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Key Findings

- The correct use of Child Restraint Systems (CRS) has been found to be effective in reducing road traffic fatalities and injuries among children.
- The following interventions have been found to be effective in increasing the use of CRS:
 - Legislation that requires children riding in vehicles to be buckled up in age and weight appropriate CRS¹⁻⁴
 - Combination of strategies including legislation, CRS educational and distribution programs:
 - CRS legislation combined with enforcement, and educational campaigns⁵
 - CRS legislation combined with enforcement, educational campaigns, and distribution of free CRS⁶
 - Education combined with other interventions such as enforcement measures⁷
 - Education combined with other interventions such as enforcement measures, distribution of CRS and car seat checks⁸⁻¹⁰



Recommendations

- CRS laws should cover children of all ages with height specifications, all seating positions, all car seat types and all vehicles, and should be subject to primary enforcement (i.e., the driver can be stopped for the sole purpose of being cited and fined for failure to comply with the child safety seat law).¹¹⁻¹⁶
- A comprehensive, multi-component strategy, tailored to the community's needs, that includes legislation and its enforcement, along with community-based interventions, such as, education, distribution of car seats and demonstration of correct use, is critical to the improvement of proper CRS use and decrease in the incidence of injuries.¹⁷⁻²²
- Further research into behavioral factors (e.g., enablers, barriers) attributing to compliance with CRS laws, low compliance groups, such as people of lower socioeconomic status and minorities, is needed.²³⁻²⁵
- Collaboration between the car seat manufacturers to develop consistent recommendations in all user guides and instruction manuals is required.²⁶
- Countries and states should have a road safety surveillance system for collection of data on CRS use and its influencing factors.²⁷



The Problem

Road traffic injuries are one of the leading causes of death among children and adolescents, globally.²⁸ Road traffic fatalities among children 5-14 years of age are more common in low and middle-income countries (LMICs) with a rate of 5.86 deaths per 100,000 in low-income countries and 4.09 deaths per 100,000 in low-middle income countries in 2019, compared to 1.66 deaths per 100,000 in high-income countries (HICs).²⁹

Despite the proven effectiveness of Child Restraint Systems (CRS), its use remains low in many countries, e.g., 7% in Colombia. In addition, data on CRS use is scarcely available in many countries. Of the 84 countries that have national Child Restraint Systems (CRS) laws, only 33 countries have CRS laws that meet global best practices. None of the CRS laws in low-income countries are compliant with global best practices, such as inclusion of age or height limits, restricting children from sitting in the front seat, and specifying a product standard.²⁸



What we already know

CRS, when used correctly, are highly effective in protecting children from death or serious injury in the event of a crash. Several studies done around the world have estimated the effectiveness of CRS. According to the World Health Organization's Global Status Report on Road Safety 2018, the use of CRS can reduce deaths by 60%. Similarly, the National Highway Traffic Safety Administration (NHTSA) estimates that CRS are 71% effective in reducing the likelihood of death of children in motor vehicle crashes, conditional on the correct installation of the CRS.^{11,30} Appropriately or properly used CRS (age-, size-, and weight-appropriate) also help reduce the likelihood of nonfatal injuries (e.g., head injuries among children, including infants and toddlers), compared to using no CRS at all.^{10, 17,30-37} However, incorrect use (incorrect installation with seats or safety belts that are not fully compatible) results in a drop in the practical effectiveness of CRS by 50% to 59%.^{11,38}

CRS use practices

A range of CRS use practices have been discussed in the literature. Several articles reported the prevalence and types of CRS use, inappropriate and incorrect use, and non-use, including the factors influencing each of these practices, a summary of which is presented below:

Prevalence of different types of CRS use practices:

- **United States and Canada:** In the United States, only 21% of booster-eligible children were found to be using booster seats, and only 17% were using booster seats properly with a lap and shoulder belt.⁸ Prevalence of CRS use decreased with increasing age and weight.^{26,39} In 2005, overall critical inappropriate CRS use was 73% and was more common among infants and young children weighing less than 18 kg (40 lb).⁴⁰ Common incorrect uses included having loose harness straps and a loose vehicle seat-belt attachment to the CRS in Canada.^{18,40} Incorrect use involving lap/shoulder belts, e.g., placing the shoulder portion either behind the back or under the arm, were also observed.¹²
- **Canada, Italy, and United States:** Premature graduation to booster seats or adult seat-belts was observed, e.g., among children in the 7 months to 8 years age group in Canada.^{30,35,40,41}
- **Brazil:** Among children ages 0-11 years, 36% were using child safety seats, 45% were unrestrained during travel, 16% were seated on an adult lap, and 2% were using seat-belts.⁴²
- **Sweden:** In 1976 and 1986, rates of incorrect use of CRS were found to be 41% and 65%, respectively. The most common type of incorrect use was not using the belt guide for the lap part of the seat-belt.⁴³
- **Australia:** Incorrect and inappropriate CRS use were each found to be 51%.³¹
- **Canada:** Overall incorrect CRS use was found to be 70% in Manitoba.¹⁸

Factors influencing CRS use practices:

a) Factors related to characteristics of children	
Age	Premature graduation to seat-belt use was observed among young children between 3 and 6 years of age. ^{12,13,30,31,35,40,42,44-46}
Weight	Evidence shows a decrease in CRS use with an increase in the weight of children. For example, in the United States, CRS use was 97% for children less than 9 kg (20 lb); 86% for children between 9 and 18 kg (20 and 40 lb); 42% for children between 18 and 27 kg (40 and 60 lb); and 11% for children between 27 and 36 kg (60 and 80 lb). ^{30,39}
Height	Shorter height in children was found to be associated with increased prevalence of appropriate CRS use in the United States. ³⁰
Number of children in vehicles	The percentage of appropriate CRS use was found to reduce from 63% ± 3% in vehicles with 1 child to 52% ± 5% when 3 or more children were present. ²⁷
Children's attitudes toward CRS use	CRS use was influenced by children's comfort. In some instances, parents reported that children could not tolerate being restrained and self-extracted themselves from CRS, which constituted 43% of the common reasons for non-use of CRS. ^{19,47-49}
b) Factors related to parents/drivers/caregivers	
Drivers' or parents' education, income, age, race, gender, and seat-belt use practices	CRS use was found to have significant associations with education (P = 0.031), race (P = 0.000), income (P = 0.013), and maternal seat-belt use (P = 0.031). For example, female drivers were more likely to be driving child passengers correctly restrained. ^{8,13,23,39,41,42,44,50}
Ease of use	Difficulty using booster seats influenced its use despite the presence of legislation mandating booster seat use. ¹⁹
Parents' preferences	Desire to hold children close to themselves was reported to be a reason for non-use of CRS. ^{47,51}
Affordability	High prices of CRS were reported to be one of the reasons for non-use of CRS. ^{48,52,53}
Perceptions of and attitudes toward CRS	This includes parents' perception that children are too big for CRS and a lack of perceived risk associated with non-use of CRS. ^{32,49,54}
Knowledge and awareness	Parental lack of knowledge about effectiveness of CRS and lack of awareness of how to restrain children and of CRS laws affected CRS use. ^{19,49,55}
c) Legislation and enforcement	
	Presence of legislation mandating CRS use (as well as seat-belt use for adults), legislation along with education and awareness campaigns with free distribution of car seats, its degree of enforcement, the ages of the children specified in the law, and the length of time the law has been in effect can influence the use of CRS. ^{13,17,24,33,39,45,49,50,51,53,55-59}
d) Others	
Neighborhood income	Correct use of CRS was lower among children living in lower-income neighborhoods (<USD 40,000) than those living in higher-income areas (≥ USD 40,000) (Odds Ratio [OR] = 0.29; 95% Confidence Interval [CI] 0.05-1.58). ⁵⁰
Number of occupants in the vehicles	Children were found to be improperly restrained with an increase in the number of occupants in cars (t ² = 17.10, p < 0.000). ⁴⁴
Length of trips	Taking short trips was one of the most common responses from parents among the reasons for non-use of any CRS, with a 16% higher likelihood of improperly restraining children during short trips. ^{47,48,56}

Vehicle size/space limitations and compatibility with CRS	Smaller vehicle size and older vehicles not compatible with booster seats were reported to be reasons for the non-use of CRS. ^{47-49,51,53}
Cultural and social norms	CRS use was influenced by family members' and close friends' opinions. ⁵¹



Aim of the Review

While several studies have explored the effectiveness of interventions that have improved CRS use, there is a lack of scoping reviews synthesizing evidence from studies that have been conducted worldwide, including all income settings, genders, and study designs. This review provides an update on a) the evidence of effectiveness of different types of interventions—namely, legislation, enforcement, and educational interventions, targeted at increasing CRS use, appropriate use and/or reducing fatalities and/or injuries among children, and b) recommendations to improve CRS use.



Summary of Evidence

Below is a summary of evidence on CRS use interventions collated in this review. Although the review attempted to capture studies from high and low-income settings, most of the evidence found was from high-income countries while evidence from low- and middle-income countries was scarce.

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
Legislation alone		
CRS laws ^{1-3,46,60-62}	<p>Effective – reduced fatalities and injuries and increased CRS use^{1-3,46,60-62}</p> <p>Partially effective – increased appropriate CRS use³</p>	<p>Evidence from United States:</p> <ul style="list-style-type: none"> • CRS use increased only for children 1 year old and under. For older children, there was increase in CRS use but not proper use.⁴⁶ • Motor vehicle collision fatalities decreased by 39% among infants and 30% among toddlers.¹ • More children were sitting in rear seats and were properly restrained.⁶⁰ • A 33% reduction in motor vehicle crash fatality rates, a 13% reduction in nonfatal injury rates for children under age 5, and increased CRS use were observed.² • Significant improvement in appropriate booster seat use was observed among 4- to 8-year-old passengers after implementation of a CRS law with requirements for booster seat use (39%), compared with use before implementation (29%). There was no improvement in the rate of appropriate CRS use for younger children (<4 years of age) after implementation.³

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
		<ul style="list-style-type: none"> The crude rate of hospitalization for all injuries following the implementation of the CRS law was 50% lower than the rate expected had pre-1982 trends continued. Rates for head and extremity injuries were 40% lower than expected. The rate for all injuries combined declined by 36%, when adjusted for vehicle crashes.⁶¹ <p>Evidence from Canada:</p> <ul style="list-style-type: none"> Provinces with new child safety seat legislation that included the use of booster seats in 4- to 8-year-old children had the highest rate of correct seat use.⁶²
<p>Booster seat laws^{4,17,63, 64}</p>	<p>Effective – more descriptive legislation led to increased compliance with enforcement, reduced injuries¹⁷ and fatalities,⁶³ and increased booster seat use and sitting in the rear seat.¹⁷</p>	<p>Evidence from Canada:</p> <ul style="list-style-type: none"> Using injury rates in children ages 9 to 14 years as controls, a 11% (95% CI, 2.70-18.90 reduction in the rate of injuries in children ages 4 to 8 years was found ($p = 0.010$). This is equivalent to a decrease of 14.30 injuries per 1,000,000 children per month.¹⁷ The monthly injury rate among children ages 0 to 3 years decreased by 13% (95% CI, 1.50-24.60 [9.80 injuries per 1,000,000 children per month]; $p = 0.030$).¹⁷ The results also show that the percentage of children ages 4 to 8 years involved in a police-reported motor vehicle collision who were using a booster seat gradually increased from 11% in 2000 to 35% in 2008.¹⁷ Between 2000 and 2008, the percentage of 4- to 8-year-olds sitting in the rear seat gradually increased from 65% in 2000 to 80% in 2008.¹⁷ <p>Evidence from United States:</p> <ul style="list-style-type: none"> Children ages 4 to 7 years in states with booster seat laws were, overall, 39% more likely to be reported as appropriately restrained in crashes than were children in other states (Prevalence Ratio [PR] = 1.39; 95% CI, 1.14-1.70). Considering differences by type of law, appropriate CRS use was 28% higher in states with a law for 4- to 5-year-olds only (PR = 1.28; 95% CI, 1.00-1.66) and 55% higher in states with a law for 4- to 7-year-olds (PR = 1.55; 95% CI, 1.19-2.05) than in states with no law.⁴ The booster seat law caused a significant reduction (OR = 0.80) in fatalities among children ages 4 to 8 years involved in a frontal motor vehicle collision. Results suggest that, with booster seat legislation, children are more likely to be restrained at all, and much more likely to be correctly restrained in a CRS.⁶³ There was little change in overall CRS use among booster seat-age children in crashes, but there was a three-fold increase in CRS use (including harnessed CRS, high-back booster seats, and backless booster seats) associated with CRS law changes.⁶⁴

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
Booster seat laws (continued) ⁵⁰	Partially effective – only shown to be effective in certain populations (white children) and higher-income neighborhoods; some increase observed in booster seat use and correct use ⁵⁰	Evidence from United States: <ul style="list-style-type: none"> • Overall, children ages 4 to 7 years showed some improvement in the use of booster seats following the implementation of the legislation. From the year before implementation to after implementation of the law, the use of booster seats increased from 24% to 43%, with a peak of 51% immediately post-legislation (CochraneArmitage trend test, $p = 0.010$).⁵⁰ • Most of the improvement occurred among white children who had booster seat use rates of 56% in the pre-implementation period and 83% after the law was implemented, and proper use rates of 48% before implementation, which rose to 68% following implementation of the law (CochraneArmitage trend test; $p = 0.020$).⁵⁰ • Proper booster seat use increased slightly following the legislation, with proper use increasing from 21% in the pre-implementation period to 28% in the post-implementation period (CochraneArmitage trend test, $p = 0.050$).⁵⁰ • The percentage of children improperly restrained increased (from 4% to 15%) as the percentage of unrestrained children decreased from (76% to 57%) between the pre- and post-implementation periods.⁵⁰
Seat-belt laws ⁶⁵	Partially effective – increased the use of CRS temporarily, but this impact was not sustained; ⁶⁵ reduced injuries only in children ages 10 to 14 years ⁶⁶	Evidence from Canada: <ul style="list-style-type: none"> • Seat-belt laws increased seat-belt use by adults Simultaneously, among children ages 0 to 11 years, CRS use increased in the first three years but remained stable thereafter.⁶⁵ Evidence from the United Kingdom: <ul style="list-style-type: none"> • Seat-belt laws reduced injuries only in children ages 10 to 14 years sitting in the front seat.⁶⁶
Legislation combined with other interventions		
Child Restraint Legislation (CRL) Reform + media and awareness campaign ²⁰	Partially effective – effectiveness decreased over time in the absence of consistent police enforcement.	Evidence from Serbia: <ul style="list-style-type: none"> • The introduction of the CRL produced an immediate effect rather than a sustained effect over time.²⁰ • The relative success of the CRL was aided by a media and an educational campaign stressing the need to properly use and install CRS. The campaign, “Attention Now,” which promoted this law and provided and installed these devices.²⁰ • In the absence of consistent police enforcement, the law only had limited effects. It remained relatively remote to the thoughts, behaviors, and norms of drivers who transport children under age 3.²⁰
CRS legislation + public information and education program ⁶⁷	Effective – decreased injuries from crashes ⁶⁷	Evidence from United States: There was a 25% decrease in the number of children under age 4 injured in crashes, associated with the law. ⁶⁷

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
CRS legislation + enforcement ²⁴	Effective – increased CRS use ²⁴	<p>Evidence from United States:</p> <ul style="list-style-type: none"> • Average levels of CRS use for all children under age 5 increased in four of the five states (West Virginia, Kansas, Virginia, and Illinois) in which interventions occurred during this study.²⁴ • Correlations between the number of citations issued and compliance levels suggest that the greater the enforcement effort, the higher the compliance.²⁴
CRS legislation + enforcement + public education campaigns	Effective – increased appropriate use of CRS ⁵	<p>Evidence from Australia:</p> <p>After controlling for child's age, parental income, language spoken at home, and adjusting for clustering, the odds of children being appropriately restrained post-legislation were 2.30 times higher than in the pre-legislation sample, and the odds of them being correctly restrained were 1.60 times greater. Among 4–5-year-old children, substantially fewer children were using adult seat-belts and more children were using forward facing CRS and boosters, post-legislation. The change in CRS use reported here likely demonstrates the effect of the legislation, enforcement, and public education campaigns accompanying introduction of new legislation, in the short term.⁵</p>
National CRS legislation along with long term programs (e.g., distribution of free CRS for children ages 0 to 9 months and provision of information around car safety for 5 years) promoting CRS use ⁶	Effective – decreased fatalities and hospitalizations with injuries ⁶	<p>Evidence from Sweden:</p> <ul style="list-style-type: none"> • There was a 76% decrease in fatalities over a 27-year period (1970-1996), and a 22% decrease in hospital care due to childhood injuries related to motor-vehicle crashes over a 19-year period (1978-1996).⁶
CRS and seat-belt laws with primary enforcement ⁶⁸	Effective – reduced hospital discharge rates ⁶⁸	<p>Evidence from United States:</p> <ul style="list-style-type: none"> • Enforcement of laws significantly reduced hospital discharge rates for Navajo children injured in motor vehicle crashes; the proportion of children discharged with more severe injuries (NISS >4) significantly decreased for Navajo children under age 5.⁶⁸

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
Education combined with other interventions		
<p>Education for drivers + enforcement and press/ media coverage of enforcement (e.g., number of tickets and warnings given)^{7,39}</p>	<p>Effective – increased CRS use^{7,39} and proper use³⁹</p>	<p>Evidence from United States:</p> <ul style="list-style-type: none"> • CRS law enforcement significantly improved toddler CRS use and proper use. Press coverage on enforcement may have been instrumental in increasing perception of enforcement, maybe even more important than the enforcement activities themselves. Education improved drivers' knowledge of proper use of child safety seats.³⁹ <p>Evidence from a systematic review:</p> <ul style="list-style-type: none"> • There was a 10% increase in the use of toddler CRS for children ages 1 to 5 years and a 13% increase in observed booster seat use from baseline to post-campaign. CRS use in rear seats in children ages 0 to 15 years increased by 8%; while there was a 50% increase in CRS use in pre-school aged children in a high-risk community and a 44% increase in children ages 5 to 11 years.⁷
<p>Education with distribution of CRS^{10,14,34,69}/ discounted coupons for CRS,⁸ and demonstration of correct use and car seat checks^{9,70-72}</p>	<p>Effective (may also be cost-effective with distribution of CRS)</p>	<p>Evidence from United States:</p> <ul style="list-style-type: none"> • Prevalence of booster seat use in intervention communities was 13% at baseline and rose to 26% at follow-up.⁸ • There was an improvement in CRS use, decline in injury claims, and increased possession of CRS.¹⁴ • From a societal perspective, a CRS disbursement program is projected to reduce crash-related costs of a cohort of 100 000 low-income children by over \$23 million (discounted).⁶⁹ • The largest effect sizes were seen among the trials that included a safety seat distribution program through a reduced-cost loan or giveaway program.⁷⁰ • There was a 72% reduction in unrestrained children, a 25% increase in children being secured in the rear-seat position, and a nearly 20% increase in driver restraint use.⁹ • Correct usage rates were above 90% at hospital discharge and maintained usage was more than 80% for one full year.¹⁰ • Project and comparison schools started at the same level of proper booster seat use (project group at baseline = 4.8%, comparison group at baseline = 4.7%; OR = 1.00; 95% CI, 0.80-1.30; p = not significant). In the 8 project schools, booster seat use for children ages 4 to 7 years increased an average of 20.90 percentage points between the baseline and follow-up rounds (baseline = 5%, follow-up = 26%; OR = 6.90; 95% CI, 5.50-8.70). For each separate year of the project, the increase in booster seat use in the follow-up period was statistically significantly higher than the baseline rate of booster seat use, and significantly higher than the comparison schools.

INTERVENTION	EFFECTIVENESS*	EVIDENCE OF EFFECTIVENESS
Education+ distribution of CRS and child passenger safety (CPS) technician certification training ⁵³	Effective	<ul style="list-style-type: none"> The multivariable analysis also showed a significant increase in booster seat use within project schools between baseline and follow-up (OR = 2.70; 95% CI, 2.30-3.10). The multivariable analysis within the comparison schools was not significant (OR = 1.00; 95% CI, 0.90-1.10).⁷² <p>Evidence from New Zealand:</p> <ul style="list-style-type: none"> A rental scheme was found to be particularly effective for infants.⁷³ <p>Evidence from United States:</p> <ul style="list-style-type: none"> Children were 2.50 times (OR = 2.55, p = <0.010) as likely to be observed in CRS, with the most conservative model showing that the odds of children being observed in CRS were 74% higher (OR = 1.74, p = <0.010) after implementation of the program.⁵³

*Interventions were classified as “Effective” if outcomes such as increased CRS use, appropriate CRS use, decreased fatalities and/or injuries, and increased rear seat use were met. “Partially effective” indicates that the intervention(s) yielded positive outcomes but were not sustained or were seen in subgroups or specific locations only.

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