Effects of tougher school zone laws on road traffic safety in school zones for children in South korea

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Introduction

- This study aimed to evaluate the effectiveness of tougher school zone laws on school-zone-related road traffic outcome (RTO) rates for children aged 0–12 years in Korea.
- RTO = RTO rates were calculated per million vehicles and per million children using data on police-reported road traffic crashes, registered motor vehicles, and registered resident population between 2015 and 2021

Abbreviations

AAPSC	Act on the Aggravated Punishment, etc. Of Specific Crimes
BSTS	Bayesian structural time-series
CITS	controlled interrupted time-series
CrI	credible interval
EF	equivalent fatality
RTA	Road Traffic Act
RTC	road traffic crash
RTD	road traffic death
RTI	road traffic injury
RTO	road traffic outcome
SD	standard deviation

Introduction

- In South Korea, the RTI mortality rate per million children aged 0-14 years fell by 95.3% from 88.3 in 1995 to 4.1 in 2020, reaching about 70% of the average of OECD countries. However, the child pedestrian fatality rate was 2.7 in 2020, the fifth highest among OECD countries.

New school zone laws in South Korea.

Act	Regulation	Before legislation	After legislation
Act on the Aggravated Punishment, etc. Of Specific Crimes (Ministry of Justice, 2019)	Aggravated penalty	None; penalty under the Act on Special Cases Concerning the Settlement of Traffic Accidents,	When a driver violated the duties in school zones to obey the speed limit of 30 km/h or to drive while paying attention to the children's safety
	For RTIs in school zones	Fine: ≤20 million KRW Imprisonment without labor: ≤5 years	Fine: ≥5 million KRW, ≤30 million KRW Imprisonment with labor: ≥1 year, ≤15 years
	For RTDs in school zones	Fine: ≤20 million KRW Imprisonment without labor: ≤5 years	Imprisonment with labor: life imprisonment for an indefinite term or ≥3 years
Road Traffic Act (National Police Agency, 2019)	Management of school zones	None; management under the Rules on Designation and Management of Protection Areas for Children, Senior Citizens, and Persons with Disabilities (Joint Ordinance of the related Ministries), Preferential installation of signal apparatus for a crosswalk on an arterial road in school zones Request by local governments to road management authorities to install safety equipment in school zones	Preferential installation of unmanned traffic regulation equipment on the roads in school zones Preferential installation of safety equipment in school zones or mandatory request by local governments to road management authorities to install safety equipment in school zones - Signal apparatus for a crosswalk on an arterial road which is at the nearest distance to the main entrance of a facility designated as a school zone - Speed restriction signs and crosswalk safety signs - Facilities for preventing overspeeding or slipping of motor vehicles, among road appurtenances - Other facilities or equipment prescribed by the Joint Ordinance of the related Ministries

Material

- Data
  - Between January 2015 and December 2021, the total, school-zone-related, and non-school-zone-related numbers of RTDs, RTIs, and RTCs reported to the police for children aged 0-12 years were obtained monthly according to the type of legal violations from the Police Road Accident Database in the Traffic Accident Analysis System
- Variables
  - EF = number of RTDs + number of server RTIs × 0.1168 + number of mild RTIs × 0.0068 + number of minimal RTDs × 0.0033

Methods

- Statistical analysis
  - The effects of school zone laws on RTO rates were estimated using BSTS models.
  - Convergence of the Markov Chain Monte Carlo algorithms was assessed using visual inspection of trace plots, Heidelberger-Welch Stationarity and halfwidth tests, Geweke tests, and Raftery and Lewi's diagnostics
  - Autocorrelation was checked by the autocorrelation function and partial autocorrelation function plots, Durbin-Watson statistics, and Ljung-Box tests.
  - Precision was evaluated by a one-step mean absolute percentage error.

with different weights: (a) $EF = number\ of\ RTDs + number\ of\ severe\ RTIs \times 0.5 + number\ of\ mild\ RTIs \times 0.3 + number\ of\ minimal\ RTIs \times 0.1$ using the inverse of the equivalent property damage only weights (Cho et al., 2014) and (b) $EF = number\ of\ RTDs + number\ of\ severe\ RTIs \times 15/90 + number\ of\ mild\ RTIs \times 5/90 + number\ of\ minimal\ RTIs \times 2/90$ based on the demerit points (Lee, 2019).

Results

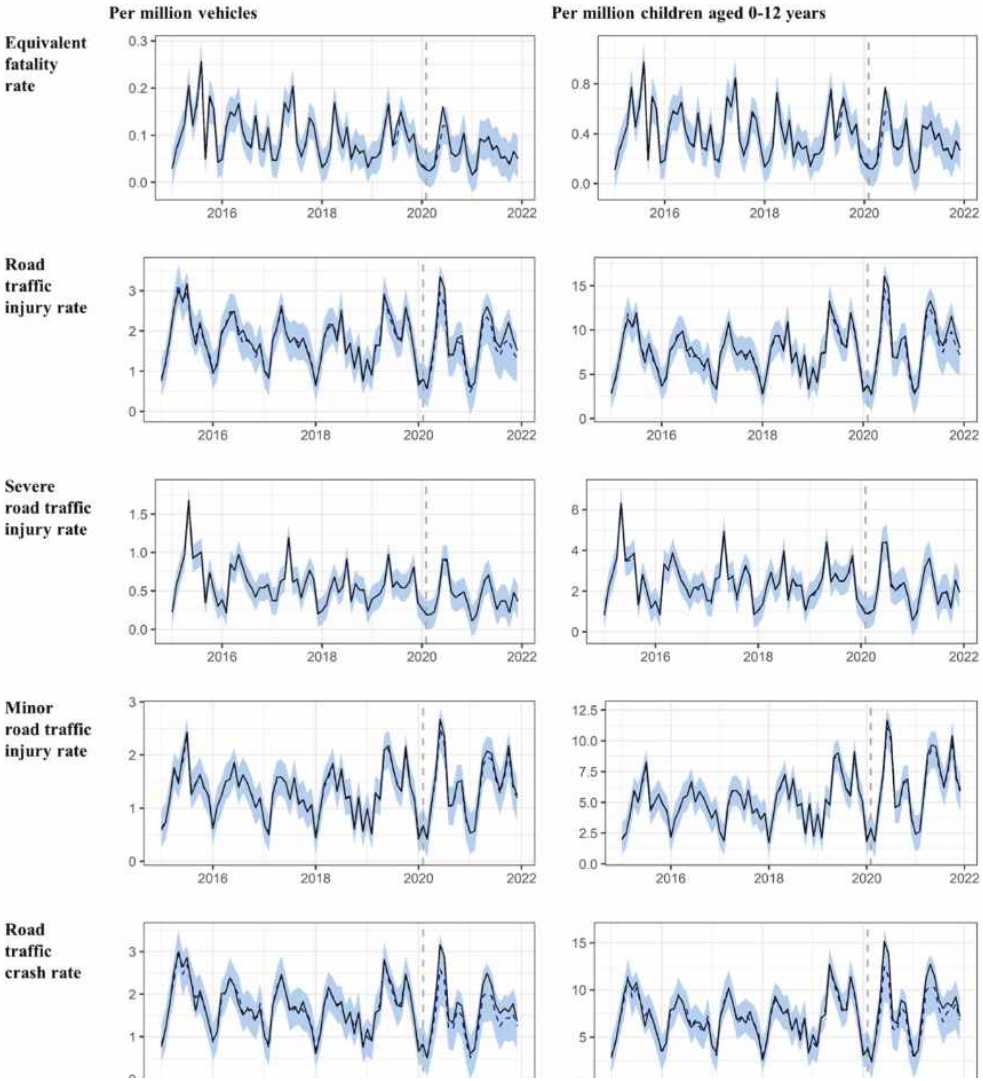
- Although all RTOs in non-school zones were lower in the post-period than the pre-period, there were no consistently significant differences between the pre-period and post-period of RTOs in school zones.

Descriptive statistics based on monthly averages for road traffic outcomes in school zones and non-school zones.

Road traffic outcome	School zones					Non-school zones				
	Pre-period		Post-period		p-value	Pre-period		Post-period		p-value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Number of equivalent fatalities	2.4	1.2	1.8	0.9	0.040	27.3	7.6	16.5	4.6	<0.001
Number of road traffic injuries	42.8	14.4	46.9	19.2	0.300	1100.9	207.3	858.1	168.5	<0.001
Number of severe road traffic injuries	14.3	6.2	11.5	5.6	0.063	151.8	47.5	85.2	28.4	<0.001
Number of minor road traffic injuries	28.5	10.1	35.4	14.6	0.049	949.1	167.3	772.9	142.0	<0.001
Number of road traffic crashes	41.0	13.5	44.0	17.9	0.411	873.3	174.5	687.0	141.1	<0.001
Per million vehicles										
Equivalent fatality rate	0.099	0.051	0.068	0.035	0.003	1.131	0.347	0.620	0.171	<0.001
Road traffic injury rate	1.762	0.604	1.757	0.722	0.973	45.360	9.324	32.148	6.301	<0.001
Severe road traffic injury rate	0.592	0.269	0.431	0.212	0.013	6.285	2.143	3.194	1.071	<0.001
Minor road traffic injury rate	1.170	0.413	1.326	0.548	0.169	39.075	7.409	28.954	5.302	<0.001
Road traffic crash rate	1.686	0.569	1.648	0.675	0.798	35.999	7.853	25.739	5.276	<0.001
Per million children aged 0–12 years										
Equivalent fatality rate	0.409	0.203	0.338	0.169	0.144	4.661	1.230	3.101	0.852	<0.001
Road traffic injury rate	7.333	2.482	8.797	3.573	0.038	188.379	34.710	160.874	31.890	0.002
Severe road traffic injury rate	2.451	1.047	2.151	1.031	0.250	25.894	7.775	15.969	5.281	<0.001
Minor road traffic injury rate	4.882	1.760	6.646	2.743	0.009	162.485	28.418	144.906	27.026	0.014
Road traffic crash rate	7.015	2.327	8.248	3.322	0.061	149.399	29.078	128.815	26.707	0.005

SD: standard deviation.
Note: The pre-period was 62 months from January 2015 to February 2020, and the post-period was 22 months from March 2020 to December 2021; P-values were calculated between pre-period and post-period by *t*-test.

Results



- Presents actual and synthetic counterfactual trends in EF, RTI and RTC rates in school zones among children aged 0-12 years between 2015and 2021 in Korea.
- In the pre-period, most RTO rates slightly decreased, but RTI, minor RTI, and RTC rates per million children aged 0-12 years tended to marginally increase.

Results

- Although all RTOs in non-school zones were lower in the post-period than the pre-period, there were no consistently significant differences between the pre-period and post-period of RTOs in school zones.

Estimated effects of stricter school zone laws on road traffic outcome rates in school zones for children aged 0–12 years in South Korea.

Road traffic outcome	Average absolute effect (95% CrI)	Cumulative absolute effect (95% CrI)	Relative effect (95% CrI)	Posterior tail-area probability of effect
Per million vehicles				
Equivalent fatality rate	0.002 (−0.019, 0.023)	0.05 (−0.43, 0.51)	3.2% (−29.2%, 35.5%)	0.423
Road traffic injury rate	0.2 (−0.2, 0.6)	3.9 (−3.7, 12.2)	11.2% (−10.6%, 35.1%)	0.164
Severe road traffic injury rate	0.003 (−0.101, 0.108)	0.1 (−2.2, 2.4)	0.8% (−23.6%, 25.2%)	0.474
Minor road traffic injury rate	0.1 (−0.1, 0.2)	1.3 (−2.7, 5.2)	4.6% (−9.5%, 18.7%)	0.263
Road traffic crash rate	0.2 (−0.1, 0.6)	5.0 (−2.3, 12.2)	15.9% (−7.5%, 38.9%)	0.091
Per million children aged 0–12 years				
Equivalent fatality rate	0.01 (−0.07, 0.09)	0.2 (−1.6, 2.1)	2.9% (−22.6%, 28.4%)	0.412
Road traffic injury rate	0.6 (−0.7, 2.2)	14.1 (−15.9, 49.4)	7.8% (−8.9%, 27.5%)	0.192
Severe road traffic injury rate	−0.02 (−0.46, 0.42)	−0.3 (−10.1, 9.3)	−0.7% (−21.1%, 19.6%)	0.473
Minor road traffic injury rate	0.2 (−0.6, 0.9)	4.3 (−12.2, 20.7)	3.0% (−8.6%, 14.6%)	0.305
Road traffic crash rate	1.0 (−0.5, 2.4)	21.7 (−10.5, 52.7)	13.6% (−6.6%, 33.0%)	0.097

CrI: credible interval.

Conclusions

- New school zone laws in Korea that centered mainly on imposing stricter penalties have failed to reduce EF, RTI, severe RTI, minor RTI, and RTC rates in school zones for children aged 0-12 years.
- To improve children's road traffic safety in school zones, along with the full enforcement of laws to detect traffic violations and install road safety equipment, area-wide traffic calming measures and prevention strategies to avoid driver inattention and distraction should be considered.

How can I apply it?

- This study conducted an analysis using a statistical hypothesis test
- There were many things that could be analyzed because the data was composed of numerical-numerical types.
- Visualization using the BSTS model is also a good idea
- In the study I analyzed, I mainly analyzed graphs, but I think using statistical analysis is also a good way