

ANALYSIS OF PEDESTRIAN SAFETY IN SCHOOL ZONES WITH GUIDELINES FOR IMPROVEMENT

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Abstract: Traffic accidents in which children are injured happen for several reasons. The most vulnerable are school children, especially as pedestrians. Unlike adults, children have smaller height, so drivers have more problems to notice them. This problem becomes worse in school environments, where parked vehicles hinder children visibility to drivers. Children do not have well-developed cognitive and perceptive abilities, and their behaviour is unpredictable. They often make wrong conclusions because they are unable to identify the dangers by the traffic. They cannot accurately estimate the speed and distance of vehicles in motion. The purpose and goal of the paper is to obtain key information on the mobility habits and behaviour of children as pedestrians and their parents. A research on general knowledge of children and parents about road safety was carried out in five elementary schools in the City of Zagreb, where two grade groups were observed – first to fourth grade, and fifth to eight grade. The research results propose general guidelines to improve road safety.

Keywords: pedestrians, schoolchildren, traffic behaviour, mobility, City of Zagreb

1. INTRODUCTION

Traffic participants are the most important links in road safety chain, regardless of applied technical measures and policy effectiveness. Road safety depends primarily on the behaviour of participants. For this reason, education, application and conciliation of laws

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are the basis for improving road safety. A road safety system must consider the possibility of human error and unacceptable behaviour, with the task of trying to alleviate it as much as possible (<http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories3.html>, 04.12.2018.).

Mobility is a fundamental right of every human being that allows children to explore the world around them, but on the other hand, it exposes them to potential dangers. However, it would be wrong to limit the mobility of children to increase road safety. On the contrary, the measures should be taken to promote independent, autonomous children's mobility by adapting traffic environment to children (Šimunović & Čosić, 2015).

In traffic accidents involving children, the most vulnerable are schoolchildren, especially as pedestrians. Unlike adults, children have lower height, making them more difficult to notice in traffic. This problem is particularly emphasized in school zones, near parked vehicles that reduce children's ability to observe vehicles, and driver visibility. Children do not have well-developed cognitive and perceptive abilities, and their behaviour is unpredictable.

Children often make wrong conclusions because they are unable to recognize the dangers in traffic. Children cannot accurately estimate the speed and distance of a moving vehicle. Often, they cannot identify the direction the sound is coming from, especially when located near roads with high traffic volume. They are not able to identify safe places to cross the street, they do not understand abstract concepts such as traffic safety, etc. To understand the causes of traffic accidents, it is necessary to have a good knowledge in physical and psychological children characteristics.

2. METHODOLOGY

As part of the project "Pedestrian Children Safety in Elementary School Zones", a survey was conducted to obtain the data and knowledge regarding the behaviour of pedestrian children and their parents in elementary school zones. The children and parents of five elementary schools in the City of Zagreb participated in the survey: Janko Drašković, Kustošija, Savski Gaj, Izidor Kršnjavi and Retkovec. Traffic infrastructure is different for each school, so for the conduction of the survey and education purposes, the schools were selected based on the collected accident data in the past five years for the least safe school zones, which was proved by the largest number of road accidents involving pedestrians.

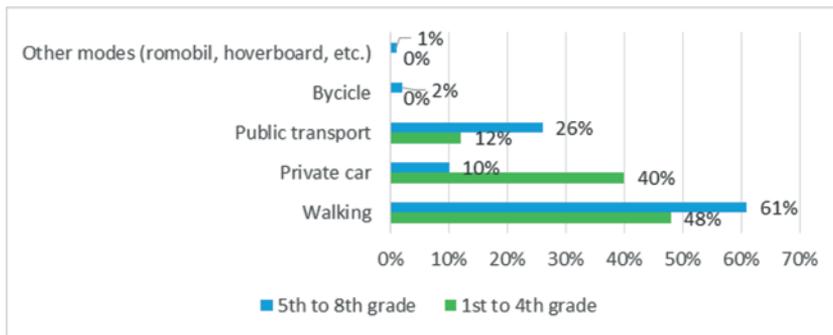
A representative sample of 541 schoolchildren and their parents was selected from approximately 55,000 schoolchildren attending elementary schools in Zagreb. The maximum limit error is 4% (with a default 95% confidence level). This means that percentages of individual responses for the entire population, i.e. for all elementary school children, vary by up to 4% in relation to the real value.

In order to gain insight into the objective behaviour of pedestrian children and drivers in elementary school zones, a field research was also conducted. The field research was conducted for the same elementary school zones as in the survey at a sample of 733 drivers and 432 schoolchildren. To obtain the best results, the field research was carried out in the morning (7:00 am to 9:00 am) and afternoon peak hours (2:00 pm to 5:00 pm), when traffic congestion is the worst, both in school zones (picking up and dropping children from school) and the rest of the transport network (traveling to or from workplace). The weather conditions during field research were mostly dry, with moderate temperatures.

Surveys and field researches were conducted in the period from September 2017 to June 2018. The limitations of the research are based on the design task and the period of the research. It is necessary to continuously monitor behavioural changes in order to gain a comprehensive view of the situation and expand the research to a greater number of schools.

3. RESEARCH RESULTS

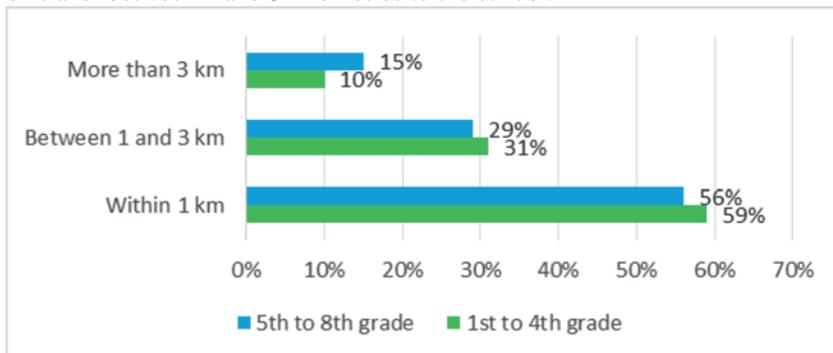
The data on trip modal distribution for children and their parents to school is shown in Graph 1.



Graph 1. Trip modal distribution (Šimunović, 2018)

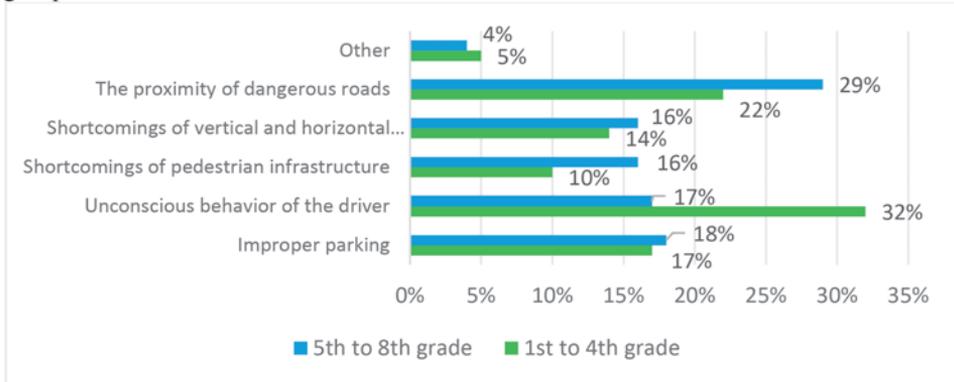
Modal distribution shows that the largest number of children are walking to school – 43% of younger children (1st to 4th grade), and 61% of older children (5th to 8th grade). The second most frequent transport mode is different for these two groups: younger children travel more often with a private car (about 40%), while older children use public transport (about 26% of their travels). Cycling and other modes of transport are poorly distributed, with a total of 3% for older children.

Regarding the distance, more than a half of the children live under distance of one kilometre (about 59% of younger children and 56% of older children). More than three kilometres is the travel distance for 10% younger children and 15% older children. Other children travel between 1 and 3 kilometres to the school.



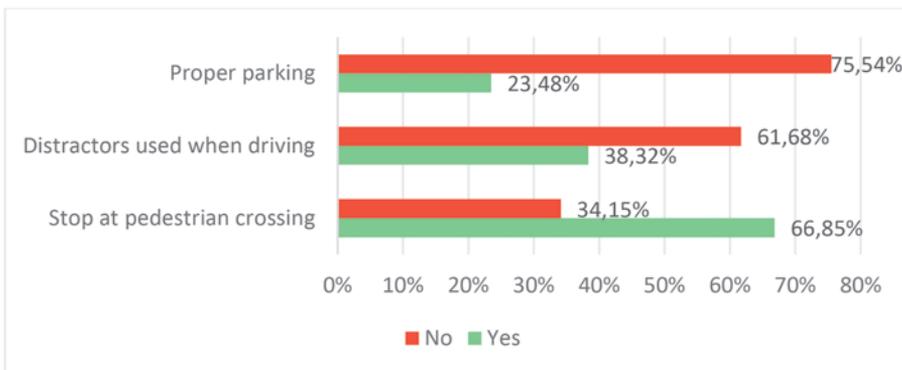
Graph 2. Distance of residence from school (Šimunović, 2018)

According to the data from the National Travel Survey UK (Central Statistics Office, 2009), which studies the behaviour of children considering their age and distance of travel, It is concluded that a very high percentage of children travel on foot at a short distance of about 1 kilometre (between 83% and 90%). When it comes to middle distances, from 1 to 3 kilometres, there is a change in behaviour, where a noticeable drop in walking is among the younger generation of schoolchildren to about 31%, while children from the 5th to the 8th grade are still in the majority (62%). Regarding travel distances of more than 3 kilometres, there is a drop to less than 10% of trips done by walking for both children groups.



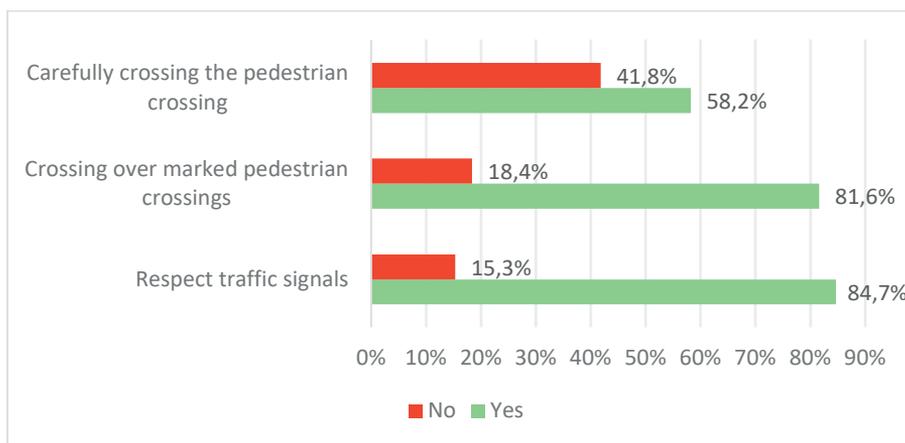
Graph 3. Traffic safety issues (Šimunović, 2018)

A survey on traffic safety issues was conducted among parents of schoolchildren. When analysing the obtained results, it is apparent that the two largest problems from the point of view of a parent are the proximity of the dangerous places and the reckless driver behaviour. While there is a lack of vertical and horizontal signalization, there are also disadvantages of pedestrian infrastructure and improper parking present (Wagner et al., 2005). Although improper parking has posed a problem, nearly 32% of parents said that they themselves parked their cars on improper places when leaving or picking up their children from schools, thereby endangering the lives of schoolchildren and other traffic participants by reducing the visibility on the roads.



Graph 4. Driver behaviour in primary school zones (Šimunović, 2018)

By comparing the graph representing the objective children behaviour obtained from field research data regarding traffic lights, it was found that over 15% of children cross the road when the red light is on. Out of the children who participated in the survey, only 12.3% of children said that they cross the road on red light. Over 18% of children pass the pedestrian crossing incorrectly. The numbers that speak of the improper road crossing and traffic light negligence are worrying. It is noticeable that careless crossing (41,8%) of children were virtually equalized with the correct crossing (58%), which represents a huge risk for children in traffic. Children using distractors are not concentrated and do not hear vehicles approaching them as they cross the road. Almost 60% of the children from 5th to 8th grade said they use distractors while travelling to school.



Graph 5. Behaviour of children in primary school zones (Šimunović, 2018)

An overview of driver behaviour in primary school zones is shown in Graph 4. Many behavioural factors have been analysed, where three main factors affecting children safety and pedestrians in traffic have been identified. It was noticed that over 75% of drivers fail to observe the rules for parking in school zones, which reduces the ability to track pedestrians, especially young children. Nearly 62% of them use distractors during driving, with mobile devices being the most frequent. The devices greatly affect driver concentration and the ability to notice changes in the traffic environment; in addition, the response or reflex of the driver when performing a manoeuvre becomes slower. The factor of stopping in front of a pedestrian crossing when approaching and crossing it is also considered, where it is noticed that 34% of drivers do not stop in front of pedestrian crossings in school zones, which can result in a pedestrian accident, especially if there is a high risk (<http://www.iloencyclopaedia.org/component/k2/92-56-accident-prevention/theory-of-accident-causes>, 15.12.2018.) of a pedestrian collision when talking about children whose behaviour is often unpredictable and unmanageable.

4. DISCUSSION

At high traffic volume, the traffic flow speed is low, and the vehicles often have a stop-and-go movement, and often remain stopped at pedestrian crossings, so the children are

moving between the vehicles to pass the intersection. This mutual mistake of children and drivers can be very dangerous for children due to their low height, which makes it impossible for drivers to notice children in time (Šimunović & Ćosić, 2015).

The reasons for accidents to occur are the following: inadequate number of parking spaces for parents in school zones, lack of areas for temporary stopping when driving children to school and a lack of adequate public transport (Brčić et al., 2016).

In addition to the behaviour of traffic participants, road infrastructure and traffic flow characteristics (speed, volume, structure, hazardous pedestrian crossings, illumination, signalling, inappropriate parking, etc.) are important. Each parameter with its characteristics affects the possibility of accident occurrence and the consequences (http://www.pedbikeinfo.org/pbcat_us/, 7.12.2018.).

In order to collect information, the observers recorded children using distractors (mobile phones, headsets) when crossing the road, with not looking left and right before entering pedestrian crossings, running or slow crossing over the road, passing and squeezing between stopped cars, etc. The most common mistake children make is the neglect of stopping before entering the pedestrian crossing and the neglect of looking left and right before crossing the road, while the increasingly common problem becomes the mobile phone usage, and this is more common among children from 5th to 8th grade.

When comparing observations with survey results, it can be concluded that children have wrong perception of their knowledge of traffic safety, therefore, they need additional education on traffic safety, both by parents, teachers, and traffic experts. The lack of education is a quite understandable reason for such behaviour. Younger children are often led by parents to school, while older children are more independent to choose the way of crossing the road, which is usually wrong.

5. CONCLUSIONS

To set a higher level of road safety, it is necessary to implement additional safety measures. Such measures are usually divided into three categories – engineering, control-penalisation and education. When implementing such measures, it is necessary to periodically monitor and analyse progress, and if no progress is made, other measures must be implemented. Some of the measures recommended to implement in school zones are:

- school traffic unit,
- school transport for children,
- “walking school bus”,
- safe routes to schools,
- other measures, mostly in the form of education.

The school traffic unit is being introduced to increase the safety of children near elementary schools. The task of the school traffic unit is to inform drivers of the place where traffic unit members control the children movement over the pedestrian crossing. There are 162 elementary schools in the City of Zagreb, and only 19 have organized school traffic units, (11.72%). This is due to the lack of awareness of road traffic safety by the elementary school’s personnel and insufficient involvement of the local community and the police in raising the awareness of organizing school traffic units. By organizing the

school traffic unit, the level of traffic safety is increased in the immediate area of the primary school.

Transportation to home and to school is organized for school children attending 1st through 4th grade, living in neighbourhoods located more than three kilometres from the school, as well as for children attending 5th to 8th grade who live in neighbourhoods located more than five kilometres from the school. If a child travels to a school from an area where there is no public transport, or there are roads without sidewalks, the transportation can be arranged for children regardless of the distance to school. Provision of transport obligations is the responsibility of local and regional authorities. For all schoolchildren with disabilities, transportation is provided regardless of distance from school. This concept is widespread in American cities, whereas in European cities it is most often seen in rural areas.

The walking school bus (http://guide.saferoutesinfo.org/walking_school_bus/, 14.12.2018.) is a concept where an organised group of children are walking to home or to school with one or more adults. Initially, it starts from a narrower area of a neighbourhood, and later it can be expanded to a wider community (city districts) with more children and more routes, which requires a structured program involving principals and local community representatives. The safety of children walking to or from school must be guaranteed with a properly safe transport infrastructure, safe routes must be defined (<http://www.walkingschoolbus.org/>, 5.12.2018.) and children need to be educated about traffic behaviour. The application of a walking school bus is possible when all the mentioned conditions are met.

The concept of a safe route (<http://www.saferoutesinfo.org/>, 5.12.2018.) to school is based on the development of programs and documents aimed at improving the safety of pedestrian and cyclists where the transport infrastructure does not provide the required level of safety. These measures include safe route suggestions, infrastructure improvement, introduction of school patrols at critical intersections, promotion of unmotorized traffic, introduction of R&D parking spaces close to elementary schools and school buses. After the adoption of the document, it is necessary to educate children and parents as well as school staff, monitor the contributions of the measures applied, and to consider changes if needed. The concept also originates from the USA (<https://www.wsdot.wa.gov/LocalPrograms/SafeRoutes/default.htm>, 6.12.2018.) where it is implemented in many schools, and because of its results in the field of safety of pedestrians and cyclists it became more attractive in European cities.

The key measure to increase traffic safety is education. As an example of a quality and proper education, the practice of the educational institutions in Norway has been recognized, where education of children begins at the earliest age (1 to 2 years). At the age between 3 and 4, children are practicing walk along the sidewalk and getting acquainted with traffic signalling. The goal of such a program is that children aged 8 to 15 develop a traffic culture and can start to think critically about messages sent by the media, related to traffic safety.

The results of the primary schools that have implemented these measures are:

- improved child safety in the local community,
- schoolchildren increased awareness about the dangers of road traffic,
- increased awareness among schoolchildren about responsible behaviour and the development of respect towards traffic rules,
- increased awareness of the required staff teaching road safety,
- increased road safety awareness among the parents.

By observing the behaviour of children and drivers in traffic, it was noticed that many children and drivers use a variety of distractors. This greatly worsened road safety, because it was also noticed that many drivers and children did not respect traffic regulations. The problem with the lack of parking spaces in the vicinity of the school was noticed in the driver case, while the most common problem with children was not paying enough attention to traffic around them.

The survey data showed that almost 58% of children live within 1 kilometre, and that children and their parents should be encouraged to walk to school to avoid as many vehicles driving in school zones as possible, which would result in reduced risk of road accidents.

In future research, it is necessary to analyse in more detail the relations between mode choice and travel distance for schoolchildren.

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