Compulsory child restraint seat law and motor vehicle child occupant deaths and injuries in Japan 1994-2005

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The purpose of child restraint seats (CRS) is to reduce the number of individuals killed or injured in motor vehicle (MV) crashes. Japanese Road Traffic Law 17–3-4 (April 2000) specifies a requirement that CRS be used for all children aged 0–5 years. The objective of this evaluation was to determine the legislative impact on fatalities in Japan for the period 1994–2005. Data were obtained from the Institute for Traffic Accident Research and Data Analysis. A time-series Poisson regression model was used to analyse the change (6 years pre/post) in incidence rate ratios of fatality and injury in MV crashes among children ages 0–5 years. Despite increases in CRS use, fatalities failed to decrease significantly after enactment of the law (incidence rate ratio: 0.80; 95% CI: 0.49–1.31). In 2005, 67% of children aged 0–5 years, who were killed as MV occupants were not seated in CRS. Between 2000 and 2005, the lack of CRS led to 43% of front seat passenger deaths, 54% of rear seat deaths, 143 children died in total and 500+ children were seriously injured. It was found that the compulsory CRS law enacted in April 2000 did not result in a statistically significant reduction in child MV occupant fatalities and injuries in Japan.

\textbf{Keywords:} legislation; CRS; child occupant injuries and fatalities; CRS misuse rate; front seating; time-series Poisson regression model

1. Introduction

International research and experiences have shown that the use of a child restraint seat (CRS) significantly reduces the risk and severity of injury and the number of deaths resulting from motor vehicle crashes (MVC). A systematic review on CRS-related research provides ample evidence in support of the proposition that the proper use of a CRS is capable of reducing the extent of child morbidity and mortality on the highway (Zaza, Sleet, Thompson, Sosin & Bolen, 2001). It has been estimated that if all children were properly restrained, approximately 70 lives would be saved in the USA each year (Pless, 1998).

A crucial step in reducing the risk of childhood injuries as a result of MVC involves encouraging parents to adhere to best practices for the use of a child restraint system (Winston, Durbin, Kallan & Moll, 2000). In the majority of motorised countries, CRS are widely used and child passenger safety has been a priority in national and state injury prevention programmes. However, both Japanese policy makers and Japanese parents have poor awareness and understanding of the safety benefits of the proper use of CRS. A survey conducted by the Japan Automobile Federation (JAF) in 1998 revealed that only 8.5% of children younger than 14 years of age used safety seats (Rowling, 1999).

It is a paradox that preventive efforts are often directed at diseases for which the means of prevention are uncertain, while other conditions (including injuries) for which effective preventive measures are available are often ignored (Pless, 1998). Effective injury prevention requires the unconditional commitment of governments. Taking their lead from Sweden, other countries including North America, Australasia and parts of Europe have recently elevated injury to a more prominent position on their political agendas (Bergman and Rivara, 1991).

Increased attention to evidence-based decision making in public health, as well as a global commitment to the millennium development goals, has generated renewed interest in strengthening child-health epidemiology as a foundation for improved efforts to reduce mortality in children younger than 5 years of age (United Nations, 2001). Since April 2000,
the law in Japan has required that children aged 0–5 years, riding in motor vehicles (MV) must be restrained in a CRS. Literature supports legislative changes as the most effective and immediate means of increasing the use of CRS (Zaza et al., 2001). Consequently, this intervention was expected to increase child passenger protection and reduce child occupant fatalities due to MVC in Japan (Hiroaki, 2002).

The objective of this evaluation was to determine the impact of the compulsory CRS legislation (enacted April 2000) on MV occupant fatalities and injuries in Japan, for children 0–5 years of age, between 1994 and 2005.

2. Methods

2.1. Study population and data

Data for the current study were obtained from the Traffic Crash Database maintained by the Traffic Bureau of the National Police Agency (NPA) and the Institute for Traffic Accident Research and Data Analysis in Japan (Institute for Traffic Accident Research and Data Analysis, 2005). These data summarise fatalities and an injury based on statistics prepared by the NPA, and consists of all reported traffic crashes and fatalities that have occurred in Japan since 1960. This database defines occupant MVC fatality as ‘died within 24 hours as a result of a motor vehicle crash’.

One method for measuring the effectiveness of laws is a time series intervention model (Abraham, 1980; Ross and Klette, 1995). This evaluation presents a quantitative analysis of 0–5 year old child occupant fatal and injury traffic crashes adjusted for time trend. The pre-change period was 6 years prior to enactment of the CRS law. Although the exact date of enactment of the law was 1 April 2000, the pre-change period from 1 January 1994 to 31 December 1999 was established, as the data only provided numbers by calendar year. The post-change period was 6 years after the law was enacted; 1 January 2000 to 31 December 2005. Potential confounding factors were controlled for MVC, including vehicle kilometres travelled (VKMT), number of driver licence holders, vehicle registration and GDP (Statistics Bureau of the Ministry of Internal Affairs and Communications, 2005).

The quality of the analysis was further enhanced by statistical adjustment that controlled for the underlying confounding factors, as these data have been shown to be strongly associated with MVC (Ross, McCleary & Epperlein, 1982; O’Malley and Wagenaar, 1991; Ostrom and Eriksson, 1993; Foss, Feaganes & Rodgman, 2001). The main outcome measure was occupant MVC fatality and injury incidence rate ratios (IRR).

2.2. Analysis

Estimated populations from Japanese census data were used to generate incidence rates (Statistics Bureau, 2005). A time series Poisson regression was used to model the before-to-after change in IRR of fatality and injury in MV crashes among children 0–5 years of age. To control potential confounders, VKMT, number of driver licence holders, vehicle registrations and GDP in Japan were added to the model. STATA SE version 9 was the statistical program used for the analyses and descriptive analyses were also performed.

3. Results

Table 1 indicates the unadjusted IRR of fatality among MV crash occupants. Despite overall increases in the use of CRS (as observed by different national surveys) after enactment of the law, the incidence rate of fatal occupant MVC among 0–5 year olds decreased by 1.05 per 1,000,000; however, the decrease was not statistically significant. Rather, the IRR of injury in MVC increased significantly (IRR 1.58, 95% CI 1.35–1.84).

VKMT, driver licence holders, vehicle registration and GDP were integrated into the Poisson regression model. The mean amounts of these variables after law enactment (2000–2005) were significantly larger ($p < 0.01$) as compared to pre-law (1994–1999).

Table 2 describes the IRR of fatal occupant MVC adjusted for VKMT, number of driver licence holders, vehicle registration and GDP. The IRR of fatality among MV occupants in the 0–5 year age group did not decrease significantly after enactment of the law (IRR 0.80; 95% CI 0.44–1.46). Similarly, the IRR of injury in MVC was not significantly increased (IRR 1.02; 95% CI 0.96–1.09), suggesting that the significant increase of injury in MVC among 0–5 year old children

Table 1. Incidence rate ratio of fatality and injury among motor vehicle crash occupants aged 0–5 years old, unadjusted.

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<tbody>
<tr>
<td>Fatality</td>
<td>5.77</td>
<td>4.72</td>
<td>0.82 (0.65–1.03)</td>
</tr>
<tr>
<td>Injury</td>
<td>115.2</td>
<td>181.8</td>
<td>1.58 (1.35–1.84)</td>
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</tbody>
</table>

<0.001
143 children died in total and 500 front seat passenger deaths, 54% of rear seat deaths. Between 2000 and 2005, the lack of CRS led to 43% of killed as MV occupants were not seated in CRS. In 2005, 67% of children aged 0–5 years, who were MVC among 0–5 year old children, it was found that all the means of these variables after law enactment (i.e. 1994–1999). 

Table 2. Incidence rate ratio of fatality and injury among motor vehicle crash occupants aged 0–5 years old.

<table>
<thead>
<tr>
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<th>Rate per 1,000,000</th>
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</thead>
<tbody>
<tr>
<td>Fatality</td>
<td>5.77</td>
</tr>
<tr>
<td>Injury</td>
<td>115.2</td>
</tr>
</tbody>
</table>

Note: Adjusted for vehicle kilometres travelled, driver licence holders, vehicle registration, gross domestic product.

was confounded by the increase of VKMT, number of driver licence holders, vehicle registration and GDP, as all the means of these variables after law enactment (i.e. during 2000–2005) were larger than before law enactment (i.e. 1994–1999).

In a descriptive analysis on fatal and injury in MVC among 0–5 year old children, it was found that in 2005, 67% of children aged 0–5 years, who were killed as MV occupants were not seated in CRS. Between 2000 and 2005, the lack of CRS led to 43% of front seat passenger deaths, 54% of rear seat deaths, 143 children died in total and 500+ children were seriously injured.

4. Discussion

It was found that the compulsory CRS law enacted in April 2000 did not result in a statistically significant reduction in child MV occupant fatalities and injuries in Japan. The introduction of the compulsory CRS law resulted in an increase in CRS use from approximately 8% in 1998 to 47% by 2004. However, observational studies and MV crash statistics reported high levels of incorrect use of CRS (Desapriya, Pike & Joshi, 2005). A recent national observational survey jointly conducted by the NPA and the JAF found that seven of 10 CRS were loosely fitted (Desapriya et al., 2005).

The rate of CRS use remains at a mere 47% in 2004 (Desapriya et al., 2005) and the rate shows a tendency to decrease as the child’s age increases (Bureau for the Future of Children, 2005). Six years after enactment of the compulsory CRS law in 2006, 86% of child MV occupants in the 0–5 age group who were killed were not restrained in a CRS. Between 2000 and 2006, the lack of use of CRS led to 31.5% of all front seat child passenger deaths and 40.1% of rear seat child passenger deaths, among children aged 0–5 years. During the same period, the deaths of 161 child passengers (younger than 5 years of age) in total were associated with the lack of use of any type of child restraint device (Institute for Traffic Accident Research and Data Analysis, 2006). In addition, more than 500 child MV occupants under the age of 5 years who were seriously injured were not using any type of CRS (Institute for Traffic Accident Research and Data Analysis, 2006).

The present data show that children in Japan continue to ride in the front seat of vehicles without any restraint use, even though traffic safety researchers have known for decades that the rear seat is safer in most crash situations. Child rear seating is a simple, effective method for reducing the risk of crash injury or fatality in a population. A child travelling in the front passenger seat may be dangerously close to the air bag when it inflates. The international research community is well aware of the countless children who are fatally injured due to the impact from front seating and inflated air bags (National Highway Traffic Safety Administration, 2000).

A recent study indicates that sitting in the rear seat offered a significant protective effect (adjusted odds ratio 1.7; 95% CI 1.6–2.0) and restraint use enhanced this effect (adjusted odds ratio 2.7; 95% CI 2.4–3.1) (Berg, Cook, Corneli, Vernon & Dean, 2000). Five recent cross-sectional studies assessing the effect of seating position on injuries all concluded that the rear seat is the safest place for children (Reeve, Zurynski, Elliot & Bilston, 2007). Additional research is required in Japan to better understand the factors and circumstances that influence CRS use and parents’ decisions to restrain their children in the rear seat or the front seat (Glass, Segui-Gomez & Graham, 2000; Towner, Dowswell, Mackereth & Jarvis, 2001). Legislation is one intervention strategy that attempts to alter child-seating patterns. In 1997, the National Transportation Safety Board recommended that each state amend its child passenger safety laws to make child rear seating compulsory (National Transportation Safety Board, 1997).

One simple, low-cost method to improve children’s safety in the vehicle is to restrain them in the rear seat rather than in the front, whenever this is possible (Lennon, 2007). Currently in Japan, there is no law that emphasises rear passenger restraint requirements. The government should enact compulsory restraint laws for rear passengers similar to the restraint laws for drivers and front seat passengers. This lack of emphasis on rear seated passengers is reflected in actual restraint use data in Japan. Drivers and front seated passengers have a greater than 90% restraint usage rate while the rear occupant restraint usage rate is as low as 12% (Lloyd, 2007).

Many factors can be highlighted as possible additional causes for ineffectiveness of CRS legislation.
those killed or seriously injured (Howard, 2002). It is common among vehicle and occupant at the time of the crash. Optimal performance of restraint systems depends on 70% CRS were misused (Desapriya et al., 2005). A recent national observational survey jointly conducted by the NPA and the JAF found that no use of CRS. A recent national observational survey crash data have established high levels of incorrect or high. Observational studies, fatality and serious injury in Japan. CRS legislation has no strict requirements or penalties. 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. In addition, CRS, particularly in Japan, are expensive, at around US$300, and government subsidies may be necessary to facilitate increased CRS purchasing and use. This process would be expensive, but when viewed against greater public health and traffic safety benefits in the long term, it may be economical.

Enforcement of traffic safety laws has been effective in influencing the behaviour of the public in a number of traffic safety areas, including restraint use. A recent NPA survey demonstrated that the public generally agree that it is important to have and to enforce CRS laws (Yamanaka, 1999). International evidence demonstrates that the level of enforcement and educational and promotional activities in child passenger safety seats include a combination of factors that most impact the use of safety seats (Bergman and Rivara, 1991; Pless, 1998; Towner et al., 2001; Zaza et al., 2001). As evident from the results of surveys and traffic crash data in Japan (i.e. high levels of CRS misuse, inappropriate seating position and completely unrestrained child occupant-related casualties are still unacceptably high), education programmes should continue to promote proper use of CRS, occupant restraint laws, enforcement of these laws, availability of CRS inspection stations, loaner programmes and local CRS hotline information assistance (Zaza et al., 2001). Extensive research is required to identify the most effective educational approaches that will enable drivers to understand and focus on the critical issue of CRS misuse. Specifically, efforts to reduce CRS misuses should extend beyond relying on parents and caregivers to read and correctly follow manufacturer’s instructions.

In summary, the results of these analyses provide no statistically significant evidence that the CRS law established in April 2000 in Japan reduced the number of child MV traffic casualties. Despite overall increases in the use of CRS, casualties among restrained and unrestrained child MV occupants are unacceptably high. Observational studies, fatality and serious injury crash data have established high levels of incorrect or no use of CRS. A recent national observational survey jointly conducted by the NPA and the JAF found that 70% CRS were misused (Desapriya et al., 2005). Optimal performance of restraint systems depends on an adequate fit between the restraint system to the vehicle and occupant at the time of the crash. Inappropriate use of child restraints is common among those killed or seriously injured (Howard, 2002). It may be useful to have child safety seat technicians trained and made widely available throughout communities in Japan, where they could be a point of contact when parents and caregivers have questions and concerns about appropriate child restraint use.

These data may be useful to public health professionals, policy-makers and educators in an effort to justify or target new interventions designed to increase appropriate CRS use to benefit children’s safety in Japan.

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