

UDK: 656.1-053.6 (497.11)

## ZAVISNOST IZMEĐU UPOTREBE SIGURNOSNIH POJASEVA I ZAŠTITNIH SISTEMA ZA DECU DO 12 GODINA NA TERITORIJI REPUBLIKE SRBIJE

### DEPENDENCE BETWEEN THE USE OF SEAT BELTS AND CHILD RESTRAINT SYSTEMS FOR CHILDREN UP TO 12 YEARS IN THE TERRITORY OF THE REPUBLIC OF SERBIA

Dalibor PEŠIĆ<sup>1</sup>, Boris ANTIĆ<sup>2</sup>, Jelica DAVIDOVIĆ<sup>3</sup>

**Abstract:** Problem: During the road accident the human body is exposed to large forces, resulting in injury and /or death. Because the design of the vehicle is not enough to protect passengers, were developed the use of restraint systems. Among others child restraint systems were developed to protect children as car occupants. Child restraint system mostly depends of using restraint system by other occupants.

**Method:** The data about the use of seat belts in passenger cars (front and rear seat) and child restraint systems (for children up to 12 years) in the territory of the Republic of Serbia, on three roads category (in a settlement, outside of a settlement, on a highway) were collected by observation research. Dependence of use of child restraint system were determined by using correlation and other statistical tools.

**Results:** We found a positive correlation between observed indicators and among them the highest correlation was on the motorway. The highest positive correlation is between seat belts use in the front seat and use of child restraint systems for children below 3 years.

**Discussion:** Similar to other experience, the biggest impact on the use of child restraint systems (for children up to 3 years) has the use of seat belts in the front seat.

**Conclusion:** The significance of this paper is reflected in the fact that the established correlation and strength between observed indicators, allow us to take the right measures and to properly select the target groups to raise driver awareness and reduce the consequences of accidents.

**Keywords:** correlation; road safety indicators; child restraint systems; seat belts;

#### 1. INTRODUCTION

The World Health Organization (WHO, 2009) highlights that more than 1.2 million people die in road accidents annually and that more than 50 million people are injured worldwide. During the traffic accident the human body is exposed to large forces, which results in injury and/or death. Since the design of the vehicle is not sufficient to protect passengers, protection systems have been developed. The most important protective systems used in passenger cars are: seat belts and child restraint systems. According to the project SAFETYNET (Wegman et al., 2008) transport safety performance indicators are, among others, the use of seat belts and the use of restraint systems for up to 12 year-old children, are PSPI3.

In addition, only 57% of the countries have regulations about wearing seat belts. This problem is considered more seriously in highly developed countries (76%), than in medium developed countries (54%) and in underdeveloped countries (36%) (WHO, 2009). The correct use of seat belts reduces the risk of fatal injuries by 40-50% for drivers and front passengers, as well as by 25-75% for the passengers in rear seats (WHO, 2013). In many countries, drivers and passengers in front seats are obliged by law to wear seat belts, which is not always the case for the passengers in rear seats. Up to 2013 seat belts use in rear seats was improved through comprehensive laws: 111 countries (69% of the global population) now apply the laws on the obligatory use of seat belts in rear seats (WHO, 2013).

Numerous studies have shown that the proper use of child restraint systems can reduce the risk of injury by 71-82% (Arbogast et al., 2004, Zaloshnja et al., 2007) and the risk of death by about 28%, in comparison with the children of the same age who use only seat belts (Elliott et al., 2006). In addition, the risk of injury of 4-8 year-

---

<sup>1</sup> Docent, Pešić dr Dalibor, dipl. inž. saobraćaja, Univerzitet u Beogradu – Saobraćajni fakultet, Vojvode Stepe 305, Beograd, Srbija, [d.pesic@sf.bg.ac.rs](mailto:d.pesic@sf.bg.ac.rs)

<sup>2</sup> Docent, Antić dr Boris, dipl. inž. saobraćaja, Univerzitet u Beogradu – Saobraćajni fakultet, Vojvode Stepe 305, Beograd, Srbija, [b.antic@sf.bg.ac.rs](mailto:b.antic@sf.bg.ac.rs)

<sup>3</sup> Asistent, Davidović Jelica, mast. inž. saobraćaja, Univerzitet u Beogradu – Saobraćajni fakultet, Vojvode Stepe 305, Beograd, Srbija, [jelicadavidovic@sf.bg.ac.rs](mailto:jelicadavidovic@sf.bg.ac.rs)

old children who use booster seats is 45% lower than of the children using only seat belts (Arbogast et al., 2009). But the risk of injury will increase if child restraint systems are not appropriately applied.

According to an observational study conducted in 2007 (Vesentini and Willems, 2007), more than half of the Belgian children were not appropriately restrained (not appropriately according to the age, weight or height).

In order to determine the proper use of child restraint systems, observational methods are usually used (Decina and Lococo, 2005; Snowdon et al., 2009, 2010; CEDRE Project, 2010; CASPER Project, 2012). Two methodologies are used for data collection. First, as in NHTSA, 2009a, 2010; Snowdon et al., 2010, trained observers are placed at intersections. The problem with this method is that it is difficult to determine whether the child is in the seat and what the characteristics of the child are when the vehicle is in motion. The second method is the survey in the car park, as in NHTSA, 2009b; Snowdon et al., 2010, which allows to determine the installation (children and the device), to collect demographic characteristics of child restraint systems as well as the information about the proper and improper use.

Within this research, an observational study was conducted on the territory of the Republic of Serbia in order to determine the road safety performance indicators. The aim of this study was to determine the correlation between seat belts use in front seats and rear seats and the use of child restraint systems for children up to three and 4-12 years. Finally, the goal was to determine if there was any dependence between seatbelts use and the use of restraint system in urban areas, outside the urban areas and on the motorways. The survey was conducted in the autumn and repeated in the spring, during the weekend, from 8:00 to 12:00 am or 1:00-6:00 pm.

## 2. MATERIALS AND METHODS

According to the SAFETYNET project, seat belts use and the use of child restraint systems for children up to 12 years have been proposed and adopted as road safety indicators, in addition to others.

For the purposes of this study seat belts use was studied:

- Seatbelts wearing rate in front seats (%) in passenger cars
- Seatbelts wearing rate in rear seats (%) in passenger cars.

In addition, Road Traffic Safety Law in Serbia states that youngest children (infants) can be transported in front seats, but in special child seats (so-called "Cradle"), while all other children under 12 years must be transported in rear seats, with the use of appropriate child restraints and other safety equipment. The project "Methods of monitoring road safety indicators in Serbia and their significance for the strategic management of traffic safety" suggested the following RSI for child restraint system in Serbia (Pešić and Vujanić, 2014):

- Proper use of child restraint systems for children up to 3 years (%)
- Proper use of child restraint systems for children 4-12 years (%).

Due to the drastic reduction in efficiency by the improper use of the protection systems, the emphasis is placed on the proper use. Thus, RSI relating to the protection of children, as well as seat belts use, include only the information on the proper use of these systems.

Observational research has been used in measuring RSI of restraint systems. Measurement points were chosen, so that the field researcher was able to see all the necessary features of the proper use / non-use of the observed indicators.

The measurement was carried out at places where vehicles, as a rule, move at lower speeds or stand (intersections, toll gates, fuel stations, etc.).

The measurement of the use of child restraint systems was carried out during the weekend, in daily conditions and in 27 police districts, including:

- highway
- outside the urban areas
- inside the urban areas.

The measurement of the observed indicators use was performed in:

- autumn (September and October) 2013.

The measurement was performed in the daily visibility conditions:

- in the morning (from 8:00 to 12:00) or
- in the afternoon (from 1:00 to 6:00 p.m).

In the sample we did not analyze the vehicles for which the researcher, for any reason, did not manage to record all the necessary information about using restraint systems.

The study was carried out on the territory of the Republic of Serbia for each police district separately (27 police districts), in the urban areas, outside the urban areas and on the motorways.

The total sample for the territory of the Republic of Serbia was 28.404 front seat occupants, 6.967 rear seat occupants, 1.730 children under 3 years and 2.161 children aged 4-12 years.

In order to indicate the relationship between the observed RSI in the urban areas, outside the urban areas and in the motorways, zero-order correlation was conducted by using statistical software SPSS Statistics.

Inputs were:

- Seatbelts wearing rate in front seats (%) in passenger cars (SBF)
- Seatbelts wearing rate in rear seats (%) in passenger cars (SBR)
- Proper use of child restraint systems (%) for children up to 3 years (CRS3)
- Proper use of child restraint systems (%) for children from 4 to 12 years (CRS4+).

Outputs were:

- the coefficient of correlation
- the coefficient of determination
- statistical significance.

### 3. RESULTS

In overall, seat belts use in front seats was 63% in the urban areas, 70% outside the urban areas and 78% on the motorways. The study found a much lower use of seat belts in rear seats (2% in the urban areas and outside the urban areas and 8% on the motorways). Child restraint systems use for children up to 3 years was much higher (32%, 29%, 46%) than for children between 4 and 12 years old (7%, 6%, 13%) in the urban areas, outside the urban areas and on the motorways, respectively.

The relationship between seat belts use in front and rear seats was calculated by Pearson's Linear Correlation Coefficient. According to Cohen (1988), the correlation size is classified as:

- small  $r=0,10$  to  $0,29$
- medium  $r=0,30$  to  $0,49$
- large  $r=0,50$  to  $1,0$ .

The study showed a large positive correlation between SBF and SBR on the motorways ( $r=0,538$ ;  $p=0,135$ ), a small positive correlation outside the urban areas ( $r=0,242$ ;  $p=0,135$ ), while the correlation in the urban areas was negative, but not significant ( $r=-0,01$ ;  $p=0,949$ ).

A high positive correlation was found between the use of seat belts in front seats and child restraint systems for children up to 3 years ( $r=0,679$ ;  $p=0,044$ ) on the motorway. The low value of the correlation coefficient showed that there was almost no significant relationship between the use of seat belts in front seats and child restraint systems for children from 4 to 12 years in the urban areas ( $r=0,146$ ), and that it was of medium value outside the urban areas ( $r=0,340$ ) and on the motorway ( $r=0,340$ ).

Table 1. Coefficient of correlation, determination and level of significance for the use of seat belts and child restraint systems in passenger cars

Relationship between		Road category	Correlation Coefficient			Determination Coefficient	Significance Level
Var 1	Var 2		Value	Relationship strenght	Direction		
SBF	SBR	Urban	-0,013	No	-	0,002	0,949
		Outside urban	0,242	Small	+	0,058	0,224
		Motorways	0,538	Large	+	0,29	0,135

SBF	CRS3	Urban	0,103	Small	+	0,10	0,610
		Outside urban	0,188	Small	+	0,04	0,348
		<b>Motorways</b>	<b>0,679</b>	<b>Large</b>	<b>+</b>	<b>0,46</b>	<b>0,044</b>
SBF	CRS4+	Urban	0,146	Small	+	0,02	0,466
		Outside urban	0,340	Medium	+	0,12	0,083
		Motorways	0,340	Medium	+	0,11	0,371
SBR	CRS3	Urban	0,019	No	+	0,003	0,923
		Outside urban	0,152	Small	+	0,0230	0,450
		Motorways	0,545	Large	+	0,30	0,129
SBR	CRS4+	Urban	0,143	Small	+	0,02	0,476
		Outside urban	0,174	Small	+	0,03	0,385
		Motorways	0,087	No	+	0,007	0,824

Table 2. Pearson's Linear Correlation Coefficient between observed road safety performance indicators, for the data collected in the urban areas

In the urban areas	SBF	SBR	CRS3	CRS4+
SBF	-	-0,013	0,103	0,146
SBR		-	0,019	0,143
CRS3			-	0,457
CRS4+				-

Observing the relationship between the seat belts use in rear seats and child restraint systems for children up to 3 years, we found a large positive correlation on the motorway ( $r=0,545$ ;  $p=0,129$ ). On the other hand, there was no relationship between seat belts use in rear seats and child restraint systems for children from 4 to 12 years on the motorway ( $r=0,09$ ), while that correlation was small in the urban areas and outside the urban areas ( $r=0,143$ ;  $r=0,174$ ), respectively.

The coefficient of determination shows proportion of the variance shared by two observed variables. The values of determined Pearson's linear coefficient correlation are shown in tables 2-4, for the urban areas, outside the urban areas and on the motorways, respectively.

Table 3. Pearson's Linear Correlation Coefficient between the observed road safety performance indicators, for the data collected outside the urban areas

Outside the urban areas	SBF	SBR	CRS3	CRS4+
SBF	-	0,242	0,188	0,340
SBR		-	0,152	0,174
CRS3			-	0,379
CRS4+				-

Table 4. Pearson's Linear Correlation Coefficient between the observed road safety performance indicators, for the data collected on the motorways

On the motorways	SBF	SBR	CRS3	CRS4+
SBF	-	0,538	0,679	0,340
SBR		-	0,545	0,087
CRS3			-	0,324
CRS4+				-

#### 4. DISCUSSION

Brijs et al. (2011) found three main reasons for not using safety belts: forgetfulness, discomfort ("restricts freedom of movement") and carelessness. Although this area is regulated by the Road Traffic Safety Law in many countries, seat belts use in the front seat is not satisfactory in many countries, including in Serbia. Seat belts use in rear seats is low in Serbia, indicating that drivers have not developed sufficient awareness about the importance of these restraint systems.

According to the data of World Health Organization (WHO, 2013), the proper use of seat belts in front seats reduces the risk of fatal accidents by 50%, and up to 75% in rear seats. According to the analysis of the results obtained by field surveys in the territory of the Republic of Serbia, the biggest problem is a very low rate of seat belts use in rear seats (2-8%). There was a negative correlation between the use of seat belts in front and rear seats in the urban areas.

Other studies have shown that the most influential factor related to the use of child restraint systems is seat belts use by the drivers. Lawrence et al. (2003) showed that in the situations when the drivers used a seat belt (91,7%), 44,2% of them used child safety seats correctly and 47,5% used seatbelts for children. They also pointed out that only 8,3% of children up to 35 kg were transported without a protective system.

According to the results of field research on measuring indicators of child restraint systems use in Serbia, a small number of children is transported properly, especially children older than 4 years (6-13%).

The results have shown considerably higher correlation between the observed indicators in the motorways than in the urban areas and outside the urban areas. The reason may be incorrect drivers' / parents' opinion that there is no need for protective systems when driving at "lower" speed. Similar to other experiences, the biggest impact on the use of child restraint systems for children up to 3 years is seat belts use in front seats.

## 5. CONCLUSION

Road Safety Indicators that deal with restraint systems' use represent significant data about the state of traffic safety, because the proper use of seat belts reduces the risk of fatal injuries by 40-50% in front seats, and between 25-75% for rear passengers (WHO, 2013), while the use of child restraint systems reduces the risk of casualties by 70% (WHO, 2004).

The determined relation between the observed indicators could be the basis for determining the cause of the use / non-use of the observed restraint systems. This enables taking the right measures and properly selecting the target group, and choosing the most efficient way to raise awareness of road users and to reduce the consequences of accidents.

The study included measuring the use of restraint systems in passenger cars in the territory of 27 police districts in Serbia, in all categories of roads. The results showed that the highest correlation between the use of seat belts and child restraint systems was on motorways, on the road category with the highest speed. The correlation between the seat belts use in the front seat and the child restraint systems at all observed categories of roads was positive and the strongest.

The obtained results may be a consequence of insufficiently developed awareness by the driver / parents about the dangers they expose themselves, their children and other passengers to if they do not use seat belts and child restraint systems.

Because of that it is necessary to educate parents, with special emphasis on the proper use of the child restraint system and seat belts on the roads on which lower speeds are developed, because injuries may also occur at low speeds. Campaigns and involvement of local communities in the monitoring of indicators can significantly reduce the severity of the consequences and death. Also, investing in the fleet, using vehicles with sensors that force drivers to use seat belts may contribute to the improvement of road safety.

Technological development brings many advantages, as shown in the example of sensors that warn drivers to use seat belts. We propose developing a sensor that will block driving if child restraint systems are not used properly, as well as obligatory seat belts use in the rear. In that way, road users would be "forced" to use restraint systems in passenger cars and this would result in raising the level of traffic safety. This equipment has to be the basic equipment for the all new research.

## 6. REFERENCE

- Arbogast, K.B., Durbin, D.R., Cornejo, R.A., Kallan, M.J., Winston, F.K., (2004). An evaluation of the effectiveness of forward facing child restraint systems. *Accident Analysis and Prevention*, 36 (4), 585–589.
- Arbogast, K.B., Jermakian, J.S., Kallan, M.J., Durbin, D.R., (2009). Effectiveness of belt positioning booster seats: an updated assessment. *Pediatrics* 124 (5), 1281–1286.
- Brijs, K., Daniels, S., Brijs, T., Wets G., (2011). An experimental approach towards the evaluation of seat belt campaign with inside view on the psychology behind seat belt use. *Transportation Research Part F*, 14, 600–613.
- CASPER Project, (2012). Child Advanced Safety Project for European Roads, <http://www.casper-project.eu/publications/> (accessed in November 2012).
- CEDRE Project, (2010). Contrôle et Etude des Dispositifs de Retenue Enfant, <http://www.projet-cedre.fr/results.html> (accessed in June 2011).
- Cohen, J.W., (1988). *Statistical power analysis for the behavioral sciences* (2nd). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Decina, L.E., Lococo, K.H., (2005). Child restraint system use and misuse in six states. *Accident Analysis and Prevention*, 37 (3), 583–590.

- Elliott, M.R., Kallan, M.J., Durbin, D.R., Winston, F.K., (2006). Effectiveness of child safety seats vs seat belts in reducing risk for death in children in passenger vehicle crashes. *Arch. Pediatr. Adolesc. Med.* 160 (6), 617–621.
- Decina, E.L., and Lococo, H.K., (2003). *Misuse of Child Restraints*, National Highway Traffic Safety Administration.
- National Highway Traffic Safety Administration, (2009). *Traffic Safety Facts: Child Restraint Use in 2008 – Overall Results*, DOT HS 811 135. U.S. Department of Transportation.
- Pešić, D., Vujanić, M., (2014). Children protective systems as road safety indicator – case study Serbia. 9th International Conference ROAD SAFETY IN LOCAL COMMUNITY, Serbia, Zajecar.
- Snowdon, A. (2010). Methodology of estimating restraint use in children: roadside observation or parking lot interview survey. *Accident Analysis and Prevention* 42 (6), 1545–1548.
- Snowdon, A.W., Hussein, A., Purc-Stevenson, R., Bruce, B., Kolga, C., Boase, P., Howard, A., (2009). Are we there yet? Canada's progress towards achieving road safety vision 2010 for children travelling in vehicles. *Int. J. Inj. Contr. Saf. Promot.* 16(4), 231-237.
- Vesentini, L., Willems, B., (2007). Premature graduation of children in child restraint systems: an observational study. *Accident Analysis and Prevention* (39), 867–872.
- Wegman, F., Commandeur, J., Doveh, E., Eksler, V., Gitelman, V., Hakkert, S., Lynam, D., Oppe, S., (2008). *SUNflower Next: Towards a Composite Road Safety Performance Index*, Deliverable D6.16 of the EU FP6 Project SafetyNet.
- World Health Organisation, (2004). *World report on road traffic injury prevention*.
- World Health Organisation, (2013). *Global status report on road safety*, Geneva.
- World Health Organization, (2009). *Global status report on road safety – time for action*. Geneva: WHO: 22-24
- Zaloshnja, E., Miller, T.R., Hendrie, D., (2007). Effectiveness of child safety seats vs safety belts for children aged 2 to 3 years. *Arch. Pediatr. Adolesc. Med.* 161(1), 65–68.