

# Child motor vehicle occupant and pedestrian casualties before and after enactment of Child Restraint Seats Legislation in Japan

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## Abstract

**Problem.** Prevention of injuries to child passengers is a significant public health priority, as motor vehicle-related injuries remain a leading cause of death for children in Japan. The purpose of compulsory child restraint seats legislation in April 2000 was to reduce the number of child passengers killed or injured in motor vehicle crashes.

**Methods.** The objectives of this preliminary evaluation are to measure the effectiveness, benefits and usage of safety seats for child passengers aged 1–5 years by analysing the child casualty data for the period of 1997–2002. Population and vehicle miles travelled based injury and fatality rates were used to compare before and after legislation trends in child casualties.

**Results.** Despite overall increases in the use of child restraint seats (as observed by different national surveys), overall casualty rates in motor vehicle occupants in the 1–5 year age group did not change (fatalities and serious injuries) or even increased (minor injuries).

**Conclusions.** Casualties among restrained children have not decreased since the law came to effect in the year 2000, perhaps because of incorrect usage of the seats. Given that exposure to crash environments is increasing, traffic safety advocates and public health community need to be aware of the importance of child restraints as a means of reducing the likelihood of injury. It is necessary to implement effective community-based child safety seat campaigns to disseminate the information on appropriate restraint use and to increase efforts to enforce the existing legislation.

**Keywords:** Child restraint seats; motor vehicle occupant casualties; pedestrian casualties; enforcement; education; crash exposure; vehicle miles travelled.

## Introduction

Injuries claim more children's lives than birth defects, cancer and infectious diseases combined and have evolved into the number one cause of death and disability among children. For example, the injury mortality rate in Japan ranked first in the age group of 1–9 years. According to the vital statistics in 2000, injuries caused by motor vehicle crashes ranked as the second leading cause of hospitalization among children aged 1–14 years in Japan.

The public health significance of child injuries caused by motor vehicle crashes has not been adequately appreciated in Japan, despite the fact that from January 1991 to December 2002 there were 3582 motor vehicle crash-related fatalities and 552,794 motor vehicle crash-related injuries involving children aged 0–5 years in that country. The high incidence of death and injury from motor vehicle accidents is now taken for granted and becomes a matter for public debate only when especially serious or horrifying incidents occur.<sup>1</sup> Despite significant advances in automobile protection over the past three decades, motor vehicle-related injuries remain a leading cause of death for children.<sup>2</sup>

At the start of the 21st century injury prevention in most countries (including industrialized ones) is poorly targeted, inadequately funded and, in particular, seldom evaluated.

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Children continue to die or suffer unnecessarily due to this ignorance and injuries are the leading cause of death to people under the age of 24 years in over half of the countries worldwide.<sup>3</sup> Recognizing the challenge of road deaths specifically, the World Health Organization (WHO) has designated World Health Day in 2004 with the theme of 'safe roads'.<sup>4</sup>

International research and experience have shown that the use of child restraint seats (CRS) significantly reduces the risk and severity of injury and the number of deaths resulting from vehicle crashes. In a systematic review of the literature, it was concluded that the accumulation of positive findings in CRS provides support for the proposition that proper use of CRS is capable of reducing the extent of child morbidity and mortality on the highway.<sup>5</sup> Moreover, CRS laws and enhanced enforcement programmes have been identified in the literature as 'strongly recommended' interventions based on their effectiveness in reducing fatal and non-fatal injuries and increasing child safety seat use.

In other motorized countries, usage of CRS is widely prevalent and child passenger safety has long been a priority in national and state injury prevention programmes. Japanese policymakers and parents have poor awareness of the safety benefits of proper use of the child restraints. A survey carried out by the Japan Automobile Federation (JAF) in 1998 revealed that only 8.5% of the parents used CRS with their children.<sup>6</sup>

In 1978, Tennessee became the first state in the USA to implement a law requiring restraint of children in motor vehicles. By 1985, all 50 states and the District of Columbia had such mandatory-use laws in effect.<sup>7</sup> Since April 2000, the law in Japan has required that children 0–5 years old riding in automobiles must be restrained in a safety seat, although infants younger than 1 year and infants who weigh less than 20–22 lbs are covered by different restraint guidelines (see below). Literature supports legislative changes as the most effective and immediate means of increasing the use of CRS.<sup>8–12</sup> Therefore this intervention is expected to increase child passenger protection in motor vehicle accidents in

Japan.<sup>13</sup> The objective of this preliminary evaluation is to investigate the effect of legislation on casualties among child passengers aged 1–5 years in Japan.

## Materials and methods

Leading causes of death in the year 2000 among children 0–9 years old has been obtained from the Vital Statistics-Ministry of Health and Welfare in Japan,<sup>14</sup> (Table 1).

This study utilized the traffic accident database maintained by the Traffic Bureau of National Police Agency and the Institute for Traffic Accident Research and Data Analysis (ITARDA).<sup>15</sup> ITARDA (2002) summarizes both fatalities and injuries based on statistics prepared by the National Police Agency. This database consists of all reported traffic crashes and fatalities that have occurred since 1980. Data on fatalities, serious injuries and minor injuries of vehicle occupants and pedestrians aged 1–5 years old were obtained from the ITARDA database. Real world road crash data are unbiased indicators of traffic safety and are used in this study to investigate child injuries and fatalities in Japan.

Analyses focused on the vehicle occupant and pedestrian casualties, based on severity (fatal, serious injury, minor injury) and on crash exposure (vehicle miles travelled (VMT)). It is practical to include VMT in the analysis as both pedestrians' and vehicle occupants' crash risks depend on the extent to which registered motor vehicles are actually operated on the public roads. Previous studies have found that VMT has a direct relationship with motor vehicle traffic crashes and casualties among pedestrians and occupants.<sup>16,17</sup> Crash severity was classified based on police officer reports of injury to occupants and reflects the most severe injury to any occupant involved in the crash. In Japan, injuries are coded as fatal, incapacitating injury (hospitalized for 30 or more days for treatment for the crash injury), visible minor injury, possible injury (complaint of pain with no visible injury) or no injury (property damage only). Injury and fatal-

Table 1. Leading causes of death in the year 2000 among children aged 0–9 years.

Age (years)	No.1 cause of death	No.2 cause of death	No.3 cause of death	No.4 cause of death	No.5 cause of death
0	Congenital malfunctions, etc. (36.2%)	Respiratory and cardiovascular disorders (15.7%)	Sudden Infant Death Syndrome (8.3%)	Accidents (5.7%)	Haemorrhagic and haematological disorders (5.4%)
1–4	Accidents (21.4%)	Congenital malfunctions, etc. (17.2%)	Malignant neoplasms (8.1%)	Pneumonia (6.2%)	Heart disease (5.5%)
5–9	Accidents (32.8%)	Malignant neoplasms (8.1%)	Congenital malfunctions, etc. (6.2%)	Benign neoplasms (5.1%)	Heart disease (4.2%)

Source: Vital statistics in Japan.<sup>14</sup>

ity data from children less than 1 year old were excluded from the analysis as transporting children this age requires special child seats and a rear-facing seating position due to their weight and size. Because of their relatively large head size and weak neck musculature, infants up to age 1 year are at particular risk of cervical distraction and dislocation in frontal crashes. For this reason, infants in Japan (0–1 year old) are required to be placed rear-facing until they reach at least 1 year of age and at least 9 kg in weight. Although the police crash report includes information on property damage crashes and possible injury crashes, this information was omitted from the study data because of its limited usefulness and great potential for serious biases.

To compute rates, 1997–2002 population estimates for 1–5 year olds were obtained from Vital Statistics. Annual VMT data for 1997–2002 were extracted from the ITARDA annual road traffic statistics files. For the analyses reported herein, we compared 1–5-year-old vehicle occupant casualty rates with pedestrian casualty rates between 1997–1999 and 2000–2002. To facilitate comparisons with studies of other traffic safety evaluation studies, we conducted analyses similar to those used in other North American jurisdictions.<sup>18,19,20</sup> Crash rates based on age-specific populations were computed to adjust for changes in population size over the years 1997–2002. It is also important to consider whether changes in casualties among 1–5-year-old may have been due to general trends in crash likelihood rather than to the legislative intervention in April 2000. As a control for these general crash trends, we compared vehicle occupant crash rates with pedestrian casualties, which would not have been

affected by compulsory CRS legislation in April 2000 but would have been influenced by other factors that may have affected crash rates or crash severity in the period under consideration (e.g., economic factors, special traffic safety initiatives or varying levels of enforcement).

To estimate the crude change in crash risks between 1997–1999 and 2000–2002 among Japanese 1–5-year-olds, relative risk (RR) and a 95% CI for each 3 year period before and after intervention were computed, and the crash rates after CRS legislation implementation were compared with the crash rates before CRS legislation. Analyses were conducted using SPSS. Casualty rates per 100,000 population and per 100,000 VMT were used to control for changes in the size of the population and crash exposure. Estimated rates of 1–5-year-old vehicle occupant and pedestrian casualties before and after the introduction of CRS legislation are presented in Tables 2, 3 and 4.

## Results

Chi squared goodness of fit tests were conducted to test the hypothesis that after the enactment of the CRS law, rates of fatalities, serious injuries and minor injuries among passengers in the 1–5-year age group would be reduced. Contrary to our hypothesis, the population- and VMT-based rates of fatalities and serious injuries in this group did not change significantly from the period before the intervention (1997 to 1999) to the period after the intervention (2000 to 2002;  $p > 0.05$ ). Moreover, the rates of minor injuries, both population- and VMT-based, *increased* significantly from before the

Table 2. Population (per 100,000 children aged 1–5 years) and vehicle miles travelled (VMT) (per 100,000 VMT) based estimates for fatality rates before and after child restraint seat law in Japan.

Category	Period	Rates	Relative Risk	95% CI
Occupants Population – based estimates	1997–1999	0.22	1.60	0.00–3.29
	2000–2002	0.35		
Pedestrians Population – based estimates	1997–1999	2.69	0.83	0.14–4.91
	2000–2002	2.25		
Occupants VMT-based estimates	1997–1999	0.07	1.42	0.00–2.23
	2000–2002	0.10		
Pedestrians VMT-based estimates	1997–1999	0.83	0.79	0.03–2.01
	2000–2002	0.66		

Source: Institute for Traffic Accident Research and Data Analysis.

*Table 3.* Population (per 100,000 children aged 1–5 years) and vehicle miles travelled (VMT) (per 100,000 VMT) based estimates for serious injury rates before and after child restraint seat law in Japan.

Category	Period	Rates	Relative Risk	95% CI
Occupants Population – based estimates	1997–1999	8.41	1.43	0.59–3.46
	2000–2002	12.10		
Pedestrians Population – based estimates	1997–1999	34.34	0.88	0.54–1.44
	2000–2002	30.48		
Occupants VMT-based estimates	1997–1999	2.62	1.37	0.28–6.75
	2000–2002	3.60		
Pedestrians VMT-based estimates	1997–1999	10.60	0.85	0.35–2.07
	2000–2002	9.05		

Source: Institute for Traffic Accident Research and Data Analysis.

*Table 4.* Population (per 100,000 children aged 1–5 years) and vehicle miles travelled (VMT) (per 100,000 VMT) based estimates for minor injury rates before and after child restraint seat law in Japan.

Category	Period	Rates	RR	95% CI
Occupants Population – based estimates	1997–1999	396.31	1.28	1.12–1.46
	2000–2002	508.43		
Pedestrians Population – based estimates	1997–1999	237.80	0.90	0.75–1.09
	2000–2002	215.70		
Occupants VMT-based estimates	1997–1999	123.35	1.22	0.96–1.55
	2000–2002	151.04		
Pedestrians VMT-based estimates	1997–1999	74.00	0.86	0.62–1.21
	2000–2002	64.10		

Source: Institute for Traffic Accident Research and Data Analysis.

intervention to after the intervention (population-based  $\chi^2 = 31.8$ ,  $p < 0.001$ ; VMT-based  $\chi^2 = 6.22$ ,  $p < 0.025$ ).

We also hypothesized that any measured statistical improvement in driving safety of CRS use and child passenger safety after the law would not enhance the traffic safety

benefits of pedestrians in a similar manner. This hypothesis was supported in that the 1–5 year age group pedestrian casualty rates (including fatalities, serious injuries and minor injuries), based on population size and VMT, did not change significantly from before to after the intervention ( $p > 0.05$ ).

## Discussion

These analyses suggest mixed results of the CRS legislation of April 2000. Population- and VMT-based fatality and injury rates reveal that the CRS law in Japan did not result in a statistically significant reduction in child casualties, at least in the relatively short time-frame examined. In fact, minor injury rates among child passengers actually increased following the legislation. This finding may be attributable to incorrect usage of CRS.

The introduction of compulsory CRS resulted in an increase in CRS usage rates from approximately 8% in 1998 to 60% by 2000.<sup>21</sup> However, many national surveys have found high levels of incorrect use of CRS and it is generally believed that this incorrect use is the major factor limiting the effectiveness and benefits of CRS in Japan, a situation that has also been observed in other countries.<sup>22</sup> For example, the most detailed national sample survey on CRS use in 2001, conducted by the National Police Agency (NPA), found that even though the usage rate had increased by up to 60% since the enactment of CRS law, only 60% of users properly installed the CRS. Similarly, a recent national observational study, jointly conducted by the NPA and the JAF, found that seven out of ten CRS were loosely fitted.<sup>23,24</sup> Loose fit of the CRS to the vehicle or the child to the harness system results in excessive forward movement of the head and upperbody and potential submarining. Head and neck injuries are among the most serious injuries that may result.<sup>22</sup>

The media reported that this shows both the lack of educational campaigns on the appropriate use of CRS and the under-enforcement of the legislation by law enforcement authorities.<sup>21</sup> Furthermore, international evidence shows that the combination of enforcement and the governments' educational and promotional activities in child passenger safety seats is among the most effective means of increasing usage of safety seats.<sup>5</sup> As the media reported an absence of enforcement, usage rates slowly dropped from 65.4% in 2000 to 51.7% in 2003.<sup>21,23,24</sup> CRS is one of the most effective and beneficial auto safety devices currently in use,<sup>5,9,12</sup> but there is still much room for increased benefits, as only about half of child passengers are using the seats and fewer than half of the seats are being correctly used.

Thus, despite overall increases in the use of CRS, casualties among restrained children have not decreased or have even increased. Given that exposure to crash environments is increasing, traffic safety advocates need to be aware of the importance of appropriately used child restraints as a means of reducing the likelihood of injury. These data may be useful to policy-makers and educators in efforts to target new interventions designed to increase appropriate CRS use in these children. In addition, this information would be of use to public health professionals and policy-makers to justify or target efforts to increase appropriate use of CRS. It is necessary to implement extensive community-based child safety seat campaigns to disseminate the information on appropriate restraint use.

In Japan, the use of child safety seats (approximately 50%) is still low compared to the use of adult seat belts, which is estimated to be as high as 80–90%.<sup>25</sup> Increasing proper CRS usage rates requires a coordinated approach involving educational and enforcement measures. The aim is to encourage CRS use by ensuring that road users are well informed and educated about the safety benefits of using such devices.<sup>4,9,12</sup>

Recent studies have shown that traffic law enforcement could yield more net savings and could also be revenue neutral if designed efficiently. These studies have empirically endorsed extensive traffic enforcement as the most promising traffic casualty reduction strategy presently in use and suggest that it has potential indirect effects on certain types of criminal activity prevention and control.<sup>26,27</sup> By contrast, the same studies show that inconsistent enforcement may increase the traffic-related casualty rates. The general deterrence model suggests that the effectiveness of a legal threat is a function of the perceived certainty, severity and rapidity of the punishment in the event of a violation of the law.<sup>28</sup> However, the legal system in Japan is currently overburdened by rising serious crime rates, such that it is barely able to handle existing prosecution requirements and often hesitant to encourage enforcement efforts that have the potential to further increase the prosecution burden. Therefore, it should be noted that enforcement should not be treated as the sole means of increasing CRS usage rates. Rather, enforcement strategies should be reinforced by appropriate public information campaigns that address the child health benefits of correct use of CRS.

Due to prevalent CRS misuse in the USA, the National Highway Traffic Safety Administration mandated the installation of a designated child restraint anchorage system in all passenger vehicles in 2002.<sup>22</sup> This system eliminates the need for the installation of CRS with safety belts. Rather, all passenger vehicles will be equipped with top and lower anchors to which CRS can be attached in a simple, uniform way. This new child restraint anchorage system promises to greatly reduce misuse related to the attachment of CRS to the vehicle. Therefore, installation of a designated child restraint anchorage in future vehicles in Japan and in other countries would be helpful in minimizing the inappropriate use of CRS. Further advances in reducing CRS misuse could be achieved by reducing the complexity of proper harness strap use.

Present CRS legislation in Japan has no strict requirements or penalties and more strict legislation may also help to reduce CRS misuse. The fine is usually very low (one demerit point and no monetary fine for this offence) and the administrative tasks associated with processing CRS law violation are often viewed as being more time-consuming than the nature of the offence warrants. Consistent with the principles of the deterrence model, one recent empirical study showed that a traffic offender conviction with two or three penalty points accrued more traffic safety benefits than no demerit points for the offences.<sup>26</sup>

CRS, particularly in Japan, is currently sold for a high cost of around US\$400. Clearly, a government subsidy would be necessary to reduce this price. This process would be expensive, but when viewed against the huge public health and traffic safety benefits that would ultimately result from such a subsidy, in the long-term it would be cost-effective. In 1982–1984, the Swedish government introduced a routine childhood car seat lending scheme. After introducing this scheme, it was found that 67% of the children used car seats on short trips and 73% on long trips, which subsequently led to a decrease in childhood injuries.<sup>29</sup>

The results of the analyses provide no evidence that the child restraint policy in April 2000 reduced the number of child motor traffic casualties. Traffic rules are of little value unless the majority of road users comply with them willingly and there should be adequate means to penalize the minority who do not comply.<sup>28</sup> Further reductions in child casualties will require more effective enforcement by the government and programmes designed to increase the education and motivation of parents to use child safety seats and safety belts.

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