



Current use of safety restraint systems and front seats in Korean children based on the 2008–2015 Korea National Health and Nutrition Examination Survey

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Purpose: The use of proper safety restraint systems by children is vital for the reduction of traffic accident-related injury and death. This study evaluated the rates of use of safety restraint systems and front seats by Korean children.

Methods: Based on data from the National Health and Nutrition Examination Survey from 2008 to 2015, I investigated the frequencies of safety restraint systems and front seat use by children under six and 12 years of age, respectively.

Results: The percentage of respondents who said they always use safety restraint systems increased from 17.7% in 2008 to 45.0% in 2015. The rate of children who did not use the front seats at all was 47.3% in 2008 compared to 33.4% in 2015. Multivariate logistic regression analysis showed a decrease in safety-restraint-system use as age increased (odds ratio, 0.63; 95% confidence interval [CI], 0.51–0.77). The use rate of front-passenger seat belts by the mother is significantly correlated with the safety-restraint-system use rate by children (odds ratio, 2.14; 95% CI, 1.12–4.06).

Conclusion: Although the rate of safety-restraint-system use for children is increasing annually, it remains low. Additionally, the use rate of front passenger seats for children is high. To reduce the rates of injury and death of children from traffic accidents, it is necessary to educate on the appropriate use of safety restraint systems according to age and body size and to develop stronger regulations.

Key words: Child, Child restraint systems, Traffic accidents

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Received: 30 April, 2018
Revised: 17 July, 2018
Accepted: 31 July, 2018

Introduction

Traffic accident is a leading cause of death in children worldwide.^{1,2)} The number of traffic accident deaths in children aged 12 or younger in South Korea dropped from 243 in 2006 to 71 in 2016.³⁾ However, although the number of pedestrian deaths dropped significantly from 176 (72.4%) in 2006 to 36 (50.7%) in 2016, the proportion of car occupant deaths increased from 27.6% (n=67) in 2006 to 49.3% (n=35) in 2016.³⁾

The most effective mean to prevent injury and death in motor vehicles is to wear a seatbelt. However, because seatbelts are designed to fit adults, children must instead use proper age-specific safety restraint systems. According to a 2017 Organization for Economic Co-operation and Development (OECD) report, the rate of child safety-restraint-system use in advanced countries, including the United States and European nations, exceeds 90%, compared with 64.2% Japan.⁴⁾ In South Korea, the rate is significantly lower, at about 9.1%–40.4%, based on data from injured patients admitted to an emergency department.^{5,6)} Although the use of

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safety seat restraints for children aged 6 years or younger became mandatory in South Korea in 2006, the use rate is still low, primarily due to the inexpensive violation fine (60,000 Korean Won [KRW]) and low enforcement rates.

The American Academy of Pediatrics (AAP) recommends that children under 12 years of age not ride in the front seat of a car, and some European countries prohibit children from sitting in the front seat by law.^{7,8)} However, front-seat passenger requirements are not regulated by law in South Korea, and there has been no previous survey of the current status of front passenger seat use in South Korea.

Therefore, this study investigated the use of proper safety seat restraints and front passenger seat use in children in South Korea based on data from the 2008–2015 National Health and Nutrition Examination Survey (KNHANES) and to identify factors associated with the use of safety seat restraints.

Materials and methods

The KNHANES has been implemented since 1998 as a national health and nutrition survey in South Korea. The state examines the health status, health behavior, and food and nutrition status of Koreans. These data are used as basic data in the health policy-making process, such as goal setting and evaluation of the national health promotion plan, and development of health promotion programs. As the subjects are selected using a complex sampling design method based on residence area, these data can be used to produce representative and reliable statistics. This study was approved by the Institutional Review Board of the Kosin University Gospel Hospital (2017-11-032).

This study used data from the fourth (2008–2009), fifth (2010–2012), and sixth (2013–2015) KNHANES conducted by the Korea Centers for Disease Control and Prevention. The use of automobile safety restraint system among 4,204 children aged 1–6 years was investigated using a questionnaire. The responses were classified into always, frequently, occasionally, rarely, never, and no response. I analyzed usage by year, age, and region. Front passenger seat use among 9,621 children aged 1–12 years was investigated using a questionnaire. The responses were classified as always, frequently, occasionally, rarely, and never; responses indicating no automobile experience or no knowledge were classified as no response.

This study was aimed at identifying the factors associated with children who are always seated in safety restraint systems in motor vehicles by analyzing the most recent data (sixth KNHANES; 2013–2015). The association of use of child safety seat restraint with household income, parents' ages, education level, use of a seatbelt when driving, and use of a seatbelt in the front passenger seat was analyzed. Household income was classified as low, middle-low, middle-high, and high with reference to the average

monthly household equivalent income (Monthly household income/ $\sqrt{\text{number of household members}}$). The reference incomes varied by year, but incomes in 2015 were divided into 4 groups as follows: 750 thousand, 1.57 million, and 2.68 million KRW.

The data for this study were extracted via complex stratified sampling and analyzed using weighted values, stratification variables, and clustering variables. Complex sample crosstabs and complex sample logistic regression were performed, with statistical significance set at $P < 0.05$. All statistical analyses were performed using IBM SPSS for Windows, ver. 24.0 (IBM Corp., Armonk, NY, USA).

Results

The percentage of respondents indicating that they always used child safety seat restraints for children under 6 years of age increased from 17.7% in 2008 to 45.0% in 2015, while the percentage of respondents indicating that they never used child safety seat restraints decreased from 60.6% in 2008 to 23.9% in 2015 (Fig. 1).

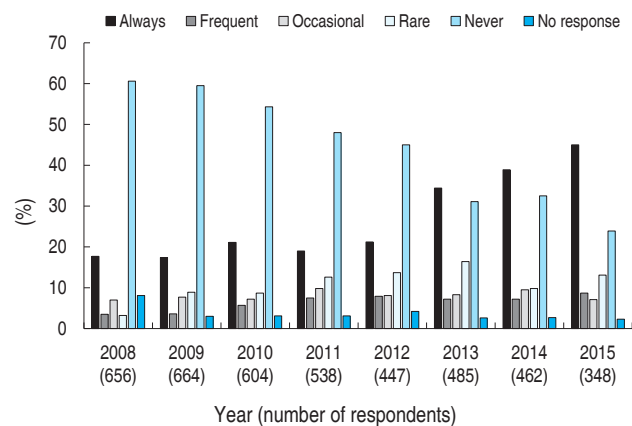


Fig. 1. Frequency of safety-restraint-system use among children under 6 years of age (n=4,204).

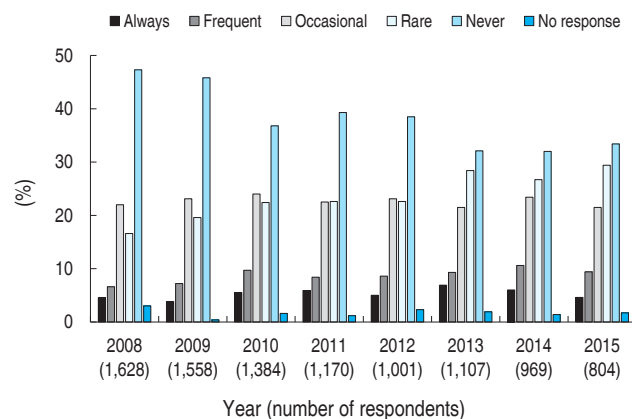


Fig. 2. Frequency of front seat use among children under 12 years of age (n=9,621).

The rate of front passenger seat use in children under the age of 12, excluding cases in which children never or rarely ride in the front seat, was high, at 33.1% in 2008 and 35.5% in 2015 (Fig. 2). The percentage of respondents indicating that they never used the front passenger seat for children dropped from 47.3% in 2008 to 33.4% in 2015. The use of automobile safety restraint systems decreased with age, from 41.7% in 1-year-olds to 12.4% in 5-year-olds; the percentage of respondents indicating that they never used the front passenger seat for children also decreased with age, from 58.8% in 1-year-olds to 28.7% in 11-year-olds (Fig. 3).

By region, the percentage of respondents indicating that they always used child safety seats was highest in Busan and Ulsan (34.5%) and lowest in Jeonnam (12.9%) and Jeju (8.7%) (Fig. 4). In the most recent (2015) data, the percentage of respondents indicating that they always used child safety seats was highest in Ulsan (93.4%) and lowest in Chungbuk (12.2%).

I performed a logistic regression of the factors associated with always using child safety seat restraints in automobiles using data

from the sixth (2013–2015) survey (Table 1). The use rate dropped with advancing age and the use of child automobile safety restraints was higher with increasing household income, among parents with college or postcollege education, parents using seatbelts while driving, and among mothers who used the seatbelt in the front passenger seat. Multiple logistic regression revealed that child age and mothers' use of a seatbelt in the front-passenger seat were the only significant factors.

Discussion

This study examined the use of automobile safety restraint systems and front seats among children in South Korea over the past eight years based on KNHANES data. Although the use of child safety restraint systems increased annually, the rate is still half that in advanced countries, and the number of respondents indicating that they never seated children in the front seat has actually decreased.

In 2011, the AAP recommended five measures to ensure the safety of child passengers: (1) use of rear-facing car seats for children aged 2 years or younger, (2) use of front-facing car seats for children aged 2–4 years, (3) use of booster seats for children aged 4–8 years, (4) use of adult seat belts for children aged 8–12 years with a minimum height of 145 cm, and (5) making children aged 13 years or younger ride in the rear seat.⁷⁾ Furthermore, the AAP also recommends advancing to the next stage in child safety seats only when children meet the maximum weight or height requirements specified by the manufacturer.

Rear-facing car seats are recommended for young children because when seated in front-facing car seats, children's relatively larger heads and weaker neck muscles increase their susceptibility to head and spinal cord injuries from severe neck-bending during a face-to-face collisions.⁹⁾ Front-facing car seats were associated

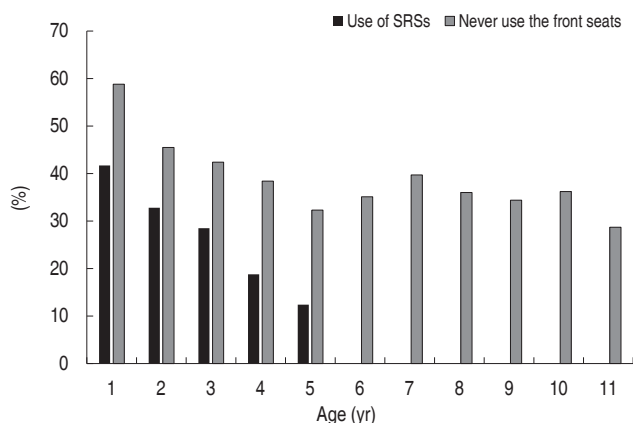


Fig. 3. Percentage, by age, of safety restraint system (SRS) use and those who never-use front seats.

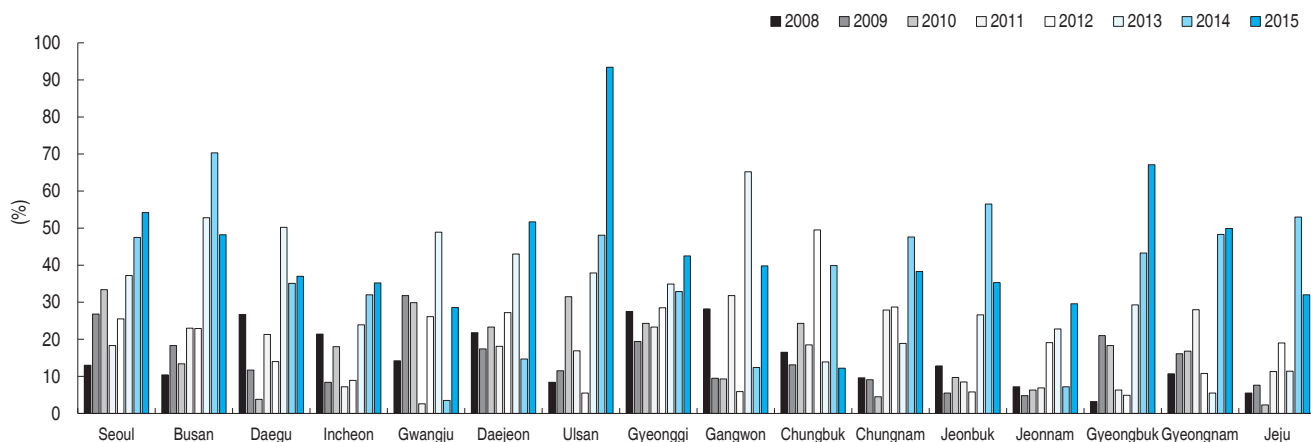


Fig. 4. Rates of safety-restraint-system use among children under 6 years of age by region.

Table 1. Logistic regression analysis of the rates of safety-restraint-system use in children under 6 years of age (2013–2015)

Variable	Always use the SRS (%)	Logistic regression			multivariate logistic regression		
		OR	95% CI	P value	adjusted OR	95% CI	P value
Age		0.66	0.61–0.72	<0.05	0.63	0.51–0.77	<0.05
Household income				<0.05			0.28
Low	20.1	Ref	Ref		Ref	Ref	
Middle-low	33.2	1.97	1.01–3.86		2.36	0.65–8.51	
Middle-high	43.4	3.04	1.57–5.89		3.17	0.92–10.9	
High	49.8	3.95	2.01–7.75		2.36	0.65–8.51	
Age of father (yr)				<0.05			0.06
≤30	28.0	Ref	Ref		Ref	Ref	
30–39	47.0	2.28	1.06–4.88		7.17	0.94–54.7	
≥40	27.0	0.95	0.33–2.66		2.9	0.25–33.35	
Age of mother (yr)				<0.05			<0.05
≤30	34.2	Ref	Ref		Ref	Ref	
30–39	42.7	1.43	0.86–2.38		0.49	0.17–1.41	
≥40	19.5	0.46	0.15–1.36		-	-	
Education level (F)				<0.05			0.94
≤Middle school	18.0	Ref	Ref		Ref	Ref	
High school	26.6	1.65	0.565–4.81		1.21	0.15–9.45	
≥University/college	47.4	4.10	1.45–11.57		1.31	0.17–9.77	
Education level (M)				<0.05			0.50
≤Middle school	11.9	Ref	Ref		Ref	Ref	
High school	26.3	2.64	0.71–9.70		0.47	0.12–1.77	
≥University/college	46.9	6.54	1.87–22.88		0.56	0.14–2.28	
Belt when driving (F)				<0.05			0.26
No	34.2	Ref	Ref		Ref	Ref	
Yes	46.6	1.68	1.18–2.39		1.55	0.71–3.38	
Belt when driving (M)				<0.05			0.72
No	33.9	Ref	Ref		Ref	Ref	
Yes	48.2	1.81	1.12–2.92		1.15	0.50–2.63	
Belt in front seat (F)				0.25			0.45
No	39.2	Ref	Ref		Ref	Ref	
Yes	44.2	1.22	0.86–1.74		0.75	0.36–1.58	
Belt in front seat (M)				<0.05			<0.05
No	30.2	Ref	Ref		Ref	Ref	
Yes	44.7	1.87	1.30–2.68		2.14	1.12–4.06	

SRS, safety-restraint-system; OR, odds ratio, CI, confidence interval; F, father; M, mother.

with a significantly higher odds ratio for severe injury (1.76; range, 1.40–2.20) for all types of collisions compared with rear-facing car seats for children under the age of 2 years.¹⁰ Therefore, parents are recommended to use rear-facing car seats with a maximum weight of 18 kg for children until they reach 2 years of age.

In South Korea, the legal car seat requirement only applies to children aged 6 years or younger. The use of child safety seat restraints for children 5 years of age is very low at about 12.4%. Although the use rate in children aged 6 years and older was not included in this study, it is considered to be lower. The age require-

ment for child safety seats in the United States varies by state but is 8 years of age on average, compared to 12 years of age in the United Kingdom, both of which are higher than Korea's requirements.^{7,11} Furthermore, these countries also specify body size requirements in addition to age restrictions, most of which specify a minimum weight of 36 kg and height of 145 cm.

In a study that compared traffic accident injuries according to the use of safety restraints in children under 8 years of age in South Korea, the rates of head, facial, neck, and abdominal injuries were higher among children who only wore seatbelts compared to those

among children seated in a car seat.⁵⁾ This is attributable to the fact that seatbelts are designed to protect an adult's body by strapping their thighs and chest but pass over the abdomen and neck in children because of their smaller bodies. The present study observed that the use of proper safety restraint systems was lowest in children aged 6–12 years, which suggests the need for active measures to promote the use of booster seats to raise a child's bodies to ensure that the seat belts properly cross the chest and thighs of children in this age group.

In addition, children are the most vulnerable motor vehicle passengers and are thus recommended to be seated in the back seat. This recommendation is substantiated with reports suggesting that riding in the front seat places passengers at an elevated risk of injury from airbags and that the risk of mortality is reduced simply by riding in the rear seat.¹²⁻¹⁴⁾ In the present study, the proportion of respondents indicating that they never used the front passenger seats for children under the age of 12 years decreased from 47.3% in 2008 to 33.4% in 2015. Although most European countries and the United States prohibit children from riding in the front passenger seat, South Korea lacks such legislation as well as an awareness of its importance.

The results of the present study indicated that the use of child safety seat restraints increased with increasing household income, parental education level, and parental use of seatbelts, similar to other domestic study.¹⁵⁾ Particularly, the use of child safety seat restraints was significantly associated with the use of seatbelts in the front passenger seat by mothers. This result suggests that caregiver awareness of seatbelt use had an impact on the use of safety restraint systems for children. A 2017 OECD report revealed that the use of rear seat belts exceeds 70% in most OECD countries but is low in South Korea, at about 30%,⁴⁾ indicating the need for action to promote the use of safety belts among adults.

In this study, the percentage of respondents indicating that they always use child safety restraint systems in motor vehicles has increased from 17.7% in 2008 to 45.0% in 2015. Korean Statistical Office reported that the number of traffic accident deaths per 100,000 populations decreased from 3.9 in 2007 to 1.9 in 2015 among children aged 1–4 years and from 3.5 to 1.5 among children aged 5–9 years.¹⁶⁾ However, the number of deaths among children aged 1–9 years was higher than that among children aged 10–14 years (1.2 per 100,000).¹⁶⁾ In addition, the number of deaths among children younger than 14 years was 1.2 in South Korea, which is higher than the OECD average of 0.9 in 2015.⁴⁾ However, the use rate of child safety restraint systems in South Korea is significantly lower than that in advanced countries, which have a use rate exceeding 90%; furthermore, the use of child safety restraint systems drops substantially in older children, indicating the need for stricter regulations.

A previous study reported that strict legal regulation has the greatest impact in increasing the use of safety seat restraints.¹⁷⁾ In

light of this finding, the Korean government should raise the age requirement for safety restraint systems, specify the appropriate safety restraint systems by age and body size, and enforce meticulous monitoring to boost the use of these safety systems. Specific guidelines such as the AAP guideline are important. A detailed guideline is needed to avoid confusion among subjects and to strengthen effective regulations, such as rear-facing car seats for children up to 1–2 years old, front-facing car seats for children up to 4 years old, and booster seats for children with heights up to 145 cm or ages up to 8–12 years.

This study is meaningful in that it reflects the current nationwide use of seat belts based on the KNHANES data. However, the analysis was performed based on parent reporting, wherein there is a possibility that the data provided may differ from the actual use, and the survey did not assess whether the appropriate type of safety restraint system was being used. Although the rate of child safety-restraint-system use in South Korea is increasing, it is still lower than that in advanced countries, and the use of child safety restraint systems is decreasing with advancing age. Furthermore, the awareness that children should not use the front seats is declining. Thus, education about proper age- and body-specific safety restraint systems and detailed, rigorous legal regulations are needed to reduce injuries and fatalities from traffic accidents among children.

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

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