set by car seat manufacturers (Enriquez, 2021; Greenwell, 2015). State law is also a source for defining appropriate restraint selections, but laws may change based on updated best practices. Inappropriate restraint selection commonly includes premature transition to the next restraint type. It can also include keeping a child in a seat longer than recommended. The methods of studies in this area included inspection by CPSTs, surveys, and crash data analysis. Researchers needed to be able to establish a child's age or size in order to cross reference the findings with each study's respective definition for appropriate restraint selection as defined by AAP, NHTSA recommendations, State law, or a combination of them.

Studies frequently used inspections by CPSTs to investigate inappropriate restraint selection. These studies found inappropriate selection was evident: caregivers prematurely transitioned children to forward-facing car seats (Enriquez, 2021; Gates et al., 2022; O'Neil et al., 2011, 2018), to booster seats (Abbe et al., 2016; Decina et al., 2005; Decina & Lococo, 2003; Enriquez, 2021; Gates et al., 2022), to seat belts (Enriquez, 2021), and to the front seat (O'Neil et al., 2018). Several studies found premature transition was more common out of booster seats compared to other seats (Aita-Levy & Henderson, 2016; Benedick et al., 2020; Cease et al., 2011; Ebel et al., 2003a; Rangel et al., 2007).

Other studies that investigated appropriate versus inappropriate restraint selection included crash data analysis and analyses of medical records. A 2019 FARS data analysis noted premature transition to a booster seat and seat belt was evident among children killed in fatal crashes (Lee et al., 2019). Of those children prematurely transitioned to a booster seat, 0.7 percent were 1-year-olds, 9.9 percent were 2-year-olds, and 14.9 percent were 3-year-olds. Of those children prematurely transitioned to a seat belt, 4.7 percent were <1-year-old, 1.3 percent were 1-year-olds, 7.9 percent were 2-year-olds, and 9.3 percent were 3-year-olds. Similarly, an analysis of children admitted to emergency departments for MVC in the National Electronic Injury Surveillance System-All Injury Program found inappropriate placement of children in seat belts before they met the recommended height of 57 inches, a metric defined by the NHTSA recommendations at the time (Lee et al., 2008). In 2020 an analysis of medical records of children admitted to trauma centers for MVC found premature transition to seat belts was the second most common improper restraint, with traveling in the front seat before the age recommended by State law as the most common (Sylvester et al., 2021).

Inadequate Restraint Installation

Misuse in CPS restraints is related to installation of the car seat in the vehicle. This section begins by looking at errors with attachments and with each attachment type. Then, the section identifies the seat types more frequently installed incorrectly and the common installation errors identified within each seat type.

NHTSA's 2011 NCRUSS assembled a group of internal subject matter experts to construct a definition of misuse (Greenwell, 2015). For this study, not every divergence from a perfect installation was considered "misuse;" instead, misuse was defined based divergences that may reduce the protection of the car seat or booster seat in the event of a crash. The definition

included a list of defined misuses when installing the car seat in the vehicle (Table D-1, p. 53), when restraining a child in a car seat, and when restraining a child in a booster seat. (The lists of misuses for restraining a child in a car seat or booster seat are included later in this chapter under Incorrect Restraint Use.) Misuses related to installation:

- Car seat's direction is incorrect
- Car seat moves 3 inches laterally once installed
- Other method of attachment of car seat to vehicle
- Car seat not attached to vehicle (i.e., no seat belt or LATCH used)
- Car seat not against vehicle seat back
- Child less than 1-year-old and car seat is upright (not reclined)
- Child less than 1-year-old and rear-facing infant car seat angle is up to 30 degrees
- Recline of more than 45° in rear-facing convertible car seat

A frequently investigated installation misuse was errors that occurred when attaching the car seat to the vehicle. CRS can be attached using a seat belt or Lower Anchors and Tethers for CHildren (LATCH) system. Lower anchors are a pair of metal bars located near the vehicle seat bight (i.e., where the seat cushion and seat back meet), and tethers are straps (single or double) located on a car seat and used to secure the top of a forward-facing car seat to the vehicle tether anchor (NHTSA, 2020). User testing analyses (Benedick et al., 2020; Tsai & Perel, 2009), CPST inspections (Bachman et al., 2016; Hoffman et al., 2016), and analyses of medical records (Sylvester et al., 2021) frequently found errors with both the seat belt and the lower anchors when securing the seat to the vehicle. In an observational study conducted by CPSTs at an inspection event, seat belt errors were more common than errors with the lower anchor system (Abbe et al., 2016). Of the caregivers (n = 295) who installed the seat using the seat belt system, 31.2 percent used it correctly. Of the caregivers (n = 122) who installed the seat with the lower anchor system, 42.6 percent used it correctly. This pattern is consistent with findings from a user testing study conducted by NHTSA, in which the error rate for infant CRS installation was 95 percent using LATCH and 100 percent using the seat belt (Tsai & Perel, 2009).

Similarly, according to NCRUSS data, a higher rate of misuse was associated with seat belt installations compared to LATCH installations (Greenwell, 2015; Raymond, Searcy, & Findley, 2018). Common installation errors when using a seat belt to attach the car seat to the vehicle included loose installation, incorrect seat belt routing, and twisted seat belts (Tsai & Perel, 2009). The most commonly observed error was loose installation (Decina & Lococo, 2003; Hoffman et al., 2016; Raymond, Searcy, & Findley, 2018). Another commonly identified error with seat belt attachment was not switching the seat belt retractor into locking mode (Bachman et al., 2016; Hoffman et al., 2016; Raymond, Searcy, & Findley, 2018). One study also showed more frequent observations of tether misuse in seat belt installations than LATCH installations (Klinich et al., 2012).

In 2002 NHTSA published a regulation (FMVSS No. 225) requiring new vehicles to include hardware components designed to standardize LATCH installations, including upper tether anchorages in the rear seats of passenger vehicles. However, the availability of LATCH does not eliminate CRS misuse (Klinich et al., 2012). The most frequent errors observed with LATCH

installation during a user testing of infant car seats were loose installation, using the seat belt during the LATCH installation, and twisted lower anchor straps (Tsai & Perel, 2009). Other studies also frequently observed a loose lower attachment installation (Decina & Lococo, 2007; Klinich, Flannagan, et al., 2013). Misuses in LATCH attachments were associated with seating position; drivers/caregivers often installed the CRS in the center position, which was not equipped with lower anchors, and incorrectly used the outboard lower anchors instead (Benedick et al., 2020; Decina et al., 2006). Attaching the car seat to the lower anchors was identified by caregivers as the reason attaching a car seat was difficult, noting it was difficult to clip or unclip hooks to the anchors (Martin & Block, 2020).

Tethers are straps (single or double) located on a car seat and used to secure the top of a forward-facing car seat to the vehicle (NHTSA, 2020). Even after the 2002 FMVSS No. 225 required upper tether anchorages in the rear seat of passenger vehicles, studies showed tether use was still negligible (Bachman et al., 2016; Decina et al., 2006; Decina & Lococo, 2007; Gates et al., 2022; Klinich et al., 2012; O'Neil et al., 2011). Non-use of tethers provides sub-optimal protection and is contrary to NHTSA recommendations (O'Neil et al., 2011). Caregivers frequently cited reasons for not attaching the top tether were that there was no place on the vehicle to attach the strap, the caregiver forgot to attach it, the strap was difficult to attach, and the belief the seat belt was good enough (Martin & Block, 2020). However, while tether use holds the promise of standardizing the installation of CRSs, drivers must still correctly connect the tether straps to the vehicles. An analysis of CPST inspection data showed even when using the top tether, it was frequently used inappropriately (Bachman et al., 2016). Two common errors with top tether use included loose tether straps (Decina & Lococo, 2007) and incorrect tether routing (Klinich et al., 2012).

Overall misuse rates varied based on restraint type, according to NHTSA's 2011 NCRUSS (n = 4,167 vehicles), which defined misuse as a combination of inadequate installation and incorrect restraint use (Greenwell, 2015). One or more misuses existed in 46 percent of car seats and booster seats; by CRS type, misuse was highest among forward-facing car seats (61%), followed by rear-facing infant car seats (49%), and then rear-facing convertible car seats (44%). Additionally, misuse rates were 24 percent for backless booster seats and 16 percent for high back booster seats.

Error rates for installation are different depending on the type of car seat (Abbe et al., 2016; Benedick et al., 2020; Tsai & Perel, 2009). In particular, the literature showed incorrect installation of rear-facing car seats occurred more frequently than with other kinds of CRSs (Abbe et al., 2016; Benedick et al., 2020; Gates et al., 2022; Tsai & Perel, 2009). Booster seats had the lowest rate of installation errors (Abbe et al., 2016; Benedick et al., 2020).

Observed errors in rear-facing car seats included incorrect recline, loose installation, and attachment errors. Several studies identified incorrect recline as the most common installation error in rear-facing car seats (Abbe et al., 2016; Raymond, Searcy, & Findley, 2018; Tsai & Perel, 2009). The literature found loose installation to be another common installation error in rear-facing, as described in the NCRUSS (Greenwell, 2015; Raymond, Searcy, & Findley, 2018), other CPST observation studies (Abbe et al., 2016; Gates et al., 2022; Tsai & Perel, 2009), and user testing (Benedick et al., 2020; Tsai & Perel, 2009). Only one study, an observation of newborn hospital discharges, found loose installation as the most common installation error, with incorrect recline the second most common error; in this case, an upright car seat was the incorrect recline observed (Hoffman et al., 2016). Other common installation misuse in rear-

facing seats included seat belt-related errors (Benedick et al., 2020) and incorrect lower anchor strap routing (Benedick et al., 2020; Raymond, Searcy, & Findley, 2018). Finally, NHTSA conducted a user testing study that found improper positioning of the seat in the vehicle was one of the main errors that contributed to unsafe installation of infant car seats (Tsai & Perel, 2009).

Fewer studies included in the review identified errors in forward-facing installation. According to several studies, a loose installation was the most common error in installing forward-facing seats (Gates et al., 2022; Greenwell, 2015; Raymond, Searcy, & Findley, 2018). This finding was consistent in another NHTSA study that combined five experiments of user testing and CPST observations (Tsai & Perel, 2009). This study also found loose installation was common in forward-facing; however, the study notes this error is common regardless of whether the seat was rear-facing or forward-facing. Seat belt-related errors are also common in forward-facing car seats (Raymond, Searcy, & Findley, 2018).

Booster seats had the lowest rate of installation errors (Abbe et al., 2016; Benedick et al., 2020; Gates et al., 2022). This review did not identify any studies that revealed specific installation errors in booster seats.

Incorrect Restraint Use

Misuse involving incorrect restraint use included errors related to the overall use of the car seat (i.e., after installing the CRS in the vehicle, how well is the child placed in the restraint system?). This section discusses errors during securement of the child and the common restraint use errors identified within each seat type. One user testing study and one hospital discharge observation study suggested errors related to securement and placement of the child were more common than errors related to installation (Benedick et al., 2020; Rogers et al., 2012).

Errors in Restraining a Child in Car Seats

The 2011 NCRUSS defined the following misuses when restraining a child in a car seat (Greenwell, 2015, p. 53).

- Child seated in front row, with an active air bag
- Car seat is cracked/broken shell
- Car seat has broken/frayed harness
- Car seat uses aftermarket product, belt tightener
- Location of car seat not on vehicle seat
- Harness not in use
- Given harness in use, harness strap not buckled
- Given harness in use, one or more harness straps behind arm/back/leg
- Given harness in use, harness slack is greater than 2 inches
- Given direction is rear-facing, both harness slot position above the child’s shoulder by more than 2 inches

- Given direction is forward-facing, both harness slot position below the child's shoulder by more than 2 inches
- Child's head is above the top of car seat

The most commonly identified restraint use errors were those related to harness straps securing the child to the CRS (Decina & Lococo, 2003). CPST inspection studies found frequently observed misuse included incorrect placement of the harness retainer clip, improper threading of the harness, and loose harness straps (Abbe et al., 2016; Bachman et al., 2016; Gates et al., 2022).

The main error contributing to rear-facing car seat misuse was securing the child incorrectly (Benedick et al., 2020; Tsai & Perel, 2009). This prevalence of restraint use errors in infant car seats may be because infants are smaller in size and therefore harder to secure snugly (Benedick et al., 2020). Placing the harness chest clip, when present, at an improper level was the most common restraint use error in rear-facing car seats (Hoffman et al., 2016; Tsai & Perel, 2009); loose harness was also observed as a common misuse (Chakraborty et al., 2022; Tsai & Perel, 2009).

As discussed above, according to NCRUSS data, overall restraint misuse was highest among forward-facing car seats (Greenwell, 2015). For errors with restraint use, a CRS with loose harness straps was the most commonly observed restraint misuse in forward-facing car seats (Decina & Lococo, 2003; Gates et al., 2022; Greenwell, 2015; Raymond, Searcy, & Findley, 2018). NCRUSS data also showed another common misuse in forward-facing car seats was one or more harness straps behind the child's back, arm, or leg (Raymond, Searcy, & Findley, 2018). Notably, an observation study (*n* = 4,126 vehicles) found forward-facing car seats were more likely to have visible damage, with forward-facing car seats accounting for 68 out of the 114 visibly damaged CRSs; the study considered visible damage to the car seat (e.g., crack in the shell and broken harness parts, frayed harness straps) to be a critical misuse (Decina & Lococo, 2003).

Errors in Restraining a Child in Booster Seat

The 2011 NCRUSS lists defined misuses when restraining a child in a booster seat (Greenwell, 2015, p. 53) as follows.[11]

- Child seated in front row, with an active air bag
- Location of booster seat not on vehicle seat
- Booster seat is cracked/broken shell
- Booster seat uses aftermarket product, belt tightener
- Seat belt is not buckled
- Child's head above vehicle seat back
- Shoulder belt behind arm or back

[11] Note that one booster seat misuse listed in Greenwell (2015) has been omitted from this list—"booster seat has broken/frayed harness"—because booster seats do not have harnesses.

- Lap belt across abdomen/ribcage
- Lap belt not used[12]

Best practices for booster seat use include correct positioning of the lap belt positioned low and across the child's hips and the shoulder belt across the child's chest (NHTSA, 2020). The most common errors with the shoulder belt included incorrect position (Morris et al., 2000) and improper fit (Decina & Lococo, 2003). Commonly observed incorrect position of the shoulder belt included the shoulder belt placed over the booster seat armrest (O'Neil et al., 2009) or observation of the shoulder belt behind the child's back or arm (O'Neil et al., 2009; Raymond, Searcy, & Findley, 2018). Similarly, a common misuse with the lap belt was incorrect positioning across the child's abdomen or ribcage (Raymond, Searcy, & Findley, 2018) or the lap belt was too loose (O'Neil et al., 2009).

Combination of Misuses

Several studies acknowledged more than one misuse was common (Abbe et al., 2016; Decina & Lococo, 2003; Hoffman et al., 2016). However, this review identified only one study that investigated in depth which misuses were commonly observed together. The findings of this study, an analysis of NCRUSS data, showed several misuses were associated with restraint type: several misuses were more common in car seats, appearing in 31.3 percent of forward-facing seats, 23.9 percent of rear-facing infant seats, 21.9 percent of rear-facing convertible seats, compared to 3.8 percent of booster seats (Raymond, Searcy, & Findley, 2018). Furthermore, harness slack, which appeared in both rear-facing and forward-facing car seats, was observed in combination with other misuses more often than it was observed as the sole misuse (Raymond, Searcy, & Findley, 2018).

Factors for Misuse

This section discusses factors associated with misuse, information that can be useful when developing strategies to prevent misuse. The research investigated child characteristics, driver/caregiver characteristics, CRS features, vehicle features, and situational factors.

Child Characteristics

Child characteristics, such as age and size, are the key factors used when selecting appropriate restraints. Characteristics associated with misuse included age, size, race or ethnicity, and behavior. A later section discusses driver and caregiver characteristics as factors for misuse.

Demographics – Child Race/Ethnicity

Several studies investigated the relationship between misuse and a child's race and ethnicity. Appropriate restraint selection, defined by age- and weight-appropriateness, was associated with child race. Black children were less likely to be appropriately restrained than White children in crashes where a child died (Lee et al., 2019; Privette et al., 2018). Black and Hispanic (any race) children were also more likely to be inappropriately restrained than White children injured in crashes (Lee et al., 2008) and admitted to level 1 trauma centers following MVCs (Rangel et al., 2007). These findings are consistent with observation studies where child race was driver-reported (Brixey et al., 2008; Gunn et al., 2005). Only one survey study covered child race as a factor for misuse, finding caregivers reported non-Hispanic Black, Hispanic, or non-Hispanic

[12] E.g., in older vehicles that may have had only a lap belt in a rear center seat.

other race children 4 to 7 years old as more likely to sit in front seats than non-Hispanic White children (Macy et al., 2014). Fewer studies investigated Hispanic ethnicity as an independent factor associated with misuse; of those, Hispanic children were less likely than Non-Hispanic White children to be appropriately restrained (Brixey et al., 2008; Ghetti et al., 2023; Lee et al., 2008).

Demographics – Male Versus Female Children

Among the studies that investigated it, sex of the child was not associated with increased likelihood of misuse (Rangel et al., 2007; Sylvester et al., 2021).

Demographics – Child Age

While two studies showed a child's age was not a factor for misuse (Raymond, Searcy, & Findley, 2018; Sylvester et al., 2021), most research identified in this review showed misuse was more common as child age increased, such that older children were increasingly less likely to be in age-appropriate restraints, as found in survey data (Levi et al., 2020), observation studies (Brixey et al., 2008; Decina et al., 2005; Gunn et al., 2005), and crash data/trauma registry analyses (Lee et al., 2019; Rangel et al., 2007; Sauber-Schatz et al., 2015; Winston et al., 2006). Older children were also more likely to transition prematurely to seat belts (Medoff-Cooper & Tulman, 2007; Privette et al., 2018), and more likely to be prematurely placed in front seats (Bachman et al., 2016; Chakraborty et al., 2022; Chen, Durbin, et al., 2005; Macy et al., 2014). Studies that investigated children of booster seat age reported similar trends as studies with wider age ranges, finding booster seat use decreased with age in the age range of 4 to 8 years old (Ebel et al., 2003a; Privette et al., 2018).

In inspections by CPSTs, child age was also a significant predictor of inadequate installation and incorrect use. When using the restraint for an older child, the restraints were more likely to be installed with improper use of lower anchors (Bachman et al., 2016). In observational studies, younger children were more likely to be riding in CRSs installed facing the incorrect direction (Bachman et al., 2016), and younger children were more likely to be improperly harnessed (Abbe et al., 2016).

Child Size

Literature on child size as a factor for misuse only covered inappropriate installation and inappropriate restraint use. The section of this report on common misuse based on restraint type discusses studies that showed children were not in the correct seats for their sizes. The two observational studies discovered in this review that distinguished between child size presented conflicting results. One study found children with lower weights were more likely to be in inappropriately installed seats than children with higher weights, and this scenario mostly applied to infant carrier seats without detachable bases (Abbe et al., 2016). The other study found heavier child weight was associated with misuse; specifically, heavier children were more likely to be in seats that had errors in lower anchor usage (Bachman et al., 2016).

A 2020 NHTSA user testing study investigated the effect on child size as a factor for installation misuse. The study used dolls of different sizes (infant, 16-month-old, 3-year-old, 6-year-old) and asked participants to install several different CRSs. Participants were least likely to make installation errors when installing seats for the largest doll and most likely to make one or more installation errors when installing the seats for the two smallest dolls (Benedick et al., 2020). Child size was one of the strongest predictors of improper restraint use (i.e., a securement error)

in this study. Participants made the lowest proportion of securement errors for trials involving the largest doll compared to the other dolls. Specifically, participants made more errors with the harness (both snugness and height) when working with the smallest doll and more errors with the crotch buckle when working with the second smallest (the 16-month-old) doll.

Child Comfort/Behavior

The literature cited child discomfort as a reason for misuse of a child restraint. As reviewed in the section on common misuse based on car restraint type, some studies showed children were not in the right seat for their respective size. Most studies investigating size as a factor for inappropriate selection used caregivers' self-report of barriers to correct use. A common reason for inappropriate selection was the caregiver thought the child was too large for a car seat (Ebel et al., 2003a) and too large for a booster seat (Aita-Levy & Henderson, 2016; Ramsey et al., 2000). Qualitative studies found perceived child discomfort was a common barrier to optimal restraint use (Medoff-Cooper & Tulman, 2007; Winston et al., 2000). In one qualitative study, parents of newborns noted they were afraid of hurting their infants in CRSs (Kendi, Howard, et al., 2021).

The literature also showed child behavior was a factor for misuse. Parents self-reported child resistance was a barrier to booster seat use (NHTSA, 2010a; Rivara et al., 2001). In one study, caregivers believed children were responsible enough to sit in any seat they chose in the car, an attitude that had a negative impact on booster seat use (Anitsal et al., 2009). Similarly, the literature reported children were unbuckling themselves from the appropriate booster seat position (Martin & Block, 2020; Medoff-Cooper & Tulman, 2007; NHTSA, 2010a). Other behavioral factors included peer pressure; caregivers often reported peer pressure from older children increased younger children's embarrassment and resistance and therefore was a barrier to appropriate use (Huseth-Zosel, 2018; Medoff-Cooper & Tulman, 2007; Rivara et al., 2001).

Driver/Caregiver Characteristics

This section discusses literature that considered driver/caregiver characteristics as factors for misuse and specifies the types of misuse (inappropriate selection, inadequate installation, incorrect use). This review considered demographic categories of race and ethnicity, male or female, age, and household factors such as the number of other children in the household, relationship of the driver to the child, and child's parents' marital status. The review also considered socioeconomic factors such as education and income. Finally, the review considered literature that investigated how a driver or caregiver's awareness, experience, confidence, and perception of risk affected observed and reported misuse.

Demographics – Driver Race or Ethnicity

Race was a factor for misuse across all types of misuse. Overall misuse was more common among Black or Hispanic drivers than White or Asian drivers, as demonstrated at CPST inspections conducted at newborn hospital discharge (Hoffman et al., 2016; Rogers et al., 2012), through analysis of NCRUSS data (Raymond, Searcy, & Findley, 2018), and through survey data (Sartin, Long, et al., 2021). Serious misuse was more common among those whose primary spoken language was other than English (Hoffman et al., 2016). Fluency in English also affected knowledge of proper CRS use, as shown in a survey study, where participants most fluent in English performed better on knowledge questions than those least fluent, even though the survey was administered in each participant's native language (Vaca et al., 2002). Race was related to

knowledge of correct infant car seat location in a survey of parents of prenatal patients; knowledge of the correct car seat location was significantly lower among African American parents, particularly mothers, compared to White parents (Robinson et al., 2002). Mediation analysis in a survey of mothers having their CRS use assessed by CPSTs showed being married and self-reported seat belt use explained 47 percent and 35 percent of the effect of race on CRS use errors (Sartin, Long, et al., 2021).

In addition to overall misuse and knowledge of correct use, race or ethnicity was a factor for misuse related to inappropriate selection and use (Jones et al., 2017; Macy et al., 2015; Winston et al., 2006). According to the Awareness and Availability of Child Passenger Safety Information Resources survey (*n* = 1,565 adults) conducted by NHTSA (Levi et al., 2020), non-Hispanic Black/African American drivers were more likely to report driving with children who were not properly restrained (35.4%), compared to Hispanic/Latino (any race) drivers (21.8%), non-Hispanic White drivers (14.6%), and other non-Hispanic drivers (19.1%). While the finding that child restraint misuse is more common among Black than White drivers was also consistent with one examination of crash data analyses (Winston et al., 2006), child race was not significantly associated with proper/improper/no restraint use among children admitted to a level I trauma center following a MVC. A field observation of specific misuses concluded that White drivers were more likely to place the child passenger correctly in the rear seat compared to drivers of other races (Chakraborty et al., 2022).

Additionally, self-report from caregivers showed higher proportions of White caregivers reported always using age-appropriate restraints for children 1 to 7, relative to non-Hispanic Black, Hispanic, and non-Hispanic other race caregivers, with premature transitions specifically reported more frequently by non-Hispanic Black, Hispanic, and non-Hispanic other race caregivers (Macy et al., 2014). Other self-reported data from a focus group with mothers showed African American and Hispanic mothers reported more misuse, in particular, the inconsistent use of booster seats (Medoff-Cooper & Tulman, 2007). However, Macy et al. (2014) did not find differences in age-appropriate restraint use by caregiver race when examining improper restraint use as coded by trained observers (versus self-report). To summarize, the literature review findings generally showed inappropriate selection is more frequently observed among Black and Non-White Hispanic drivers compared to White drivers.

While most of the literature on driver/caregiver race or ethnicity considered inappropriate selection, a few studies specifically identified misuse rates with race or ethnicity for incorrect installation and incorrect restraint use. According to an analysis of NCRUSS data, there were significant differences between races for the lateral movement of CRS installations; lateral movement of CRS among White drivers was lower than all other races, i.e., installation misuse was less common for White participants (Penmetsa et al., 2018). Similarly, a study consisting of CPST observations found non-White drivers (defined in the study as Black, other, or not reported) were more likely to have the child secured in a loose seat belt (O'Neil et al., 2009). In this same study, non-White drivers had an increased likelihood of having improper shoulder belt use, including improper use of the shoulder belt guide or observation of the seat belt behind the child's back (O'Neil et al., 2009). Another study supported the finding that African American drivers or drivers of other races were less likely to properly use CRSs; however, this study defined race and correct use by subjective determination by observers (Chakraborty et al., 2022).

Demographics – Male vs. Female Drivers

The consensus within the literature is that male and female drivers do not differ with respect to misuse (Chen, Durbin, et al., 2005; Eby et al., 2005; Kallan et al., 2014; Lee et al., 2019; Macy et al., 2014; Penmetsa et al., 2018; Raymond, Searcy, & Findley, 2018; Sylvester et al., 2021). The few studies that did identify differences between males and females were inconsistent. In an observational study, correct placement of the child in the rear seat was strongly associated with female drivers (Greenberg-Seth et al., 2004), and males were less likely to correctly restrain children in the rear seat (Kallan et al., 2014; O'Neil et al., 2011). Only one study identified differences in installation misuse between males and females, finding male participants in user testing were more likely than female participants to have a snug harness and the correct recline angle (Klinich, Manary, et al., 2013).

Demographics – Driver Age

The literature showed driver/caregiver age was associated with overall misuse and incorrect installation of CRS. According to NCRUSS data, younger drivers (under 30) were more likely to have overall misuse than middle-aged drivers (Raymond, Searcy, & Findley, 2018). Similarly, an observation conducted by CPSTs found age was the only variable associated with overall misuse; younger drivers (15 to 24 years old) were more likely to exhibit one or more misuses relative to drivers 25 to 64 years old (O'Neil et al., 2009).

The large quantity of studies that investigated inappropriate selection, specifically, presented conflicting findings for what driver age is most associated with inappropriate selection. Only one study, an analysis of 2011 to 2015 FARS data, concluded appropriate restraint use was unrelated to age of the driver (Lee et al., 2019). Meanwhile, several studies, including other crash data analyses (Chen, Durbin, et al., 2005; Privette et al., 2018) and a field observation that assessed age through subjective assessment of observers (Chakraborty et al., 2022) found inappropriate selection was more common among younger drivers. Specifically, types of inappropriate selection observed to be more prevalent among younger drivers compared to older drivers included premature transition to forward-facing car seats, as seen in survey data (Macy et al., 2015), and inappropriate seating of a child in the front seat, as seen in crash data (Chen, Elliott, et al., 2005; Sauber-Schatz et al., 2015). By contrast, other studies of crash data (Winston et al., 2006) and self-reported survey data (Levi et al., 2020) found inappropriate selection increased with increasing driver caregiver age. The same crash data analysis that identified young drivers (age 20 or younger) as having an increased likelihood of inappropriately seating a child in the front row also found this misuse with older drivers (60 or older), and only middle-aged drivers were likely to have appropriate use (Sauber-Schatz et al., 2015). An observation of participating vehicles by CPSTs confirmed this finding as well, but the investigators note drivers aged 50 and older were only slightly less likely to correctly put children in the rear seat compared to younger drivers (O'Neil et al., 2011). Booster seat use (among children who should be placed in booster seats) was lower for children riding with drivers older than 60; however, driver age was determined through subjective assessment in a field observation (Eby et al., 2005).

Household Factors

Only two survey studies examined the number of children in the household as a factor for misuse. As the number of children in the household increased, a child was less likely to be properly restrained, with proper restraint defined as proper selection based on age appropriateness (Levi et al., 2020). Similarly, as the number of children 5 to 9 in the household

increased, respondents were less likely to report regular use of booster seats (Anitsal et al., 2009).

Very few studies considered caregiver's relationship to the child, in this case the specific relationships of the child's immediate family, as a factor for misuse. According to a survey of parents in an emergency room discharge, parental relationship (mother, father, or other) was not associated with self-report of placing children in the front seat (Macy et al., 2014). Several misuses were common when older siblings were responsible for buckling younger children into the CRS (Decina et al., 2005). In a study of trends in child occupant safety in Indiana from 2005 to 2010, siblings were the least likely to correctly put children younger than 12 in the rear seat compared to parents and drivers unrelated to the child (O'Neil et al., 2011). Only a few studies differentiated between fathers and mothers in misuse rates; these findings are discussed in the Male Versus Female Drivers section (above). One study, however, did find that researchers noted differences in parenting style, such as negotiability, when comparing parents of children in booster seats with those in seat belts (Simpson et al., 2002).

More commonly, the literature investigated whether parents versus grandparents driving the children affected rates of misuse. Grandparent drivers were associated with having children in the vehicle who were not restrained according to best practice recommendations; a CPST observation study (O'Neil et al., 2012) and crash data analysis (Henretig et al., 2011) supported this finding. The observation study also found grandparents were more likely to have loose installations (O'Neil et al., 2012). Additionally, the observation study conducted a follow-up focus group that found the responses to questions regarding driver knowledge of how old a child should be when they can sit in the front seat explained higher misuse among grandparents; parents were significantly more likely than grandparents to give the correct answer (O'Neil et al., 2012). In a field observation of passing vehicles that showed elderly drivers were less likely to properly restrain child occupants, researchers speculated this trend could be because elderly drivers traveling with child passengers are likely to be the grandparents, and they might have inadequate information on proper use (Chakraborty et al., 2022). Furthermore, many of the grandparents in a focus group about barriers to correct CRS use expressed the belief that physical issues such as arthritis, back pain, difficulty in mobility, decreased strength, and vision problems made correct CRS use difficult (O'Neil et al., 2012).

Only one study associated marital status with misuse. Among parents of children admitted to emergency departments for reasons other than critical illness or MVC, single parents were more likely than married parents to have lack of knowledge of correct CRS use (Funk et al., 2003). The survey on parental knowledge defined incorrect knowledge as not knowing that the rear seat, rear-facing position is the safest car location for infant car seats.

Socioeconomic Factors

Families of potentially lower socioeconomic status backgrounds were more likely to misuse CRS (Decina et al., 2005; Ghetti et al., 2023; Hoffman et al., 2016). In an observation study of booster seat use, appropriate use was more frequent among those living in areas with higher median incomes (Brixey et al., 2008). The literature noted caregivers had progressively lower knowledge on CRS knowledge scales if they had lower income or had fewer years of education. Only one study, a field observation of misuse, did not find county-specific socioeconomic factors, including income and education level, were associated with misuse (Chakraborty et al., 2022). The reason for this lack of findings is unknown but one possibility is that examining predictors

of misuse at the county level obscured any effects. A combination of income and education did, however, affect the knowledge of proper CRS use, as shown in survey data, where participants with lower income and fewer years of education had progressively lower knowledge of correct CRS use (Funk et al., 2003; Vaca et al., 2002).

Some studies parsed out the socioeconomic status of drivers/caregivers by level of education and investigated the impact of education on inappropriate selection. Less education (i.e., non-college or high school or less) (Levi et al., 2020; Rogers et al., 2012; Winston et al., 2006) or an associate degree or less (Hoffman et al., 2016) was associated with inappropriate selection. Specifically, lower education level was associated with premature transition to a forward-facing car seat (Macy et al., 2015). Similarly, college-educated drivers/caregivers were more likely to self-report correctly using rear-facing car seats (Jones et al., 2017) and less likely to be observed incorrectly placing children in the front seat (Macy et al., 2014; O'Neil et al., 2011).

Other studies investigated the impact of income on inappropriate selection. One study, an analysis of crash characteristics based on medical records, found lower household income did not affect proper use among children admitted to a level 1 trauma center after MVC (Sylvester et al., 2021). However, some studies did find lower household income was associated with incorrect restraint use based on age-appropriateness (Levi et al., 2020; Winston et al., 2006). Specifically, lower household income was associated with premature transition to a forward-facing car seat and incorrect placement of a child in the front seat (Macy et al., 2015). Additionally, a higher annual household income (greater than $100,000) was associated with correct use of rear-facing CRS (Jones et al., 2017).

Only a few studies investigated socioeconomic factors such as education and income, and the impact of these factors on incorrect installation and incorrect restraint use. A user testing study found participants who had graduated from college made fewer errors when achieving tight installation and correctly routing the belts relative to participants who had not attended college (Klinich, Manary, et al., 2013). Similarly, in an observation study conducted by a CPST, drivers who reported less education were more likely to have the shoulder belt mis-positioned across the child's chest or under the child's arm (O'Neil et al., 2009). Furthermore, there was an increased risk of having improper use of the shoulder belt guide for drivers who had a reported family income of less than $35,000 (O'Neil et al., 2009).

Overall misuse was more common in rural areas compared to urban locations (Hafner et al., 2017). A field observation specifically observed drivers in rural areas were likely to be inappropriately carrying children in the front seat (Huseth-Zosel, 2012). Parents in rural areas were also more likely to prematurely transition from a rear-facing car seat to a forward-facing car seat, according to survey data (Huseth, 2013; Macy et al., 2015).

Driving Behavior

As shown in Chapter 2: Non-Use, driver restraint use was related to non-use of CRS; similarly, studies investigated whether a driver's restraint use was related to misuse. According to two analyses of children killed in motor vehicle crashes that investigated age-appropriate CRS use at the time of the collision, drivers who were unrestrained were less likely to appropriately restrain child passengers, with one of the studies finding a 60 percent lower likelihood of age-appropriate CRS use with unrestrained drivers (Lee et al., 2019; Privette et al., 2018). An observational study aimed at investigating predictors of appropriate child safety restraint use for White and Black child passengers also found driver restraint use was significantly associated with appropriate

CRS use among both White drivers and Black drivers (Gunn et al., 2005). The finding that appropriate driver restraint use is associated with appropriate CRS use was consistent with findings from observational studies; a properly belted driver increased the likelihood of observing a properly restrained and properly positioned child, with proper restraint defined as appropriate selection and proper position defined as not inappropriately placing children in the front seat (Chakraborty et al., 2022; Greenberg-Seth et al., 2004). According to self-reported data, children sitting in the front seat were less common among caregivers who reported always using a seat belt compared with those who did not (Macy et al., 2014). The literature also reported inappropriate use with improperly restrained drivers and booster seat users; booster use was more common when the driver was observed wearing a seat belt (Ebel et al., 2003a; Eby et al., 2005). On the other hand, analyses of NCRUSS data found overall rates of misuse were unrelated to the driver's restraint use (Raymond, Searcy, & Findley, 2018), perhaps because the rates of driver restraint were unusually high (about 98%).

While the research on driving behavior and its impact on child restraint misuse more frequently investigated driver restraint use, a few studies did consider whether other driver behaviors, such as alcohol-impaired or distracted driving, affected the likelihood of misuse. These studies used crash data to analyze whether children had an increased likelihood of police reporting they were improperly restrained when the driver exhibited unsafe driving behavior. Drivers with police-reported alcohol use were associated with a lower likelihood of appropriately restraining child passengers (Lee et al., 2019; Privette et al., 2018). In crashes where police suspected driver drug or alcohol use was a contributing factor for the crash, drivers were more likely to have children riding in the front seat compared to crashes where these factors were not suspected (Sauber-Schatz et al., 2015). Drivers who were distracted or in a speed-related crash had a lower likelihood of traveling with correctly restrained children and a higher likelihood of traveling with children riding in the front seat compared to drivers involved in crashes not exhibiting these behaviors (Sauber-Schatz et al., 2015).

Psychological Factors

Psychological factors of the caregiver included awareness, knowledge, experience, confidence, and risk perception with respect to CRS. Knowledge plays a key role in optimal CPS; caregivers must have the knowledge base for accurate selection of CRS for every point in their child's development (Winston et al., 2000). Parents may be aware of best practices surrounding CPS, but several studies showed caregivers still lacked the knowledge for appropriate restraint selection, particularly as it applies to premature transition (Decina et al., 2005; Funk et al., 2003; Mattingly & Bennett-Shipman, 2001; Rivara et al., 2001; Vaca et al., 2002; Webb, 2019). However, knowledge alone did not guarantee correct use (Funk et al., 2003; Simpson et al., 2002). Therefore, it is important to consider how these psychological factors work together and work with other factors.

Correct CRS use is related to awareness of laws governing correct selection, resources for understanding correct installation, and best practices for use of CPS. The literature noted differences in awareness as barriers to booster seat use; caregivers who appropriately used booster seats for their children demonstrated greater overall awareness of CPS issues (e.g., best practices, laws, installation, etc.), particularly when compared to caregivers of children in seat belts (Simpson et al., 2002; Yuma & Maldonado, 2006). Additionally, lack of awareness of available resources was a factor for misuse: according to a survey of adults who drove children

up to 9 years old, respondents who used proper restraints were more likely to be aware of inspection stations compared to those who did not use proper restraints (Levi et al., 2020).

A few studies investigated lack of knowledge of the increased safety benefits of CRS as a factor for misuse. Some caregivers self-reported their lack of knowledge was the reason they did not choose to use booster seats (Ebel et al., 2003a) or did not use LATCH systems during installation (Decina et al., 2006). Incorrect seating position was associated with overall low health literacy (Heerman et al., 2014). Parents who acquired knowledge through CPS resources had lower rates of misuse. Specifically, correct use of rear-facing car seats was associated with knowledge of the AAP's recommendations (Jones et al., 2017), correct booster seat use was associated with the use of a Car Seat Checks program (Cease et al., 2011), and correct installation was associated with having worked previously with CPSTs (Hoffman et al., 2016).

Experience is also an important part of CPS; caregivers must have reasonable mastery of all the skills involved in installing a seat properly (Winston et al., 2000). The literature included user testing analyses that investigated whether participant-reported experience was related to correct installation (e.g., tight installation) and correct use (e.g., harness use). According to these studies, first-time installers and those with little experience had high error rates when attaching CRSs with seat belts or LATCH (Benedick et al., 2020; Tsai & Perel, 2009). When novice participants used seat belts to attach the systems, they were more likely to make errors such as incorrectly using the retractors or forgetting to switch them into locking mode when appropriate relative to experts (Benedick et al., 2020). When novice participants used the LATCH system to install the CRSs, they were more likely to incorrectly use both the seat belts and the lower anchor system (Benedick et al., 2020).[13] Lack of prior experience also contributed to loose installation of the systems (Benedick et al., 2020; Klinich, Manary, et al., 2013). Finally, participants with less prior experience installing CRS were more likely to have errors with fastening and positioning the chest clips (Benedick et al., 2020) and have difficulty obtaining snug harnesses (Klinich, Manary, et al., 2013).

Some studies showed there was no observed difference between prior experience with CRS and CRS misuse (Hoffman et al., 2016), in particular, inappropriate CRS selection (Benedick et al., 2020) and CRS placement (Rogers et al., 2012), although parents self-reported more experience with installation was a facilitator for optimal use (Kendi, Howard, et al., 2021). Conversely, in a different study, caregivers who self-reported prior car seat experience were less likely to be correctly using rear-facing car seats (Jones et al., 2017). Researchers suggested experienced caregivers may be less aware of new recommendations for car seat use or less inclined to change the ways in which they already use car seats.

Parents showed poor self-confidence in their ability to correctly use CRS was a barrier to optimal use (Kendi, Howard, et al., 2021). However, one user testing study found participant confidence in their installations was not associated with the amount of accuracy or security of the installations (Mirman et al., 2014). Other studies found drivers with lower confidence were more likely to misuse, as demonstrated in NCRUSS data (Raymond, Searcy, & Findley, 2018) and installation testing (Benedick et al., 2020). Notably in both studies, drivers with higher confidence still had objectively high misuse rates, perhaps because highly confident drivers were less likely to seek out information about correct usage (Raymond, Searcy, & Findley, 2018). In

[13] In general, use of the seat belt and lower anchors together to install a CRS is prohibited by vehicle and CRS manufacturers; however, a few permit it.

fact, high confidence was often prevalent while studies observed high overall misuse (Greenwell, 2015), high installation error rates (Mirman et al., 2014; Tsai & Perel, 2009), and age inappropriateness (Levi et al., 2020). Looking at restraint use (e.g., harness use), there was no difference between the confidence of the users and securement errors (Benedick et al., 2020).

The literature on perception of risk as a factor for misuse was heavily focused on booster seat non-use among child passengers for which booster seat use is recommended. The reasons caregivers gave for appropriate and correct use of any restraint were the consequences of a wrong decision and to protect the child from injury (Aita-Levy & Henderson, 2016; Kendi, Howard, et al., 2021; Medoff-Cooper & Tulman, 2007). Parents who regularly used booster seats for their children viewed booster seats as effective and had a higher risk perception of what would happen to their children if they were not restrained compared to caregivers who (incorrectly) used seat belts instead (Bracchitta, 2006; Winston et al., 2000). The literature suggested booster seat non-use may be because caregivers are unaware of the risk for injury (Yuma & Maldonado, 2006). Barriers to booster seat use included the perceptions of safer alternatives, such as the belief that lap belts were adequate (Rivara et al., 2001; Simpson et al., 2002; Winston et al., 2000). Lack of risk aversion with CRS use, such as identifying a higher number of situations where riding without a CRS was acceptable, was associated with greater likelihood of driving with children improperly restrained (Levi et al., 2020). Similarly, risk aversion in other facets of driving, such as always buckling up or paying attention to vehicle safety features, had a positive impact on booster seat use (Anitsal et al., 2009).

CRS & Vehicle Features

The literature on CRS misuse considered features of the system, the attachment system, and the vehicle as factors for misuse. Several studies considered physical features of the CRS or vehicle as factors for incorrect installation; a few CRS and vehicle factors were also associated with inappropriate selection. The CRS features included were related to ease of use of the system. The attachment characteristics included the location and visibility of the attachment systems in the vehicle. The vehicle characteristics included the type and age of the vehicles.

CRS Features

According to qualitative studies investigating booster seat use, participants frequently cited cost as a reason for not selecting a booster seat for a child for which booster seat use was appropriate (Anitsal et al., 2009; NHTSA, 2010a; Rivara et al., 2001; Winston et al., 2000). Cost may particularly be a barrier for caregivers from some communities such as low-income families; please see Chapter 6: Communities with Lower CRS Use for a discussion of CPS in specific communities.

The research identified lack of ease of use of CRS as a barrier for appropriate use and correct installation, either through self-reporting of the users or through researcher assumption based on user testing. Parents and caregivers perceived some features of CRSs served as barriers to optimal restraint use, like the increased number of straps in forward-facing car seats (Kendi, Howard, et al., 2021) and buckling children into CRSs is difficult and takes too much time (Kendi, Winkels, et al., 2021; Medoff-Cooper & Tulman, 2007). In user testing, car seats deemed more challenging by participants had higher rates of installation misuse (Benedick et al., 2020). Several studies showed booster seat non-use was a result of problems when attempting to use the seat, such as logistical difficulties (Anitsal et al., 2009; NHTSA, 2010a; Ramsey et al., 2000). In addition to inappropriate selection, users were likely to incorrectly install when there

was confusing hardware present, like other plausible places to attach a tether (Jermakian et al., 2014; Klinich et al., 2014). Finally, one study considered whether the material of a car seat affected misuse: while installation errors using LATCH were more frequent in vehicles with leather versus cloth seats, installation errors using seat belts were similar across material types (Tsai & Perel, 2009).

Vehicle Features

The shape of the vehicle seat affected the location and visibility of the attachments for the child restraint systems; user testing of participants installing CRS demonstrated these aspects affected the rate of correct installation. For seat belt installation, the location of the buckle closer to the seat bight, the area where the seat bottom and seat back meet, resulted in tighter installations compared to an installation where the buckle location was forward of the bight (Klinich et al., 2012). A higher location of the anchor (i.e., a lower anchor depth) was associated with a higher rate of tight installation in both LATCH and seat belt installations (Klinich et al., 2012; Klinich, Flannagan, et al., 2013). The visibility of the anchor did not affect the rate of achieving a tight installation, but the visibility was associated with higher rates of correct attachment of the LATCH belt compared to lower anchors that were not as visible because they were buried (Decina et al., 2005; Klinich et al., 2012). Similarly, the clearance angle around the lower anchors was associated with a high rate of correct lower anchor use (Klinich, Flannagan, et al., 2013). The findings suggest the location of the attachment feature in the vehicle can affect the likelihood of a tight installation.

In the literature on vehicle types associated with misuse, pickup trucks were more likely to have misuse present. In evaluations of correct CRS installation through user testing, participants made more installation errors in pickup trucks (Benedick et al., 2020; Klinich et al., 2014). For example, participants in the pickup truck trials had higher likelihood of not installing the CRS tightly and having tether-related errors (Benedick et al., 2020). The finding that pickup trucks were more likely to have inappropriately restrained children was consistent in field observations (Chakraborty et al., 2022; Eby et al., 2005; Huseth-Zosel, 2012) and crash and injury data analyses (Lee et al., 2019; Lee et al., 2008; Privette et al., 2018). Because of the visual assessment during field observations, easily observed characteristics defined inappropriate restraint, such as the child being in the front seat of a pickup truck (Chakraborty et al., 2022; Huseth-Zosel, 2012) or non-use of a booster seat (Eby et al., 2005). However, these visual assessments also meant the child's age and weight were based on an observer's judgement. It is important to note these findings may be confounded by the fact that some pickup trucks do not have rear seats (Huseth-Zosel, 2012).

In addition to vehicle type, the literature presented findings about whether higher rates of misuse were associated with newer or older vehicles. According to a qualitative study of caregivers about barriers and facilitators to optimal child restraint, participants identified older vehicles as more challenging and a barrier to optimal use (Kendi, Howard, et al., 2021). An observation study supports this finding; older vehicles were associated with higher incidence of misuse such as loose installation, which the researchers attributed to difficulties with properly locking the older vehicle's safety belt latch plates (Decina et al., 2005). Analyses of FARS data covering 2011 to 2015 also supported the finding that misuse is more common in older vehicles, with vehicles involved in fatal crashes manufactured after 2009 more likely to contain appropriately restrained child passengers compared to older vehicles; these studies defined appropriate restraint as being in the correct restraint system based on child age or located in the front seat

(Lee et al., 2019; Privette et al., 2018). A similar study, Crash Outcome Data Evaluation System (CODES) using data from 2005 to 2008 considered newer vehicles as those manufactured after 2002 but came to the same conclusion: a higher percentage of children were optimally restrained when they were riding in newer (76%) compared to older vehicles (71%) (Sauber-Schatz et al., 2015). Based on CPST observations at an inspection event, child restraints in older vehicles were also more likely to be installed in front of air bags compared to older vehicles; however, this observation study also found child restraints in newer vehicles were more likely to have the seat belts routed incorrectly compared to older vehicles (Bachman et al., 2016).

Situational Factors

This section discusses the studies that investigated situational factors that affect CRS misuse. Situational factors include the purpose of the trip, the vehicle in which the trip took place, the number of other passengers in the vehicle, and whether the drivers are in a hurry. Additionally, situational factors include those that describe the circumstances in which the trip took place such as the time of day, the day of the week, weather, and posted speed limits.

Trip Purpose

More children were inappropriately restrained on recreational trips compared to non-recreational trips (Chen, Durbin, et al., 2005). Caregivers were also less likely to report booster seat use when "driving just around the corner" or going on a "short trip" (McDonald et al., 2018; Winston et al., 2000). A few studies found self-report of being in a hurry or car seats being inconvenient were factors for misuse. According to caregiver self-report, being busy or in a hurry was a barrier to optimal CRS use (Kendi, Howard, et al., 2021; NHTSA, 2010a; Winston et al., 2000). Often, being busy or in a hurry heightened feelings about the inconvenience of the systems, and inconvenience was also cited as a barrier to optimal use (NHTSA, 2010a; Winston et al., 2000).

Different Vehicle

Moving a car seat between vehicles was a frequently cited reason for why a car seat was not securely attached (Martin & Block, 2020). Caregivers showed driving a different vehicle was a barrier to correct use (Kendi, Howard, et al., 2021; Winston et al., 2000). Caregivers noted this was because it is cumbersome to transfer car seats between vehicles when someone else was driving the child, such as a babysitter or grandparent (Medoff-Cooper & Tulman, 2007). In an observation study conducted at daycare centers, booster seat non-use was attributed to the driver's self-report that the restraint was missing from the car because it was in another vehicle (Ebel et al., 2003a). Caregivers self-reported the CRS missing from the car was among reasons for booster seat non-use (McDonald et al., 2018; Medoff-Cooper & Tulman, 2007). Situations where booster seat use is low because the systems may be missing from the car included rental cars, taxis, or a relative's car (McDonald et al., 2018; Medoff-Cooper & Tulman, 2007). Additionally, according to caregiver self-report, carpooling was a common driving situation during which booster seat use was inconsistent (Macy, 2011; Macy et al., 2012).

Number of Passengers

Some studies investigated whether the number of other passengers in the vehicle, both children and adult passengers, affected misuse rates. Analyses of NCRUSS data found overall rates of misuse were unrelated to the number of occupants in the vehicle and the number of child passengers under 9 (Raymond, Searcy, & Findley, 2018). However, the review identified several sources that showed appropriate restraint use was associated with the number of vehicle

occupants, both adult and child. Correct restraint use was associated with fewer children in the vehicle (Decina et al., 2005; Greenberg-Seth et al., 2004). Not using a booster seat for a child for whom a booster seat is recommended was associated with an increase in the number of vehicle occupants in both self-reported data (Levi et al., 2020; Winston et al., 2000) and crash data/observation studies (Chakraborty et al., 2022; Chen, Durbin, et al., 2005; Ramsey et al., 2000). Several studies showed caregivers self-report the reason for incorrect use is the inadequate space in the vehicle due to accommodating extra passengers (Huseth-Zosel, 2018; Kendi, Howard et al., 2021; McDonald et al., 2018; Medoff-Cooper & Tulman, 2007; NHTSA 2010a; Rivara et al., 2001; Winston et al., 2000). While additional adult occupants are associated with misuse, a crash data analysis study found presence of other adult passengers meant correct placement of children in the rear seat because the additional adult passenger was almost always occupying the front seat (Kallan et al., 2014).

Time of Day/Day of the Week

Some studies investigated whether situational factors related to when the drive took place, such as the day of the week or the time of day, affected misuse rates. An observational study showed proper placement and proper restraint use was more likely over the weekends, as well as in the afternoon relative to the morning (Chakraborty et al., 2022). Studies examining insurance claims and police-reported crashes found optimal restraint use, defined as age-appropriateness, was greater during the daytime than the nighttime (Chen, Durbin, et al., 2005; Sauber-Schatz et al., 2015). By contrast, studies examining children killed in crashes found no association between misuse and either day of the week or time of day (Lee et al., 2019; Privette et al., 2018).

Weather

Only a few studies found misuse was associated with the weather at the time of the misuse. According to a field observation study, the likelihood of proper seating position and proper child restraint use increased during light fog or rain compared to clear weather conditions (Chakraborty et al., 2022), and parents self-reported they would explicitly use a booster seat in bad weather (Winston et al., 2000).

Posted Speed Limit

Some studies found factors related to where the drive took place, such as the posted speed limits at the location where the misuse occurred, affected the likelihood of reported misuse. According to FARS data analyses, children killed in MVCs were less likely to be in age-appropriate restraint selections on roads with lower speed limits (<55 mph) compared to children traveling on roads with higher speed limits (Lee et al., 2019; Privette et al., 2018). However, an analysis of crashes in insurance claims found the posted speed limit was not associated with misuse, at least as it pertains to child's front row seating (Chen, Durbin, et al., 2005).

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Part II: Research on Reducing Child Fatalities and Injuries in Motor Vehicle Crashes

As discussed above, there is extensive research on the way CRSs are used (and not used) in the United States. Education and legislative responses are meant to address ongoing and pervasive non-use and misuse. Education combats non-use and misuse by providing caregivers with knowledge about best practices, access to CRSs, or hands-on training. Laws mandate child restraint and use of appropriate CRSs. Strategies that combine CRS laws, education, and enforcement aim to reduce non-use and misuse of CRSs. This section is an overview of research on whether and how education and legislation are effective as injury prevention techniques for CPS.

Chapter 4: Education and Outreach

Introduction

This chapter synthesizes research findings on interventions fostering positive behavior changes toward the recommended CPS best practices that seek to change behavior by communicating information to caregivers.

The report organizes finding by three components of education and outreach.

> <u>Content of Intervention:</u> Information educators and educational campaigns seek to convey to caregivers
>
> <u>Context for Communication:</u> The environment in which target audiences receive CPS educational information
>
> <u>Conveyance of Information:</u> The content of the education and context in which it is communicated; conveyance encompasses the critical aspects that make up an effective campaign

This chapter briefly summarizes findings, followed by an overview of research on educational *content* for both a CPS-specific audience and direct messaging to children. *Context* is discussed next, reviewing studies tied to specific contexts (e.g., a visit with a primary care physician or recruitment after an emergency department (ED) visit). The remaining sections discuss *conveyance*, how information is conveyed and presented to the target audience. CPS education often includes a multi-modal approach, but some studies have evaluated the role a particular technology (e.g., mobile apps) may have on conveyance. Also discussed is the role of CPSTs and their education of caregivers. A brief discussion of campaigns targeting high-risk populations is included, though a more thorough discussion is found in Chapter 6: Communities With Lower CRS Use.

Summary of Findings

- Messaging that includes information about injury risks and how to reduce those risks is effective in achieving behavior change.
- Tailored content is helpful when customized to the restraint needs of the child (e.g., age and size) and can also accommodate the caregiver's existing knowledge.

- Medical practitioners and settings are important sources of CPS information for caregivers. However, it is not always offered or may not be as thorough or accurate as needed.
- Community-based interventions, general injury-prevention efforts, and CPST interactions are all important sources of information and mechanisms for behavior change.
- Digital modes of communication and other multi-faceted approaches conveyed information to broader audiences.
- Messaging likely needs to be customized to target high-risk populations.

Content

The content of a CPS campaign may be as specific as seeking to inhibit the sale of defective or used car seats or as broad as correcting prominent misuse misconceptions (Mittelstaedt & Simon, 2004). Most interventions were intended to improve child restraint use. While these were often grounded in health behavior frameworks, a full explication of these models is outside the scope of the review. This section delves into the specific content of a CPS campaign such as risk presentation, customizing content for specific contexts and target audiences, and crafting direct messages for children.

Presentation of Risk

The concept of *risk* is frequently included in CPS education campaigns, with several studies evaluating its efficacy (Decina et al., 2016; England Will & Geller, 2004; England Will et al., 2009, 2015). Researchers observed more positive change in behavioral intention in participants who viewed risk reduction material (i.e., material discussing potentially poor outcomes and how they can be avoided) than those who viewed factual information like car seat recommendations by age (Decina et al., 2016); observed effects were suggested to be a result of the inclusion of a rationale behind the education (e.g., this education is important because there could be fatal consequences). Those authors therefore emphasized the importance of framing CPS recommendations through the lens of associated injury risks.

Video messaging encouraging caregivers to use booster seats and place children in rear seats that included high-threat consequences (i.e., messaging about the risk of injury and fatality) has resulted in increased use of booster seats, as well as overall restraint use for children (England Will et al., 2009). The authors speculated the reason for this effect was action motivated by showing the risk to all children involved in a crash, not only those in booster seats. Some researchers have suggested messaging about CPS may most effectively communicate risks when it generates “outrage” among caregivers (England Will & Geller, 2004).

Tailored Content

The literature suggested content was especially beneficial when tailored to individual needs. That is, providing specific, pertinent information is more effective than providing the full body of CRS information. What is meant by “tailored” content varies among authors and falls broadly into two types. In one, content is based upon the child’s characteristics. The second accommodates the caregiver’s existing knowledge.

Child's Characteristics

Tailoring content to a child's CRS needs ensures the caregiver receives the information relevant for that child at the time of the intervention. Tailoring the information to the child's characteristics (e.g., age and size) is the most common tailoring strategy seen in the literature. Caregivers who received tailored information had lower self-reported injury risk scores after the intervention than those who received generic recommendations, especially among the caregivers who discussed the information with medical staff during the visit (Nansel et al., 2002). However, implementing this strategy has been complicated by differences among national recommendations, manufacturer and vehicle instructions, and State laws (Weaver et al., 2013).

The volume and complexity of CRS information can be overwhelming. Self-reported exposure to a greater number of CRS resources has been associated with less confidence in CRS installation by Mirman et al. (2014), who suggested this may result from campaigns emphasizing installation difficulty as opposed to correct installation, or that those lacking confidence may seek out CRS information (Mirman et al., 2014). We speculate tailored content may prevent caregivers feeling overwhelmed by sorting through the breadth and depth of available information.

Even when caregivers successfully navigate correct restraint at one point, they must repeatedly revisit the topic as the child grows. As Weaver et al. (2013) point out, appropriate CPS behavior depends on the child's age, weight, and height—characteristics that change over time. Generic messaging may be insufficient to cover the complexities and nuances of appropriate CPS behavior (Weaver et al., 2013). Other research has demonstrated caregivers who received tailored information about CRS reviewed it at slightly higher rates (83%) than those who received generic information (74%), though less than half (43%) read all the information (Macy, Kandasamy, et al., 2019). This finding led the authors to conclude it is indeed important to demographically tailor (i.e., include child's name, age, and size) education material.

Some CPS education content has been tailored to specifically addresses booster seat use. Prematurely restraining a child in a seat belt (without a booster seat) is considered misuse when recommendations would place the child in a booster seat. As seen in *Chapter 3: Misuse*, caregivers often prematurely transition children out of booster seats to seat belts. However, caregivers have attributed lack of use of booster seats to a lack of awareness that booster seats were important for children older than 4(Simpson et al., 2002). Therefore, booster seat education may aim to addresses knowledge gaps and misuse risk.

A systematic review of five studies to increase booster seat use in 4– to 8-year-olds revealed interventions were generally successful in increasing use (Ehiri et al., 2006). Programs that included both seat distribution and education elements had the largest effect compared to no intervention in this review. *Boost 'em in the Back Seat* is an example of an educational video that targeted caregivers and used messages of high-threat consequence to generate a 16 percent increase in booster-seat and rear-seat use among 4- to 8-year-olds (England Will et al., 2009).

A sample CPS community-based campaign sought to increase caregiver awareness of the need for booster seats, reduce the motivational and financial barriers to purchasing seats, and reinforce booster seat use through public health messages (Ebel et al., 2003b). The intervention resulted in a statistically significant increase in booster seat use (13% to 26%) when compared to the control site. Yet even after the intervention, older children were still significantly less likely to be in booster seats than their younger counterparts. Another program used a community-based mobile education intervention to provide children with information on the correct use of restraints (both

booster seats and seat belts), the safest place to ride in the vehicle, the importance of always being restrained and what could happen if unrestrained, and finally, who should be in a booster seat (Emery et al., 2010). Parents in the latter half of the study (2002 onward) received brochures on motor vehicle safety that included information on booster seat use. Results found a significant increase in self-reported (by children) booster seat use, but the effect was even greater when caregivers also received education. However, the study's results are potentially confounded by the fact that the program's added element of education for caregivers coincided with an increase in State laws requiring booster seat use.

One intervention examined whether addressing the cost barrier affects the success of educational interventions related to booster seats. Simply providing education in a pediatric ED did not convince caregivers to buy and use booster seats, but when education was combined with free booster seats, caregivers were significantly more likely to use them than caregivers who received education alone (Gittelman et al., 2006).

Caregiver's Existing Knowledge

The second type of tailoring is messaging accommodating caregiver existing knowledge. Those who scored high on a pretest of CPS knowledge performed better (were more likely to choose the correct restraint) if they received brief refreshers of the basic concepts they already know plus targeted updates, rather than detailed installation information (Decina et al., 2016). Those who scored low on the pretest performed better after covering basic information and installation in more detail, compared to receiving the brief refresher/updates. Researchers caution, however, that caregivers who self-select to participate in CPS educational campaigns already have high CPS compliance (80%) (Dukehart et al., 2007), so the observed effects may not generalize to all caregivers.

As noted, most recipients of CPS information did not read all the presented material (Macy, Kandasamy, et al., 2019). Caregivers also do not retain all information indefinitely. For example, bilingual participants' knowledge of appropriate booster transition was higher in those who had taken an education course recently compared to those who had completely a course more than 6 months previously (Weiss-Laxer et al. 2009). Given these limitations, tailored content may be effective because it conveys to caregivers the subset of information relevant to them rather than all of the information available.

Direct Messaging to Children

Some CPS education content is aimed at directly providing children with information that allows them to be agents of their own safety. The goal is often twofold: One, that children improve their compliance with restraint, and two, that children become ambassadors in the family for improved restraint practices (Klassen et al., 2000). Messaging to children has mostly been tested in the context of community-based interventions where the target group was a unit such as a school or neighborhood rather than an entire State. The community context is covered later in this chapter, under *Context*.

An example of a community-based intervention that communicated injury prevention directly to children 3 to 11 years old used a converted ambulance decorated in a jungle theme (the *Junglemobile*) (Emery et al., 2010). The *Junglemobile* traveled 30,000 miles to 110 events in rural Colorado, Wyoming, and Nebraska. Community members (rather than CPSTs) trained on injury prevention topics and conducted the intervention. They observed significant improvement

in knowledge of correct CRS placement in children younger than 7 and significant improvement on the safest place to ride and self-reported restraint use in children over 7. Findings also included a correlation between 7- to 11-year-old children's reports on their intent to use CRSs and self-reported use at a 30-day follow-up. Other work affirmed caregivers felt messaging that comes from an authority figure (e.g., law enforcement officers), a sympathetic figure (e.g., Barney), or a celebrity figure would likely be effective in targeted communication to slightly older children, such as those 5 to 7 years old (Decina et al., 2009).

Context

Context describes the messenger or the setting in which content is provided. The messenger and the setting are difficult to disentangle. For example, medical staff and a medical setting are inextricable. The three most common contexts where caregivers obtained CRS use information were at the hospitals where the children were born, in the instructions in a previously purchased car seat, and from the pediatricians (Cease et al., 2011). This report consolidates these contexts into *medical care* and *community events*.

Medical Care

The medical setting has been an important context for CPS education. Indeed, many caregivers have reported learning about CPS from a doctor, nurse, or hospital personnel (Penmetsa et al., 2018). Child safety experts and physicians have been key stakeholders to join with caregivers to ensure child safety (Weaver et al., 2013). Most CPS education offered in medical care takes place in two main settings: routine primary care and hospital visits.

In an urban, lower-income primary care office, a CPS education program was associated with a significant increase in CRS use rates and a significant decrease in major misuses at follow-up observations occurring 14 to 443 days after an initial well-visit (Quinlan et al., 2007). The cost of the intervention was relatively low -- about $60 per child. However, the United States Preventive Services Task Force concluded that, on balance, there was insufficient evidence to determine whether counseling in the primary care setting increases proper CRS usage (USPSTF, 2007). However, the USPSTF authors stated their review of existing research showed interventions in the primary care setting that included an educational component plus a demonstration of use or a distribution component were more effective than those with education alone.

One reason why physician interventions may have variable results is the content of the conversations had with caregivers. One study sought to analyze what physician residents said in conversations with caregivers after receiving a printed prompt to mention car seat safety (Barrios et al., 2001). Typically, physicians brought up CPS during a well-child visit after receiving the prompt to do so, though sometimes they relied on leading questions or statements (e.g., "*You use a car seat with him, right?*" or "*I know you use a car seat.*"). The content of the mentions consistently (93%) involved more basic topics such as CRS ownership or use and less frequently addressed more nuanced topics like frequency of use (11%).

For physicians to effectively educate on CPS, they must themselves have knowledge of current CPS best practices and a general awareness of how to pass this information on to caregivers. Research suggested pediatric healthcare providers had limited knowledge of recommendations from the AAP or NHTSA (e.g., when children should transition from a booster seat to a seat belt, Ekundayo et al., 2013). Other research showed 78 percent of pediatric interns cited lack of confidence as the reason for not discussing CPS with caregivers (Morrissey et al., 2016). A short

training session on appropriate CPS resulted in significant improvement in healthcare professionals' ability to correctly answer questions related to AAP or NHTSA's CPS recommendations (Ekundayo et al., 2013) and a complete restoration of interns' confidence, even when evaluated at a 6-month follow-up (Morrissey et al., 2016). Effective material for physician education has included prompts designed for physicians to use as open-ended questions in discussions with caregivers of children; physician education material may also provide guidance on the important aspects of behavioral intervention counseling, including caregiver concerns, acknowledgement, and importance of use (Barrios et al., 2001).

Hospitals

Researchers have evaluated hospitals as a context for CPS education. One rationale for education in the hospital setting is caregivers bringing children to the hospital may have recently experienced a potential injury-inducing event (e.g., a car crash) or may lack access to a primary care physician. Caregivers visiting EDs who received counseling sessions plus tailored brochures were more likely to self-report using the size-appropriate CRS during 6-month follow-ups than ED-visiting caregivers who received either generic information sheets or those who were mailed tailored brochures (Macy, Kandasamy, et al., 2019). However, there was no control group in non-ED settings, so the study's results leave open the question of whether the ED location is a critical feature. As of 2014, the American College of Surgeons required Level 1 Trauma Centers in the United States to have injury prevention staff to provide education on the community's most common cause of injury (Committee on Trauma, 2014). Given the frequency that lack of CRS use is a leading cause of injury for children, many trauma centers are likely to have injury prevention staff familiar with CPS education.

However, it remains unclear if caregivers are specifically "teachable" in the ED context or whether it is simply an instance of knowledgeable hospital staff providing education (Gittelman et al., 2006). Caregivers who attended a multi-faceted CPS class advertised at a hospital ended with significant knowledge gains about CRS use (Muller et al., 2014). A similar effect was also observed with a simple paper-based intervention for caregivers consisting of a CPS knowledge questionnaire and an informational handout given at a hospital (Cooper-Sood et al., 2021).

Hospital nurses are candidates for educating caregivers on CPS. Some research found nurses concerned about adding to their workload (Elliott et al., 2013) or their lack of CPS knowledge (Smola et al., 2020), and therefore they may not be the best candidates for educating on CPS (Rogers et al., 2013). Furthermore, training nurses on CPS has not always translated to correct use for new mothers. One study of mother-newborn dyads observed after training nurses on how to educate mothers on correct CRS use, misuse among mothers instead increased (Rogers et al., 2013). However, not all nurses who interacted with study participants received the CPS training, and many (44%) of the study mother-child dyads reported they received no nurse education on child restraint.

In another study, one hospital found offering training for nurses on CRS use and caregiver education, combined with making CRS compliance a required field on computerized intake forms, dramatically increased nurse compliance with CPS screening policies. At the introduction of the computerized program, only 17 percent of nurses chose to screen patients at the ER; less than a year later, nurses screened 87 percent of patients for appropriate CRS use and provided those patients with CRSs if they did not have them (Kiley et al., 2014). A small-sample study (n = 64) of nurses trained on CPS best practices found numeric increases in nurses' intent to

counsel ED patients on important best practices like booster seats, but these increases were not statistically significant (Smola et al., 2020).

Training nurses may take the form of a resource guide detailing how to educate on CPS. One study developed such a guide for nurses who were tasked with CPS education during after-hours visits (CPSTs are only on-staff during certain hours). Use of the guide resulted in nurses distributing CRSs to caregivers who otherwise would not have received one due to unavailability of CPSTs (Pollok et al., 2019).

Community-Based Interventions

Community-based interventions are another way to convey important public safety information to caregivers. These programs are described as community-based because of the size of the social group, targeting caregivers in a unit such as a school or neighborhood rather than the entire State or Nation. They should not be confused with community-led programs in which the target group has agency and decision-making power over specifics of the interventions.

A community-based intervention focuses less on the messenger and more on the setting for the information: Caregivers receive content as members of their community rather than leveraging, for example, the credibility of a medical expert to achieve behavior change. As such, community-based interventions identify not just the content of the information but also points of access to caregivers. Although non-users report some awareness that CPS information is available at fire stations and police stations, a group of panelists with CPS expertise expressed that the communities most in need of intervention for CPS may be uncomfortable with law enforcement or in public service buildings (Decina et al., 2009). Further information is provided in *Chapter 6, Communities With Lower CRS Use*. Further, caregivers who were identified as non-users recommended conducting education events at locations already providing goods and services related to children, along with a host of other access points (Decina et al., 2009).

CPS messaging campaigns have increased effectiveness when combined with community-based interventions (USPSTF, 2007). For example, critical components of a community-based educational campaign to increase booster seat use included a strong theoretical basis, coalition-building, focused public health messages, focus groups to guide campaign messaging and development, and evaluation of campaign effectiveness (Ebel et al., 2003b).

Organizing CPS community outreach education efforts in "pulses"—continuing education in a given community until saturation is reached—has been recommended (Anitsal et al., 2019). Specifically, Anitsal et al. found a significant relationship in Tennessee between the number of "Ollie Otter" safety outreach events and the number of crash-involved child occupants who were properly restrained, though the lack of a control condition calls for caution in interpretation. Repetition of the content may be a critical component of behavior change.

Schools are an important community context for CPS education of caregivers and children. One advantage of such programs is quick implementation, typically requiring between 4 months and a year to plan and implement (Venkatraman et al., 2021). Though there is documentation such programs are often well received within the communities in which they take place, there is limited research available on their effectiveness (Venkatraman et al., 2021). Messaging directly to children (see *Messaging Directly to Children* earlier in this chapter) has been successfully conducted in the school context. Some caregivers have reported obtaining information from teachers or daycare providers (Macy et al., 2014). Self-reported age-appropriate restraint use was

less accurate among these caregivers at ED discharge than among caregivers who did not name teachers or daycare providers as an information source. This finding could be interpreted as an indicator teachers and daycare providers are not accurate sources or caregivers who obtain information from those sources do so at the exclusion of other sources. However, because some caregivers obtain information from teachers and daycare providers, there is the potential to enlist theses sources as partners for safety and provide them with accurate, up-to-date information and resources.

General Injury Prevention Efforts

CPS education can take place in the context of larger, more general injury prevention efforts (Glerum et al., 2019). General injury prevention campaigns occasionally resulted from private partnerships between industry and academia (Roberson et al., 2001), but most injury prevention efforts were put forth by publicly-funded campaigns or non-profit organizations.

One general injury prevention effort has been Safe Kids Worldwide (SKW); the organization began in 1988 to help families and communities keep kids safe from traffic injuries, drownings, falls, burns, poisonings and more (SKW, 2023). SKW has developed a network of coalitions, inspection stations, mobile vans and partners in the United States and abroad. A CPS-focused aspect of SKW is the Safe Kids Buckle Up program. Over the past 20 years, it has used CPSTs to instruct caregivers on correct CRS installation and inspect their usage of the devices (MacKay et al., 2017).

The effect of SKW in distributing CPS education has been studied along several dimensions. The hands-on education by CPSTs at Safe Kids Buckle Up events increased caregiver knowledge, skill, and confidence, regardless of education level (MacKay et al., 2017). Attending an SKW car seat safety program has been shown to increase self-efficacy in the use of rear-facing CRSs (Rossow, 2021). Specifically, attending an event resulted in a 45 percent increase in the no-error rate of use after 6 weeks, as observed by a CPST. The confidence of caregivers also numerically increased. However, no tests were conducted to determine whether either of these increases were statistically significant.

Yet, awareness and motivation to attend SWK events varied. Only 30 percent of caregivers showed they were aware of SKW's car seat checks (Cease et al., 2011). Attendance of SKW events to gain CPS knowledge was deterred by caregivers' confidence of their correct use and located far away from checks. Caregivers who did attend an SKW event said they did so to "be sure everything [was] OK" or because "they just got a new car seat" (Dukehart et al., 2007, p. 3).

Other programs such as the World Health Organization's (WHO) Safe Communities have joined with SKW to create general injury prevention efforts. The WHO implemented Safe Communities in the United States to address all injuries, with traffic safety being one focus (NHTSA, 2001a). The Safe Communities model was a multifaceted approach that both assessed and obtained input from the community about existing views on traffic safety (Istre et al., 2011). Safe Communities then designed targeted interventions and evaluated their impact. In a 1999 report to Congress, four Safe Communities demonstration sites showed numeric increases in correct CRS usage, but the programs were not rigorously evaluated (NHTSA, 2001a).

Subsequent Safe Communities work leveraged an intervention designed to create a multidimensional awareness program that emphasized the importance of CRS use (Istre et al., 2011). The program educated caregivers on State laws and on proper CRS use. Caregivers were

also eligible to receive a CRS or booster seat for an (optional) donation. Evaluation of the intervention included the observation of 9,478 birth- to 8-year-olds both in the intervention area and at a comparison control site. Researchers observed significant improvement in the prevalence of proper (i.e., compliant with State law) child restraint usage after the intervention relative to the control site; a second, independent observation also found the study area had about a 24 percent greater increase in child restraint use compared with all other ZIP Codes in the city (Dallas). The authors concluded the multi-faceted community-based intervention successfully raised the prevalence of proper CRS usage.

Another program that situated CPS in general injury prevention efforts is *Buckle Up America* (*BUA*). Introduced in 1997, the *BUA* campaign targeted increasing restraint use for all occupants. The primary components of the *BUA* campaign were

- building partnerships;
- enacting new legislation;
- conducting strong enforcement; and
- expanding public information and education (Solomon et al., 2001).

BUA included public information and education components. For example, the Air Bag and Seat Belt Safety Campaign publicized that buckled caregivers usually meant protected children (Solomon et al., 2001). *BUA* was also able to get public companies on board with messaging. For example, trucking companies agreed to paint 1,500 freight trailers as *BUA* billboards reminding drivers to use seat belts and child restraints. The insurance company Progressive (in conjunction with other companies) created educational material featuring the movie character E.T. called "E.T.'s Car Safety Challenge," along with public service announcements, coloring books, and posters for distribution at events and in schools.

However, an evaluation of *BUA* presented mixed results on the effectiveness of the campaign in increasing child passenger safety (Solomon et al., 2001). The campaign successfully increased enforcement activity for child restraint use increased by 8 percent at the State level across the nation. Observed child restraint rates, as measured by NOPUS, increased during the study period, and child fatalities declined – both unrestrained child fatalities and restrained child fatalities declined over the study period. However, due to the lack of control sites, it cannot be determined whether the decrease in fatalities shown in these years is due to the influence of the campaign. Further, while events and engagement in the program were chronicled in detail, no analysis compared, for example, unrestrained child fatalities in States with greater activity to those in States with less activity. The lack of a comparison or control is a major limitation of this study.

Conveyance

Previous CPS education campaigns have conveyed information to caregivers through means such as face-to-face education, web-based campaigns, and access to free or low-cost CRSs (Glerum et al., 2019).

Child Passenger Safety Technicians and Child Passenger Safety Inspection Stations

One major avenue for conveying CPS education is through CPSTs. CPST training and certification are available through the National Child Passenger Safety Certification Program

(Venkatraman et al., 2021). The Standardized Child Passenger Safety Training Course, complemented by the national certification process has provided a system to train safety professionals and other interested parties in the fundamentals of correctly choosing and installing the proper car seat for child passengers and correct placement of the child in the car seat (Venkatraman et al., 2021). After completing the certification course, technicians work at inspection stations, also known as fitting stations or checkup events.

CPS inspection stations are designated places where caregivers learn to keep children safe while traveling in passenger vehicles by properly using the appropriate car seat, booster seat, or seat belt. A nationally certified CPST gives one-on-one instruction on proper use and installation of car seats (Ostergaard & Guzzetta, 2021). One report described it as, "At these inspection stations, technicians offer hands-on training about proper use and installation of child restraints and advise caregivers as to what restraint is age and size appropriate for their child passengers" (Dewey-Kollen & Prom, 2003, p. 3). Inspection stations are opportunities for hands-on education as well as preventing misuse and distributing CRSs as appropriate (NHTSA, 2013).

The work of CPSTs has been evaluated by educational programs given to groups of participants for the purpose of research, as well as routine assessments of actual observed CRS use conducted at designated inspection sites. Specially designed educational programs conducted by CPSTs, often consisting of lectures and hands-on demonstrations, increase CPS knowledge among caregivers (Budziszewski et al., 2021; Perez et al., 2020). Studies that investigated the change in CRS misuse following CPST instruction have typically examined usage directly after a CPST inspection; results showed decreased misuse rates following instruction of proper installation (Macy et al., 2016; Macy, Brines, et al., 2019; O'Neil et al., 2013). Fewer studies have examined CRS misuse rates directly after inspection *and* at follow-up points later in time. One such study found after 4 months, participants in an intervention group (who received a CPS educational safety brochure and an inspection from a CPST) demonstrated lower misuse rates compared to those in the control group (who only received the educational safety brochure), indicating the hands-on educational component of CPST work was critical for decreasing misuse rates (Burstein et al., 2017).

Additional research also evaluated ways to modify and contextualize CPST educational material to convey it to the appropriate audience. One large-sample study sent family resource center staff to CPST training; these staff then offered 60- to 90-minute training sessions to caregivers in English, Spanish, and Russian, which resulted in significant improvements in knowledge related to chest buckle placement and booster seat usage among all caregiver groups (Adams et al., 2017). Despite contextualization and other outreach efforts, it has been noted few caregivers have received CPS information directly from CPSTs (Penmetsa et al., 2018); the one-on-one nature of the CPST-caregiver interaction, the hands-on training, and the customized instruction for caregivers likely limits the number of caregivers who can be served.

Computers and Apps

While CPSTs have historically offered in-person education on CPS, computerized education has also been explored as a means conveyance. Digitalized education can be thought of as CPS information that has been modified from a typical written or oral form into a form that can be presented via computer or mobile app. In one study, researchers implemented an education program for caregivers of 4-week and 6-month-old infants coming in for a well-child visit in a New Mexico hospital that served almost exclusively Navajo patients. When comparing

computerized guidance (intervention) to written education guidance (control), there was a significant improvement in knowledge of use of rear-facing car seats in the rear seats and optimal car seat knowledge (Sanghavi, 2005). The computerized guidance required no extra time from providers, with potential benefits of decreased charting time (automated) and the ability to tailor guidance based on areas of deficient knowledge. In a separate case-controlled randomized study, researchers used the educational DVD *Keeping Baby Safe in and Around the Car* to educate caregivers of children under two on proper CPS usage (Swartz et al., 2013). They found the intervention resulted in significant gains on knowledge of car seats and recognition of installation errors in a doll simulation, compared to a control group that viewed information about general safety but none of the content regarding vehicle safety.

Apps have also been used to create theory-based tailored messages toward the goal of correct and consistent CPS use. One group developed (Gielen et al., 2015) and then evaluated (Omaki et al., 2018) an app based on the elaboration likelihood and precaution adoption process models. The randomized control trial used a CPS app (fire safety app for control) to deliver tailored information to caregivers of 4- to 7-year-old children (Omaki et al., 2018). At 3 months, the group that received the CPS intervention self-reported significantly improved safety behaviors related to using the correct car seats, having the child ride in the rear seat all the time, and having the car seat inspected. Those in the intervention group had nearly twice the odds of correctly practicing three of four safety behaviors after 3 months.

However, others have argued apps may be less applicable for guiding installation of CRSs. One study combined focus group data and survey data to identify where caregivers currently accessed installation information for CRSs and the potential of accessing this information via smartphone app (Fleisher et al., 2017). Focus groups revealed mixed opinions on the utility of an app. Some participants believed an app that would only be used a few times was not worth having on their phones, while others simply did not use apps; conversely, a subset of participants felt an app would be helpful, particularly for friends or family who may be installing CRSs in their vehicles for the first time. National survey data from the same study revealed only 36 percent of participants would definitely use apps for CRS installation, but 68 percent were agreeable to downloading apps about child health and safety. Notably, over half of participants would prefer to use the internet over an app to access CRS installation information; 82 percent found it easy to access installation information using existing resources.

Multi-modal

While previously presented studies analyzed the specific relevance of computers and smartphone apps, much of the research looked at the cumulative effect of CPS education that included several means of conveyance. In fact, the majority of CPS campaigns relied on more than one mode of conveying relevant information to caregivers. These multi-modal campaigns sought to leverage several means of conveyance to increase efficacy. For example, CPS education commonly included a demonstration or other hands-on component. A randomized clinical trial in Hawaii of parents who were 7 months pregnant compared receiving standard CRS training via educational video (control) to receiving standard training plus hands-on instruction on how to install a car seat and secure an infant in the seat (intervention) (Tessier, 2010). At a follow-up when infants were approximately 2 months old, researchers observed a significant effect of the intervention on correctness of use: parents who had received hands-on training were about four times more likely than the control group to be correctly using their car seat. The overall rate of errors was 33 percent less in the intervention group. Notably, no other variable evaluated (age,

education, income, and help from others after the teaching session) had any significant effect on the results.

There is also some evidence education combined with enforcement is more effective than enforcement alone. One California-based study found exposing a caregiver who had received a CRS violation to an educational class with a hands-on component resulted in gains on both CPS knowledge and correct CRS installation of a 20- to 40-pound child, relative to a caregiver who only received a violation (Agran et al., 2004). The study noted pre-test/control group findings showed violators had an existing high knowledge of the law. Effective education interventions may therefore need to do more than simply present CPS rules and regulations; caregivers may need hands-on education.

Another intervention used law enforcement to convey CPS education; the program was conducted in 2005 and 2006 in Pennsylvania to increase "tween" (8- to 15-year-olds) seat belt use (Alonge et al., 2012). The educational campaigns were customized for delivery at local elementary, middle, and high schools. The focus was on consistent seat belt use, proper positioning, and need for all occupants to buckle up. Law enforcement officers delivered the educational content on campuses as well as conducted on-road enforcement, participated in community activities, and contributed to media events. The multi-faceted intervention campaign resulted in significant improvement in seat belt wearing for all age demographics. There was also significant improvement in sitting in rear seats by children younger than 12. Researchers confirmed these results with both observational data and surveys distributed to students. Through surveys, 80 percent of tweens showed their primary reason for buckling up was "it's the law." The intervention also resulted in driver seat belt use increasing 12 percent. Alonge and colleagues emphasized the importance of law enforcement for conducting on-campus educational interventions, as some superintendents indicated they may not have participated if anyone other than uniformed law enforcement officers conducted the programs.

Alabama also implemented a multi-faceted educational and legislation campaign over the course of several years (King et al., 2007). Researchers evaluated CRS use, injury rates, and death totals for years prior to the intervention (1994 to 1999) and the years when the intervention was taking place (2000 to 2005). Billboards and radio segments presenting "*80% of loving caring parents put their child at risk by not having their car seat properly installed,*" served as the primary educational components of the campaign. The campaign established a CPST hotline and installed 22 fitting stations throughout the State. The State enacted a primary seat belt law during the intervention period as well as a modified CPS law indicating infants must remain rear-facing until reaching 1 year old and weighing 20 pounds. The multi-faceted campaign was associated with a significant increase in CRS use (59% to 86%) and a significant decline in serious injury. The program was also found to be cost-effective; based on Federal Highway Administration cost estimates associated with injury and death of children, there was an estimated return of $75 for every $1 spent on the campaign. It is important to note the combination of education, law changes, and enforcement campaigns were presented over the course of years, so it is not possible to completely isolate the contributions of specific components or to confirm the effects were due to the multi-faceted campaign and not to a general nationwide rise in CRS use during the time period.

Limitations

The research summarized in this chapter provides evidence of the effective content, context, and conveyance mechanisms found in evaluations of CPS education in the United States. However, there are some limitations of this research. First, in a review of educational interventions, while research measuring changes in knowledge of CRSs often showed significant results following the interventions, research that measured behavioral change related to CRSs found mixed results (Glerum et al., 2019). These may indicate changes to knowledge alone are not necessarily sufficient to result in behavior change. Glerum and colleagues also expressed concerns over the limited number of CPS studies that included long-term follow-up and suggested the importance of measuring knowledge retention, sustained behavior change, and outcomes over time to accurately assess the effect of interventions. Other researchers have similarly called for studies that demonstrate persistent impact of interventions over time, as follow-up studies in existing literature are often short or demonstrate high rate of attrition (Ehiri et al., 2006). A second review found of the 35 interventions reviewed, less than half used randomized control trials, the most rigorous evaluation methodology (Glerum et al., 2019).

An additional concern is the outcome measures used in this body of research. Many interventions evaluate outcomes using self-reported behavior for practical reasons. However, self-report has the potential for substantial bias in any population, and self-reported behavior by children may be even more susceptible to bias. Many CPS education studies relied on self-reported rates of medical professionals offering CPS guidance to mothers with whom they interact (Morrissey et al., 2016). Other studies relied heavily on self-reported data by caregivers themselves, and these results are limited by the caregiver's own recollection, demand characteristics, and social desirability bias. Furthermore, study participants are typically not blind to the condition in which they are being enrolled (e.g., whether they receive education or a free seat) (Sartin et al., 2019), making true randomized studies difficult to execute. Finally, self-reported behavior is an indirect measure, and researchers cannot know how closely self-reported behavior translates to actual behavior.

Finally, representativeness and sampling are a persistent challenge for CPS research as whole but particularly for research on education and outreach. Many evaluations take place in medical settings where the researchers can access samples of caregivers, but it is not always clear whether these samples are representative of the broader population. For example, educational campaigns that take place in hospital settings often sample families who use emergency room services—families who might differ from the general population in their health care access, their risk of accidental injury, or other confounding factors. Caregivers who self-select to participate in CPS educational campaigns also may already have more knowledge or safer behavior and may not represent population of caregivers at greatest risk (Dukehart et al., 2007).

Chapter 5: State Laws and Enforcement

Introduction

State laws and enforcement are a long-standing cornerstone of efforts to improve safety for child passengers. At the time this review was conducted, all 50 States and the District of Columbia require children up to age 4 (at a minimum) to be restrained in a CRS (rear-facing, forward-facing, convertible, or booster, depending on age) and protect children at least through age 8 by requiring them to be restrained in all seating positions (e.g., front and back seats) (IIHS, 2023).

Summary of Findings

- State laws requiring child restraints were associated with increases in usage rates and decreases in injury and fatality rates for children involved in MVCs.
- Caregivers tended to adhere to State laws rather than to recommendations. Caregivers may rely on State laws for accurate guidance.
- Campaigns that combined enforcement with education and outreach were associated with higher rates of observed or reported child restraint use.
- Campaigns that increased adult seat belt use also increased child restraint use.
- Caregiver decision-making regarding child restraint was influenced by different factors than decision-making regarding adult seat belt use.

Effectiveness of State Laws

The first CPS law became effective in 1977, after the National CRS guidance was issued at the beginning of the 1970s (Partyka, 1988). The AAP provides and updates national recommendations on the appropriate CRS for children based on their age, weight, and height. Over time, States have incorporated the AAP's guidance into their legislation to varying degrees, with variations in the specific language and requirements (GHSA, 2022).

Impact of State Laws on Use Rates

State child restraint laws and booster seat laws are effective at increasing child restraint use (Barraco et al., 2010; Decina et al., 2008; Gunn et al., 2007; Híjar et al., 2012; Violano, 2015; Winston, Kallan, et al., 2007). Some researchers reported when States passed more stringent CPS laws, the likelihood of compliance increased by up to 30 percentage points, and the caregivers of an estimated 8.6 million American children were "legal compliers" who changed their behavior when laws change (Jones & Ziebarth, 2017).

According to several qualitative studies on correct booster seat use, caregivers and CPS experts stated barriers to booster seat use included lack of a booster seat law and caregivers would be more likely to use booster seats if it was mandated by law (Bingham et al., 2005; Martin & Block, 2020; NHTSA, 2010a; Winston et al., 2000). Markedly, two survey studies found respondents living in States with strong CPS laws or where the law specifically mentioned car seat orientation were more likely to report proper car seat use than States without such laws (Levi et al., 2020; Macy et al., 2015). Analyses of FARS data further supports this finding. Specifically, the death rate in counties where the State law only required the use of CRS for child passengers ≤6 years old was higher than in counties where the State law required the use of CRS for child passengers up to 7 or 8 (Shaw et al., 2022). However, some studies suggested the absence or presence of a law was not enough, noting caregivers were unfamiliar with existing child restraint laws, did not understand what the law specifies, and were often misguided by inadequate laws (Medoff-Cooper & Tulman, 2007; NHTSA, 2010a; Yuma & Maldonado, 2006).

A survey conducted 9 months before the 2002 Washington booster seat law became effective showed only 18 percent of childcare facilities were compliant with the national booster seat guidance at the time, yet 43 percent of the facilities were preparing to comply with the new law 9 months before it became effective (Chang et al., 2002). This study also showed 70 percent of

respondents were willing to comply with the CRS law, but only 18 percent voluntarily complied with those same measures when they were only guidance (Chang et al., 2002).

The effectiveness rates of child safety seat laws may differ by age of the child due to several factors. The percentage of children who were already restrained before the law was implemented varied greatly by age (Jones & Ziebarth, 2017): younger children had higher rates of over-compliance, while older children had lower rates. This difference in baseline compliance rates affected the calculated effectiveness rates of the laws. In addition, laws affecting children of different ages were implemented in different decades, making it difficult to isolate the impact of the laws from the effects of evolving social norms (Jones & Ziebarth, 2017).

A study of car seat use in Connecticut found car seat use was more likely after implementation of Connecticut's CPS law, with the largest use rate increase seen among children 4 to 6 (Violano, 2015). Another study found the difference between pre- and post-law CRS compliance was high for infants younger than 1 (39 percentage-point increase) and for 1-year-olds (26 percentage-point increase), but the law did not seem to induce caregiver behavior changes for 2- and 3-year-olds (Jones & Ziebarth, 2017). They stated, however, that CRS use also varied by age in the pre-law years, as well, with nearly 50 percent of 1-year-olds being restrained before it was required by law but only 3 percent of 7-year-olds restrained in safety seats before required by law. Furthermore, there was little research on the impact of laws on use rates for children 3 and under published during the review period (2000 to 2022). This was likely due to most States adopting legislation for this age range before 2000; most post-2000 studies were conducted on CPS laws enacted after 2000 that mainly related to booster seat use for children 4 and older.

For children 4 to 7 years old, booster seat legislation was found to effectively increase usage rates (Decina et al., 2008; Farmer et al., 2009; Jones & Ziebarth, 2017; Violano, 2015; Winston, Kallan, et al., 2007). Research has shown in States with booster seat laws, 4- to 8-year-olds were more likely to be restrained and also much more likely to be appropriately restrained (i.e., in a booster seat) (Farmer et al., 2009). Specifically, one study found children 4 to 7 years old in States with booster seat laws were 39 percent more likely to be reported as appropriately restrained (Winston, Kallan, et al., 2007). Similarly, when Tennessee enacted an enhanced child restraint law to include new booster seat requirements for 4- to 8-year-olds, there was significant improvement in appropriate booster seat use in that age group, increasing from 29 percent to 39 percent (Gunn et al., 2007). In Wisconsin, significantly more children were appropriately restrained following enactment of a booster seat law; appropriate restraint use over the same time period in Michigan (control State) did not change significantly (Decina et al., 2008).

Impact of State Laws on Injury and Fatality Rates

Though some research demonstrated child restraint laws, in general, can help to reduce motor vehicle injury and fatality rates (Barraco et al., 2010), much of the research showed booster seat laws, specifically, decreased fatalities and injuries in booster-seat-aged children (typically 4 to 7 years old) involved in MVCs (Connell, 2009; Farmer et al., 2009; Mannix et al., 2012; Pressley et al., 2009; Sun et al., 2010).

A 2012 study examined the effectiveness of booster seat legislation (introduced in 47 States from 2001 to 2009) in reducing motor vehicle fatalities in children (Mannix et al., 2012). The combined risk of fatality decreased by 11 percent in States whose legislation covered 4- to 5-year-olds, by 23 percent in States whose legislation included 4- to 6-year-olds, and by 25 percent in States whose legislation included 4- to 7-year-olds. Another study reported children 4 to 6

experienced an 18 percent reduction in traffic injury rates after booster seat legislation was implemented in New York State, which Sun et al. (2010) primarily attributed to the increase in child restraint use (which increased from 29 percent to 50 percent after the implementation of the law). Other researchers used the FARS database to examine the association between booster seat laws and fatalities of children 4 to 8 years old in frontal collisions from 1995 to 2005 and found an approximate 20 percent reduction in fatalities in States with booster seat laws as compared to States without booster seat laws (Farmer et al., 2009). The study also found children were significantly more likely to be restrained in States with booster seat laws compared to States without booster seat laws.

Another study examining motor vehicle occupant injury among 3- to 8-year-olds found children covered by booster seat laws (i.e., children of an age covered by the law in their State) were significantly less likely to be hospitalized for motor vehicle occupant injury than children not covered by booster seat legislation (i.e., children in States with no booster seat law, or children outside of the age range covered by their State law) (Pressley et al., 2009). Mannix et al. (2012) concluded booster seat laws should include children until at least 7 years old and ideally until they reach a recommended height of 4 feet 9 inches, but some studies have gone further to suggest the maximum age requirement for a booster seat law should be 8 years old (Pressley et al., 2009).

Booster seat laws seem to provide spillover benefits as well. At the time of some of these studies were published, some States had booster seat laws that only covered 4- to 5-year-olds; however, decreases in injuries and fatalities were still seen in children younger than 4 (Connell, 2009) and children 6 to 7 years old (Connell, 2009; Mannix et al., 2012), suggesting positive effects may have spilled over to other age groups even if they were not specified in the law. Similarly, another study reported children 4 to 8 years old are less likely to die in a fatal crash if they live in States with booster seat laws, even if some State laws only applied until 6 or 7, as compared to States without booster seat laws (Farmer et al., 2009). However, other research demonstrated there were limitations to potential spillover effects, with no significant changes in injury rates for children who were not directly affected by booster seat laws after booster seat legislation was passed (Sun et al., 2010).

Degree to Which Families Rely on State Laws for Accurate Guidance

Experts say State laws inform caregiver perception of the reasonableness and appropriateness of various child restraint methods (Rivara et al., 2001) and caregivers have often self-reported a lack of legal requirements is a barrier to caregivers selecting the age-appropriate seat or using it correctly (Decina et al., 2009; Macy et al., 2012; Simpson et al., 2002). Parents who reported a lack of laws as a barrier felt the laws were not clear or specific enough (Decina et al., 2009), and they reported being more likely to use the appropriate CRS if the law required the appropriate CRS (Macy et al., 2012). Similarly, laws can inform youth decision-making. In a survey of tweens ranging from 8 to 15 years old, "it's the law" was the most common reason these youth reported they wore their seat belts (Alonge et al., 2012).

Some researchers have speculated a weak State law could lead caregivers to believe more cautious restraint practices are unnecessary. For example, based on focus groups with parents, Rivara et al. (2001) concluded laws "affect how parents perceive the adequacy of different restraint methods" (p. 212). Further, the degree to which families relied on State laws varied based on factors such as the age of their child, social norms, awareness of the law, and

knowledge of the specific requirements of the law (Benedetti et al., 2017; Jones & Ziebarth, 2017; NHTSA, 2001b). In some cases, caregivers may have been aware they should restrain their children but were either less knowledgeable in the specific features of the law (Agran et al., 2004) or less confident in specific requirements by age, weight, or height (Owens et al., 2019). For example, a survey conducted in California among caregivers of children 6 and younger admitted to the ED found only 59 percent of caregivers knew the California State law required CRS use for children weighing up to 40 pounds (and up to 4 years old) (Vaca et al., 2001).

Laws seem to be more effective than information alone. Nine months before the 2002 Washington booster seat law became effective, a survey showed only 18 percent of childcare facilities were already compliant with the law, which reflected national booster seat guidance at the time (Chang et al., 2002). This conclusion is consistent with Benedetti et al. (2017), who coded State laws for their adherence to national recommendations and examined restraint use. The analysis revealed, among restrained children, children in States with laws that met current best practices were more likely to optimally versus sub-optimally restrained; this finding could be interpreted as demonstrating drivers are more likely to adhere to State law than current recommendations.

Jones & Ziebarth (2017) concluded the primary mechanism for State laws to impact behavior was by signaling the effectiveness of CRS use, not through the cost of fines for noncompliance; indeed, they did not find higher fines predicted greater compliance in their examination of FARS data (1978-2011). In addition, the authors found drivers of newer vehicles, who the authors assumed may have more wealth and thus be less motivated by fines, were more likely to conform to the law. Variables associated with lower compliance included an assortment of indicators for risk-taking such as driver maleness, driver youth, and the driver having a previous major violation (Jones & Ziebarth, 2017). That is, noncompliance appeared to be related to risk-taking propensity rather than economic factors. Conversely, compliant drivers may be restraining their children to reduce their risk of injury rather than to avoid an economic penalty.

Other Considerations

Three studies documented the time lag in knowledge diffusion and policy adoption for State CPS laws (Bae et al., 2014; Dodington et al., 2017; Weatherwax et al., 2016). For example, States did not start adopting laws requiring seating minors in rear seats until some two decades after the evidence supporting this became available (Bae et al., 2014). These time lags present challenges as State laws may not be incorporating current best practices (Dodington et al., 2017). CPS laws also vary widely between States, and, in 2016, no States had CPS laws that completely reflected the most recent recommendations of the AAP (Weatherwax et al., 2016). Children older than 8 typically fall under adult seat belt laws, which also vary by State. A study conducted in Georgia found the State's child restraint law did not cover most of the children who were found to be at risk (i.e., not complying with the latest AAP recommendations for CRS at the time) (Staunton et al., 2005).

Another issue noted in the reviewed research related to State CPS laws was the unclear responsibility for restraining children in different transportation modes, with many States placing responsibility on the child's guardian or on the "person transporting the child," which can lead to confusion and a gray area of legal liability (Bredikhina et al., 2021; Prince et al., 2019). A study

to assess the safety standards for children traveling in transportation network companies (TNC)[14] found in the absence of laws specifically addressing car seat use in TNC vehicles, there was confusion about who should be held liable in cases of car seat violations in TNC vehicles (Bredikhina et al., 2021). Furthermore, the lack of specific laws pertaining to or addressing CPS in taxis or ride-shares may lead to confusion for caregivers. In a 2019 national survey, only 49 percent of respondents who had taken their children in ride-share vehicles reported being "somewhat," "not very," or "not at all confident" they had followed State laws (Owens et al., 2019). The issue of unclear responsibility may lead to lower rates of use or misuse; one study found the use of a child specific restraint for children under 8 years old in taxis was low (about 6%) (Prince et al., 2019).

Some researchers suggested CPS laws varied significantly among States due to "slow learning-based diffusion, complexity of the state of science, and lack of strong [F]ederal guidance" (Bae et al., 2014, p. 35), and others speculated the absence of nationwide authority was a possible contributor to State-level variations in CPS legislation (Bae et al., 2014; Sartin, Lombardi, et al., 2021; Staunton et al., 2005). However, Bae et al. (2014) showed a correlation between the availability of Federal grants tied to specific CPS legislation and the adoption of that CPS legislation at the State-level.

Other researchers have suggested between-State variation is compounded by the complexity and lack of clarity for age, weight, and height requirements in each State's CPS legislation (Owens et al., 2019); indeed, some caregivers reported booster seat legislation resulted in increased rates of premature transition to booster seats as they attempted to comply with new law (Brixey et al., 2010; Winston et al., 2000). One survey suggested a need for studies to evaluate the effects of legislation on populations known to have lower CRS use (Sartin, Lombardi, et al., 2021), and several studies suggested avoiding certain wording in legislation that may encourage premature transitions to the next step in child restraint products (Klinich et al., 2017; Winston et al., 2000). Finally, several studies concluded national guidance on CPS legislative language with simple, informative fact sheets and with the latest data/guidance could help legislators implement clear, concise, and up-to-date CPS legislation in a timely manner (Haring et al., 2015; Bae et al., 2014).

Effectiveness of Enforcement

Primary versus Secondary Enforcement

The potential influence CPS laws have on use rates is partially influenced by the type of enforcement (primary or secondary laws) (Dunn et al., 2016). If the law is primary enforcement, a law enforcement officer can stop a driver if a violation is observed. If the law is secondary enforcement, a law enforcement officer can only stop or cite a driver if they stopped them for another primary violation.

Adult Seat Belt Use

Several states have seat belt laws as a primary offense, and research indicates primary seat belt laws are more effective than secondary enforcement laws (Alonge et al., 2012; Decina et al., 2008; Glassbrenner et al., 2004; Hernandez, 2008). Further, adult seat belt legislation and

[14] Companies such as Uber and Lyft that use smartphones applications to connect passengers with drivers as well as other organizations are often called "ride-sharing" or "ride-hailing." These companies differ from traditional taxis by using independent contractors rather than fleets and often face specific regulatory requirements regarding background checks, insurance, and licensing.

enforcement had an impact on the likelihood of children being restrained (Benedetti et al., 2017; Weatherwax et al., 2016). For example, a multi-faceted approach to improve overall restraint use was implemented in Alabama from 1999 to 2005 (King et al., 2007). This approach included legislation, with a primary seat belt law enacted in 1999, as well as education on correct child restraint use and services (including car seat fitting stations and classes). After the primary seat belt law was implemented along with associated education and services, there was a significant increase in child restraint use. It is important to note the specific components of this program could not be isolated, and there was no control location, so it is not possible to directly attribute the increase in child restraint use to the law, to the enforcement, or to the program as a whole. However, the relationship between driver restraint and child restraint suggests interventions that improve adult seat belt use may also improve child restraint practices.

Sanctions

Research on seat belt use in adults suggested higher fines resulted in higher rates of observed seat belt use (e.g., Nichols et al., 2010). However, this review did not identify any research that examined the effects of specific sanctions (e.g., fine amounts, points on license) for child restraint law violations on CPS use rates. A survey conducted as part of a hospital-based CPS program showed 63 percent of participants reported the fear of receiving a ticket as a motivating factor for buckling their child in their safety seat (Weiss-Laxer et al., 2009); however, people may lack insight into their own behavioral influences and motivations (e.g., Nisbett & Wilson, 1977).

In some cases, alternative penalties may be issued in place of fines. For example, some enforcement efforts have issued informational warnings or vouchers that would waive fines for noncompliance with CRS if a driver purchased a child safety seat (Zaza et al., 2001). Similarly, a multicomponent intervention to improve restraint use in Latino communities involved community awareness, education, child passenger restraint distribution, and law enforcement focused on educational traffic stops with a warnings-only phase followed by a phase where citations were issued (Schaechter & Uhlhorn, 2011). Observed child restraint use rates improved in the communities before and after the intervention, but the improvement was not significantly different from changes in use rates in a control community. Further, this evaluation did not isolate the effect of warnings from other aspects of the intervention.

Enforcement Strategies

The following sections highlight some specific practices for identifying and enforcing child restraint law violations. Regulations on how these practices can be used vary by State (e.g., checkpoints are illegal in some States). Dedicated roving patrols can be used to actively search for children not properly restrained. Patrols may also remain in stationary spots where many child passengers are likely to be encountered, such as near elementary schools or shopping centers. Both forms of patrolling have been reported as useful tools in identifying child restraint law violations (Alonge et al., 2012; Decina et al., 2010).

Checkpoints can be used to stop or slow traffic so law enforcement officers can observe child passengers to enforce child restraint laws. Several studies have cited this as an effective tool in identifying child restraint law violations (Alonge et al., 2012; Zaza et al., 2001). Even checkpoints not solely dedicated to identifying child passengers can be a way to identify child restraint law violations. For example, a 2007 study on general seat belt compliance in Kentucky

employed saturated enforcement checkpoints, from which 478 child restraint citations were issued during a 2-week enforcement period (Agent et al., 2007).

A "mini-cade detail" typically involves setting up an officer and a vehicle at a particular location with message boards or signs (e.g., indicating "seat belt" or "car seat"). In some cases, the officer may simply observe and record restraint use, or the officer may give verbal warnings or distribute educational information; these details do not typically involve ticketing (Decina et al., 2010). A benefit of mini-cade details is they require less staffing than checkpoints (Connecticut DOT, n.d.). Mini-cade operations were part of Pennsylvania's *Avoiding Tween Tragedy* campaign to increase seat belt use among 8- to 15-year-olds (Alonge et al., 2012), but this evaluation did not specifically isolate the effect of mini-cade details on child belt use.

Enforcement is typically used in conjunction with education and outreach (Agent et al., 2003, 2007; Alonge et al., 2012; Zaza et al., 2001). However, the combination means evaluations of these campaigns are not typically able to isolate effects of specific enforcement activities. Enforcement can be combined with other components in several ways. Multi-modal campaigns may use any combination of enforcement, outreach, education, and other interventions. When enforcement is a centerpiece of the effort, media and outreach may increase campaign awareness. This strategy of combining enforcement with visibility elements and a communication strategy to educate the public on the laws is referred to as high-visibility enforcement (HVE) (NHTSA, n.d.-b). HVE combines highly visible and proactive law enforcement with a communication strategy to educate the public on the laws to target a specific safety issue, such as CPS enforcement (Alonge et al., 2012). The enforcement strategies such as patrols, checkpoints, and mini-cades are high-visibility enforcement that can be components of larger enforcement campaigns. Several studies used enforcement combined with media and outreach to increase awareness of the enforcement campaigns (Agent et al., 2007; Decina et al., 2009) and increase awareness of appropriate child restraint use (Office of Behavioral Safety Research, 2021). Similarly, research has shown CPS educational programs were more effective when combined with enhanced enforcement campaigns (Agent et al., 2007; Zaza et al., 2001). For this reason, this section covers enforcement as a component of campaigns and not as an isolated phenomenon.

One example of a CPS campaign that included enforcement was conducted in 2003 and 2007 in Kentucky, "Buckle Up Kentucky: It's the Law and It's Enforced" (Agent et al., 2003, 2007). Both the 2003 and 2007 campaigns promoted adult and child restraint use. Evaluation of the campaigns included observations of seat belt usage, motorist surveys, and a comparison of crash data during the enforcement period and for the same time periods in the five years prior to the campaign. The observation data found usage rates increased during both years' enforcement periods; the data on injury crashes also showed decreases during the campaign periods relative to years before the campaign (Agent et al., 2003, 2007). However, the evaluations did not include control sites, and the authors did not examine whether decreases before and after the campaign in Kentucky were statistically significant.

Another example is the *Avoiding Tween Tragedy* (ATT) campaign conducted in Pennsylvania from 2006 to 2007. It intended to increase restraint use at local schools and included educational, messaging, and enforcement interventions (Alonge et al., 2012). Components of the enforcement interventions were patrols, checkpoints, and mini-cades. Between the pre- and post-intervention, seat belt usage increased significantly, while restraint use decreased significantly in the comparison schools. Correct placement in rear seats position for elementary school children also

increased. Seat belts use after the intervention increased among elementary, junior high, and high school students by 13 percent, 17 percent, and 20 percent.

Finally, one CPS program that included enforcement was conducted from 2004 to 2009 by four American Indian tribes (West & Naumann, 2014). This program involved implementing multi-faceted road safety interventions to reduce vehicle-related injuries and deaths. The interventions involved school and community education programs, media campaigns, and enhanced enforcement components focused on specific issues and aimed at increasing citations for illegal behaviors. Observational surveys of child restraint use revealed an increase in the use of child safety seats in two of the intervention communities, and one community observed an increase in the percentage of law enforcement officers who could properly identify requirements for child safety seats and booster seats. However, it is unclear whether these changes in restraint use are statistically significant or different from communities that did not receive the intervention.

Law Enforcement as Partners for Child Passenger Safety

Law enforcement officers both enforce CPS laws and engage with community members about CPS by giving presentations to the community, performing child safety seat checks, posting on social media, partnering with other organizations such as hospitals or schools, and participating in public events (Alonge et al., 2012; Decina et al., 2009; NHTSA, 2010a; West & Naumann, 2014). Researchers suggested law enforcement should play active roles in the community (e.g., educating students, participating in health fairs, events, and appearing in media) because they are authority figures and thus will be able to convey the importance of restraint use to the public (Alonge et al., 2012). The findings of several focus groups supported this concept that authority figures, such as law enforcement, would be one of the most effective ways to communicate with children (Decina et al., 2009), but also that law enforcement officers should be used as guest speakers to help teach about child restraint use (NHTSA, 2010a) and demonstrate proper installation and use of child safety seats and booster seats (Decina et al., 2009). One study suggested the mere presence of uniformed officers in the schools can have a positive effect on students and increase participation in safety programs aimed at increasing restraint use in students (Alonge et al., 2012). Similarly, school administrators were generally supportive of CPS enforcement activities near schools (Alonge et al., 2012).

On the other hand, a group of experts in child development, CPS, and health education suggested that, for some communities, community leaders would be the best messengers for CPS campaigns (Decina et al., 2009). Additionally, law enforcement in some communities may face barriers to implementing effective enforcement. For example, barriers for law enforcement in Tribal communities may include insufficient staff, competing priorities, beliefs about the effectiveness of enforcement, and family relationships between law enforcement and community members (Brixey et al., 2010).

Other Considerations

Many caregivers are unfamiliar with child restraint laws (NHTSA, 2010a), and judges and prosecutors may dismiss violations because they do not fully understand CPS issues or feel the citations are frivolous (Decina et al., 2009). These factors may limit the impact of laws and of any enforcement efforts related to them. Educating law enforcement officers about the CPS laws in their States may lead to increased confidence in enforcing the laws (Decina et al., 2009) and increased enforcement of the laws (West et al., 2014).

There may also be institutional barriers to the enforcement of child restraints at various stages of the enforcement process (police management, legislation, funding, sentencing, and police education). For example, law enforcement officers have reported a lack of commitment by management (e.g., police chiefs) or lack of resources to enforce booster seat laws was a barrier to law enforcement officers enforcing CPS laws (Decina et al., 2008). Enforcement campaigns can be costly (Venkatraman et al., 2021) and some high-visibility enforcement strategies (e.g., checkpoints) may require additional manpower and resources.

Another factor that may affect the effectiveness of enforcement of CPS laws is parents and other caregivers reported the perception child restraint laws were not being enforced, which made them less likely to use child restraints, especially booster seats (Bhaumik et al., 2020; Decina et al., 2009; Hernandez, 2008; NHTSA, 2010a). In another study involving focus groups with caregivers, brainstorming sessions with experts, and discussions with law enforcement officers, study participants said they did not think they would get caught for CPS non-compliance, child restraint laws were not being enforced, law enforcement had more important matters to attend to, and violations would be difficult to spot (Decina et al., 2009). Similarly, respondents in another study said they did not use child restraints at night because they did not think law enforcement officers would be able to spot the violation (Bhaumik et al., 2020). Participants from one study reported the presumed effectiveness of the CPS strategy would improve if the perceived risk of being ticketed was greater and if the penalties were more severe (Decina et al., 2009); however, psychological research has showed people do not necessarily have insight into higher-order mental processes like those that initiate complex behaviors (Nisbett & Wilson, 1977).

Limitations

Limitations exist to the research reviewed in this section, primarily related to gaps identified in the research related to State laws and enforcement. For example, there was a lack of recent literature related to the effectiveness of different ways in which communities engage with law enforcement on CPS, not only survey results of a community's perception of the activities but also on CRS use rates.

We also discovered a lack of research examining the mechanisms how caregivers make child restraint decisions, especially given that adult seat belt and child restraint decisions may be affected by different factors. For example, for adult seat belts, road users may comply to avoid tickets, and laws with primary enforcement, higher fines, and HVE enforcement all are associated with higher adult seat belt use rates. For child restraint, however, the few analyses of sanctions and enforcement suggest the chief influence on a caregiver's decision is the presence and knowledge of a law requiring child restraint rather than the threat of citation. By contrast, if child restraint laws are effective by providing information to caregivers rather than through the possibility of enforcement, it is unclear why national child restraint recommendations do not have the same effect on CRS use as State laws.

We speculate there may be several reasons why this is the case. First, press releases and media coverage associated with law changes may result in greater awareness of information about child restraint than national recommendations achieve. Second, caregivers may give greater weight to the importance of information issued by States (via laws) than by other means. Finally, State laws may be more likely to either establish or reflect current social norms related to child restraint. For example, caregivers may interpret a change in a State law as signaling a change in social norms in the State. State laws may also be more closely related to caregivers' child

restraint behavior than national recommendations if the enactment of the laws *followed* a change in social norms related to child restraint use in the State. A better understanding of the way enforcement, State laws, and national recommendations inform caregiver behavior would facilitate the development of messaging and programs to increase CRS use.

Chapter 6: Communities With Lower CRS Use

Introduction

Some populations are less likely to use child restraints and are more susceptible to misuse when they do use restraints. These groups include Black, Latino or Hispanic, American Indian/Alaska Native, lower socioeconomic status, lower education, rural populations, and children with special transportation needs. In this review, descriptions of group membership follow the original paper's language. Chapter 2: Non-Use and Chapter 3: Misuse provide more thorough discussions of driver and demographic factors associated with non-use and misuse.

Summary of Findings

- Common barriers for child restraint use in lower-use communities included cost, knowledge and access to information, language barriers, and misconceptions about devices, especially booster seats.
- Solutions to common barriers to use included car seat distribution, education, enforcement, and combinations of these approaches.
- Promising programs for increasing restraint use in lower-use communities were usually community-led.
- These programs included the following characteristics: sustained support and technical expertise; local control of decisions wherever possible; placing expertise in the community social network, visible activities led by community members, and strategies that included the combination of education, enforcement, and training.

Challenges and Solutions in Communities With Lower CRS Use

This section addresses barriers and potential solutions to raise child restraint use, and increase correct use, in populations with low rates of CRS use and higher rates of CRS misuse. Specific barriers and related solutions appear first, followed by a discussion of approaches identified in the literature review for broader engagement with these communities. Though non-use and misuse have been documented in specific populations (see Chapters 2 and 3), relatively few well-controlled studies have investigated potential barriers or evaluated interventions for these communities.

Cost

Financial barriers to child restraint use pose challenges to some communities. The direct cost of CRSs has been reported as a barrier for Black (Cordy et al., 2002; Johnston et al., 2008), Latino (Ebel et al., 2006, Lee et al., 2003), American Indian and Alaska Native (Lapidus et al., 2005), lower income (Johnston et al., 2008; Samuels et al., 2009), lower education (Winston, Erkoboni, et al., 2007), specific lower income ethnic communities (Johnston et al., 2008; McKenzie et al., 2017), rural populations (Huseth-Zosel & Orr, 2015), and families of children with special

transportation needs such as those in spica casts, a cast used to immobilize the thigh bones and pelvis (Adams et al., 2019). Programs to provide child restraints free or at low cost can help overcome the direct cost of devices; this strategy has resulted in increased use (Brixey et al., 2009; Gockley et al., 2015; Letourneau et al., 2008; McKenzie et al., 2017; Piontkowski et al., 2015; see Glerum et al., 2019 for a review).

However, there may be challenges in determining the method by which car seats are allocated to communities with lower CRS use (Peterson et al., 2016), and at least one study did not observe differences in use in a lower-income community that received a multi-component program that included distribution of booster seats, relative to a control community (St. Louis et al., 2008). Increases in use rates may also drop as time elapses after the giveaway (Brixey et al., 2009), and affordability issues can go beyond the cost of the CRS. For example, families with lower income and fewer resources may share vehicles and frequently need to transfer CRSs. Other caregivers report having to remove child restraint devices to fit more people in the car (Johnston et al., 2008; McKenzie et al., 2017), a cost-related problem above and beyond the cost of devices.

Knowledge and Access to Information

Caregivers in some communities may have less knowledge about proper child restraint and correct use. Only 61 percent of lower-income obstetric clients in Louisiana were able to identify the correct placement for an infant CRS in a vehicle, and knowledge was lower among African-American women relative to White women, and women who had never given birth relative to those who had (Robinson et al., 2002). Black caregivers in focus groups expressed limited knowledge of booster seats (Cordy et al., 2002), and almost half of drivers of child occupants aged 8 or younger on tribal lands said they did not know whether there were any child restraint laws in their communities (Lapidus et al., 2005).

Health care providers are a potential source of information about child restraint (Penmetsa et al., 2018), and hospital-based education programs have successfully increased urban, low-income caregivers' knowledge about CPS (Budziszewski et al., 2021), even when they took place with no personal interaction (information distributed via a computer kiosk, Gielen et al., 2007). However, CPS information in healthcare settings may be less available to some communities. Rural providers were less confident about their CPS knowledge and were less likely to provide CPS-related anticipatory guidance than urban providers, leaving rural caregivers with less information from these trusted sources (Huseth-Zosel & Orr, 2015). However, this review did not identify any additional research related to guidance given in healthcare settings in other lower CRS use populations.

When predicting child restraint knowledge among caregivers of users of a Southern California Level I trauma center and emergency department, several respondent characteristics were significant predictors of less child restraint knowledge: lower incomes, lower education level, Hispanic ethnicity, and less fluency in English, though the predictive value of education level was not significant when other variables were included (Vaca et al., 2002). Of these, the strongest predictor was English fluency, demonstrating language barriers and information access go hand-in-hand. Relatedly, one study reported extensive English-language campaigns failed to reach caregivers who spoke other languages (i.e., Somali families in McKenzie et al., 2017). Further, specialized information, such as methods for safely restraining children who must travel in wheelchairs, can be complex in any language (Manary & Schneider, 2011) and may not be available in the languages spoken by families who need the information.

Producing information in other languages might seem to be a solution, but complications arise. For example, literacy of caregivers was reported as a challenge in one study with a lower income ethnic community (McKenzie et al., 2017), and written material supplied with child safety seats were often written at 7th to 12th grade reading levels (Wegner & Girasek, 2003). Even if provided in other languages and at accessible reading levels, material may not be responsive to how communities seek information; caregivers may primarily seek information from friends, relatives, coworkers, or acquaintances rather than impersonal sources (e.g., library or brochure). For example, McKenzie et al. (2017) noted Somali families tend to acquire health information and information about CPS by word of mouth, and Kendi, Howard, et al., (2021) found a group of English- or Spanish-speaking caregivers listed friends and family as information sources about CPS. Martin et al. (2006) mention "*personalismo,*" a Latino cultural concept that places greater trust in information that comes with personal connections, which may influence the way this community obtains information about CPS. However, if the information in a social network about CPS is limited, the available information may be correspondingly limited.

Community health workers (also called lay health workers, *promatores*, or peer educators) are trained people who are similar to the target population. More broadly in public health, research has suggested they are effective educational conduits in Latino communities in the United States and other nations (Ayala et al., 2010). Some evidence supports the effectiveness of community health workers as CPSTs in reaching lower-use populations. Martin et al. (2006) delivered an educational intervention (demonstration of car seat installation) to a predominantly Latino sample and included delivery of the intervention by Latino community health workers trained as CPSTs. The evaluation of this intervention compared CRS misuse between caregivers who had received this intervention and caregivers who had attended another CPST event. The evaluation found fewer misuses among the intervention group than the comparison group devices. However, because the intervention also included other features (e.g., a hands-on session with an office demonstrator that simulated several vehicle types), the improvement cannot be attributed solely to the involvement of the Latino community health workers.

Combined Education and CRS Distribution

Some research has suggested education alone may not be sufficient to achieve behavior change among all caregivers. In one study, lower SES caregivers who visited an emergency department with children 4 to 7 years old and 40 to 80 pounds received one of three interventions: standard discharge instructions (control), education only, or education plus installation of a free booster seat. Only the "education plus installation" condition significantly increased self-reported booster seat use one month later (Gittelman et al., 2006). Similarly, observed booster seat use increased among low-income families after an intervention that included education and free booster seats. Booster seat use increased among 4- to 8-year-olds, and the percentage of unrestrained children decreased (Apsler et al., 2003). However, this evaluation lacked a control group, so it is unknown whether the increases could reflect a general rise in booster seat use.

Another multifaceted program was associated with increases in observed child restraint among Hispanic families. Based on the Safe Communities model, this program was tailored to the community and included education and car seats available at greatly reduced or no cost. The program also included an emphasis on driver restraint. Over the course of 3 years, restraint use among Hispanic people improved significantly for both children and for drivers, with the two being closely associated; this improvement was greater for Hispanic children at study locations than for all children at surrounding (control) locations (Istre et al., 2002).

Enforcement

The review identified research indicating caregivers from some lower-use communities perceive enforcement as a motivator for child restraint: Latino caregivers said their motivators for booster seat use included the risk of receiving a citation (Ebel et al., 2006; Weiss-Laxer et al., 2009). However, other research suggested members of lower-use communities may prefer to receive information about CPS from community leaders rather than law enforcement (Decina, et al. 2009). One study also found that in three communities on Tribal reservations no citations were issued for CPS violations, and law enforcement did not conduct any CPS-related campaigns, which the authors suggested may have undermined the effectiveness of child restraint laws (Smith & Berger, 2002). Further, enforcement alone may not be sufficient to produce behavior change: an investigation of predominantly Latino, lower-income caregivers who had paid fines for CPS law violations in the past 3 months found 41 percent said they did not always use car seats for their children (Agran et al., 2006).

Other Barriers

The reviewed research showed members of populations with lower CRS use report many of the same barriers as caregivers, more broadly. For example, Latino caregivers said barriers included child behavior or resistance to the seat (Agran et al., 2006; Ebel et al., 2006; Lee et al., 2003), vehicle crowding (Agran et al., 2006; Lee et al., 2003; Weiss-Laxer et al., 2009), concerns about child comfort (Weiss-Laxer et al., 2009), and inconvenience (Agran et al., 2006). Parents with lower education levels said lack of information, fear of injury caused by the seats, child' lack of comfort, and child noncompliance were barriers for booster seat use (Winston & Erkoboni, 2008).

Successful Strategies for Engaging Communities With Lower CRS Use

The literature review identified few controlled evaluations of engagement strategies for communities with lower CRS use, specifically; therefore, this section covers empirically-evaluated strategies but also notes examples of promising approaches that may not have been formally or rigorously evaluated.

Partners In Community, Local Champions

As noted earlier, "trusted messengers"—information sources with credibility—are likely to be an important component of any intervention to increase child restraint use. However, there may be variations among caregivers, particularly those from lower-use communities, about who is perceived to be a trusted messenger. For example, Black focus group participants, which included parents of children younger than 4, reported strong support for Black representation in vehicle safety outreach material, and many said they trusted nonprofit organizations, community centers, faith communities, and schools as sources of health and safety information (Cordy et al., 2002). Some efforts to reach lower-use populations have focused on placing expertise in the community. For example, North Carolina identified rural populations as low use in their efforts to improve CPS and prioritized training CPSTs in every county (Raymond & Jackson, 2022); however, it is unknown whether this approach resulted in improvements to child restraint use in rural areas.

Examples of Successful Community-Led Engagement in Lower-Use Populations

Community-led engagement places ownership of the program with the community rather than an outside force. In community-led engagement, the community makes choices about how a program is implemented. For example, four tribes used CDC funding to tailor, implement, and evaluate motor vehicle injury prevention programs. Each tribe created a multifaceted approach that included elements of education, outreach, and enforcement, chosen from the *Guide to Community Services* (Task Force on Community Preventive Services, n.d.) and tailored to their own tribes. Observations established improvement in child restraint and a reduction in injury crashes before and after the intervention; however, the changes were not compared to any changes observed in communities that did not receive the intervention (West & Naumann, 2014).

Another example of community-led engagement is the Ride Safe program developed by the Indian Health Service that was primarily implemented through Tribal Head Start centers. It included extensive community engagement, a CPS curriculum for use by staff, funding for CPST training, child restraint seats at low or no cost, and evaluation activities that included behavioral observations. This approach engaged trusted messengers and members of the community to implement the program, and it embedded expertise in the intervention communities' social networks. While the Ride Safe program has been associated with observed increases in CRS use after implementation relative to before (Letourneau et al., 2008), this evaluation did not include observations in any control communities.

Given these promising results, five additional tribal communities chose strategies from the *Guide to Community Preventive Services* (Billie et al., 2016, referencing Task Force on Community Preventive Services, n.d.). All five communities' programs included elements of enforcement, CRS distribution, and education. Trusted messengers and members of the community were engaged, tribes took the lead on implementation, and expertise was placed in communities. Increases in child restraint were observed in all five communities (Billie et al., 2016), although comparison communities were not examined.

A multifaceted 2-year program aimed at increasing restraint use in Latino communities included a public outreach campaign called *Abrochémonos a la Vida* (Let's Buckle Up for Life), restraint use education with CRS distribution conducted by Latino CPSTs, and enforcement. Two communities received the intervention, and a third served as a control. Results were not conclusive: observed child restraint increased in all three communities over the implementation period, and changes at the study sites were not significantly different from changes at the control site (Schaechter & Uhlhorn, 2011).

Finally, a controlled evaluation of two community-based booster seat promotion programs showed mixed results. Two communities, one low-income with mixed demographics and another predominantly Hispanic, received programs designed by CPS advocates living in each community and tailored to include activities targeting the community's population. While some elements of each community's program were similar (e.g., vouchers for booster seats, inspection stations), some differed (e.g., in the Hispanic community, a priest conducted a booster seat blessing). The evaluation found no significant change in the low-income program community relative to a comparison community with similar demographics; however, there was a significant increase in booster seat use in the Hispanic community relative to a comparison community (St. Louis et al., 2008).

Although promising, there are limitations to some of the evaluations of CPS programs involving community-led and community-based engagement. First, as noted above, most of these evaluations did not include a control or comparison; therefore, it is unknown whether improvements can be attributed to receiving the intervention. Second, most of the programs described here involved several components, and the evaluations cannot determine which program elements were related to the presence or absence behavioral change.

Generalizing Strategies Among Communities With Lower CRS Use

Although strategies for engagement described in the literature tended to be tailored to specific populations, some broad principles and strategies may transfer among groups. For example, tribal motor vehicle injury prevention (TMVIP) best practices provide information on building programs through long-term engagement, collaboration, data sharing, tailored strategies, and technical support (Letourneau & Crump, 2016). Though the principles and strategies are geared toward American Indian and Alaska Native efforts, the content may have broad applicability for other communities to improve child restraint. These strategies tended to have the following characteristics:

- Community support: technical experts offered evidence-based strategies, and they provided sustained engagement. Communities were not expected to create a program entirely from scratch, and they selected strategies rooted in evidence.
- Communities had control of many program aspects: for example, from the menu of evidence-based strategies provided by technical experts, communities chose specific interventions and customized them to their community.
- Guidance from technical experts ensured interventions were varied (e.g., they included elements of education, enhanced training, and enforcement).
- Expertise did not reside solely in the technical experts: members of the community received enhanced training (e.g., as CPSTs). That is, knowledge was deliberately placed in the community social network.
- Visible activities were conducted by members of the community: for example, priests blessed car seats, and tribal community health workers conducted seat distribution.

These strategies may be beneficial for the following reasons:

- Community-led programs offer information in the community dialect and reflected community culture.
- Communities owned the effort. They chose the interventions and customized events and materials. In so doing, they signaled CPS was important to the community.
- Enhanced training placed greater knowledge in trusted messengers in the social network. After the project ended, the knowledge did not leave with the technical experts.

Limitations

Some communities demonstrate lower child restraint use rates and more misuse of restraints. Reported challenges for these communities included cost, knowledge and access to information, and awareness about CPS laws and best practices. However, behavioral safety research on effectiveness interventions specifically for these populations was limited, and controlled evaluations were rare. Some strategies for tribal populations have been evaluated, but most study designs lacked a comparison community or control group. Although the identified strategies may form a structure for engaging other lower CRS use communities, applications of these strategies to other populations have not been conducted or evaluated.

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Part III: Conclusions

Chapter 7: Limitations and Conclusions

This comprehensive review synthesized existing knowledge about child passenger safety in the United States. Initial searches led to 2,301 papers. Of these, 918 were potentially relevant and received critical review, leading to the 292 papers that were the most relevant, of the highest quality, and were the basis of this report. This chapter offers limitations of the review, gaps identified in the research, and major conclusions.

Limitations and Gaps

The body of literature on CPS identified in this review had some limitations, many of which are noted in individual chapters. Some of these limitations apply to behavioral research, generally, while others are specific to research on child passenger safety. For example, any studies that allowed participants to opt-in may be susceptible to selection bias, particularly if participants opt-in to receiving an intervention, since people who choose to participate in research or an intervention may differ systematically from those who do not. Selection bias serves as a threat to the representativeness of the sample and limits the extent to which a study's results generalize to the entire population. Selection bias in the field of child passenger safety may be especially problematic for evaluations of car seat inspection events. Caregivers who choose to attend a CRS inspection event may differ from those who do not. For example, caregivers who are willing and able to appear at a specific location, spend a portion of their day, and interact with a CPST may be more likely to attend. Furthermore, the locations in which events are held likely affects the sample of caregivers who participate.

Additionally, the research team noted four areas with noticeable gaps in existing research. First, there was little research on children who have transitioned out of booster seats. Older children are less likely to be restrained than younger children, but restraint use and potential countermeasures for children for whom seat belts are appropriate have been studied less comprehensively than for children younger than 8. Second, although descriptive studies have documented the prevalence of tether non-use and misuse for forward-facing car seats, relatively little behavioral safety work has investigated ways to improve tether non-use and misuse. Third, the research team did not identify much research published in the review period related to the effect of enforcement of child passenger safety laws on child restraint use. While several programs identified in the literature included enforcement as a component, evaluations of these programs could not separate the effect of enforcement from the effects of other program aspects like education and car seat distribution. Finally, there were few controlled evaluations of effective ways to increase child restraint use specifically in populations with lower CRS use.

Conclusions

Children were well protected under the age of one year, with almost every infant traveling in a rear-facing CRS. However, older children were less likely to be restrained and, even if they were restrained, less likely to be correctly restrained. Non-use and misuse of CRS were associated with short trips, uncommon trip types, State laws, and drivers who were lower income, were Black, lived in rural areas, drove older vehicles, and had more passengers in the vehicle. Unrestrained drivers were more likely to drive with unrestrained children.

While education about CPS contributed to programs to increase restraint use, education alone was sometimes insufficient to achieve behavior change. Effective programs were typically multifaceted. Some population groups had lower child restraint rates and more misuse of restraints; potential barriers for these groups in using child restraints included cost, knowledge and access to information, and misconceptions about CRSs, especially booster seats. Community-led programs for American Indian and Alaska Native or Hispanic and Latino communities yielded increases in child restraint use but have not been sufficiently evaluated to draw strong conclusions.

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Appendix A. Methods

Selection of Chapter Topics

A virtual meeting of stakeholders in February 2021 informed the development of the chapter topics, research questions, and systematic literature review plan. The meeting discussed the goals and the means of the information to be collected and presented. Stakeholders:

- National Safety Council, Tammy Franks
- EMS-C, Maryland Institute for EMS; Cyndi Wright-Johnson
- Eastern Virginia Medical School, Kelli England, PhD
- Children's Hospital of West Los Angeles, Helen Arbogast, PhD
- American Academy of Pediatrics, Marilyn Bull, MD
- Governor's Highway Safety Association, Kerry Chausmer
- Texas Department of Public Safety, Spokesman; Lieutenant Lonny Haschel
- Juvenile Products Manufacturers Association, Joe Colella
- Indian Health Service Injury Prevention, Captain Holly Billie
- CDC, Commander Erin Sauber-Schatz, PhD
- NHTSA Region 7, Sherri Cannon
- NHTSA Region 3, Megan Miller

They discussed important issues, areas of knowledge, gaps in available information, stakeholder needs, the audience, and the most useful format for the work. They requested a plain-language summary at the beginning of each chapter for non-researchers but specified caregivers were unlikely to be a primary audience. Those who stakeholders believed were likely to find this information useful were a broad group:

- Researchers,
- Policymakers, including lawmakers and planners,
- Advocates,
- Hospitals,
- Injury-prevention professionals and programs,
- Social workers who engage with foster children,
- Organizations that provide childcare,
- Educators, including those who train medical personnel,
- Students,
- State Highway Safety Offices, and
- Manufacturers of child restraint products and vehicles.

Chapter Topics and Research Questions

The research team developed the chapter topics and their associated research questions from information gathered during the stakeholder virtual meeting, input from NHTSA, and their own expertise on CPS.

Study Inclusion Criteria

The research team selected studies for inclusion in the review that met these criteria:

- English-language papers,
- Published from 2000 to March 2022
- Research conducted in the United States, focused on children from birth to age 12, traveling in passenger vehicles,
- Empirical research studies found in:
  - Peer-reviewed scientific journals,
  - Conference proceedings,
  - Federal and State Government reports,
  - Technical reports,
  - “Grey” (unpublished) literature, and
- Behavioral safety topics only, excluding engineering, crash dynamics, biology, advocacy, etc.

Searches

Databases and search services included Google Scholar and the following resources.

Name	Focus	URL
APA PsycNET	Behavioral and social science	https://psycnet.apa.org
National Transportation Library’s Repository & Open Science Access Portal (ROSA-P)	Transportation	https://rosap.ntl.bts.gov/
Psychology and Behavioral Sciences Collection	Child and adolescent psychology	www.ebsco.com/products/research-databases/psychology-behavioral-sciences-collection
PubMed	Life sciences and biomedical	www.ncbi.nlm.nih.gov/pubmed
ScienceDirect	Multi-disciplinary	www.sciencedirect.com/
Transport Research International Documentation (TRID)	Transportation	https://trid.trb.org/

Literature Review Spreadsheets

As potential studies were identified using search engines, databases, and search terms, researchers reviewed abstracts or document summaries to determine relevance and ensure inclusion criteria were met. All potentially relevant documents were added to Mendeley, an online reference manager, for storage and further review (Elston, 2019). Spreadsheets were used to track and prioritize relevant studies and assist with the literature review synthesis. Researchers recorded the results of their reviews and indicated their recommendations for a more detailed

critical review. These fields were also used as a tracking mechanism to know the review history of each source added to the database.

Screening Potential Publications

The research team used a two-step process to evaluate the literature. An initial review determined whether a document should be included in the literature review. Initial review covered the title and abstract, which efficiently excluded patently irrelevant studies. After initial inclusion, members of the research team conducted a critical review and extracted relevant information from the document. Critical review required thoroughly reading each selected document to gain a full understanding of the content and findings. The reviewer documented essential information (e.g., research methods, key findings) and any notable strengths or weaknesses of a given study. Critical review also included evaluation using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018). The MMAT includes evaluation criteria for five methodological categories of empirical work: qualitative research, randomized controlled trials, non-randomized studies, quantitative descriptive studies, and mixed methods studies. The child passenger safety literature consisted largely of studies that fall in these five categories. In each category of methodology, five criteria are given to assess the quality of the work. Each item is clearly defined for the user. Pitfalls of the methodology (e.g., confounds in non-randomized trials) are targeted for assessment, and general sound research practices (e.g., representativeness of the sample) are documented.

The research team also noted if and why a document should not be considered for inclusion in the review (e.g., the relevant exclusion criterion). To avoid including findings from original sources as well as the same findings included as part of existing literature reviews, the research team reviewed the source articles for primary inclusion in the review process and cited the existing literature review article for its unique contributions (e.g., trends noted, conclusions drawn, recommendations made.)

Initial searches across all chapter topics led to 2,301 unique papers. Of these, 918 were potentially relevant and received critical review, leading to the 292 papers that were the basis of this report.

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