

Keywords: road safety; pedestrian crosswalks; survey of pedestrians and drivers; observation of road users' behaviour

Maria DĄBROWSKA-LORANC, Katarzyna SICIŃSKA*

Motor Transport Institute

Jagiellońska 80, 03-301 Warsaw, Poland

*Corresponding author. E-mail: katarzyna.sicinska@its.waw.pl

SURVEY OF PEDESTRIANS AND CAR DRIVERS' ATTITUDES AT THE AREA OF PEDESTRIAN CROSSINGS OVER PERIOD OF TIME

Summary. This article presents the newest trends among pedestrians' and car drivers' attitudes from a survey performed at a roadside at the area of zebra crossings in Poland in 2018. Trends in road users' attitudes and performance allow an understanding of the causes of road safety crashes to decrease deaths and injuries. Surveys of attitudes from questionnaires help gauge knowledge of road traffic laws and risky behaviours regarding road safety issues at crosswalks. Data of 800 questionnaires collected in 2018 according to the methodology first adopted in 2015 were analyzed and compared. Reliable and comparable results from 2018 published for the first time show changes in car drivers' and pedestrians' attitudes. Over the last three years, there have been changes in car drivers' declared attitudes and performance towards 4 different road traffic situations at the crosswalks (when a pedestrian is approaching, waiting, entering, crossing). Before and after survey at the zebra crossings showed in 2015 according to questionnaire 88% car drivers declared giving way to pedestrians (in fact during observations on road only 20% car drivers gave way), in 2018 declared 85% car drivers and 78% already gave way to pedestrians on crosswalks. Drivers and pedestrians know the law, but do not always follow them in traffic. According to drivers' opinions, both pedestrians and drivers display risky behaviours. 78% of pedestrians and 72% of car drivers favored more restrictive laws for car drivers to ensure that they slow down before approaching a crossing to allow pedestrians to cross. Risky pedestrian behaviour was mentioned by 76% of car drivers and pointed out as the main problem at crosswalks. In self-declared questionnaires, 90% of pedestrians stated that they must be extremely careful when crossing. The presented results influenced policy changes for implementation of more safety for pedestrians not only at zebra crossing but also when approaching it in Poland since 2021. The aim of the changes is to reduce pedestrians' risk while crossing the road.

1. INTRODUCTION

The goal of the Vision ZERO road safety policy to halve the number of fatalities and severe injuries by 2030 in the European Union is based on implementation of several preventive and effective measures. Risky road users' behaviours are defined as a problem in traffic. Creating correct, positive attitudes and encounters among all group of road users in traffic is complex issue but reduce risk and save lives. Expected positive attitudes, behaviours in real traffic conditions and road users' interactions on the road are as important as infrastructure improvements, legislative regulations, enforcement, education, and social campaigns to decrease the number of deaths. A survey on road users' social attitudes provides insight into the magnitude and nature of the safety problem. Research on road users' opinions (attitudes) and their observed behaviours in real traffic over period of time (before and after comparative study) is recommended method of road safety diagnostic. It indicates

problems and stimulus changes for improvements. As the human factor is a significant factor governing road incidents, analysis of road users' attitudes and behaviours will provide important data to improve road safety. Knowing opinions about road users' motivations, expectations and risk perception in terms of cultural aspects can be helpful to develop road safety policies, implement new solutions and evaluate the effectiveness of countermeasures taken. Opinions, viewpoints, social attitudes and experience or culture background govern human behaviour in general. The human factor is the most important element in traffic safety. In Poland according to police statistics it was responsible for 95% accidents in 2017 [1]. Surveys of social attitudes focus on various topics related to road safety such as walking, alcohol use, drug use, phone use while driving, speeding, cycling, and using public transport.

There has been an increase in the number of pedestrians due to environmental and health benefits, and walking is a very popular activity nowadays and a major kind of exercise that requires monitor and data gathering. These vulnerable road users need special attention due to the lack of protection (by car body, seat belts, helmets). Statistically, from 20% to 40% of all journeys are made on foot or by cycle [2]. This results in higher risk to vulnerable road users. As walking is particularly important for children and older individuals, the highest percentage of pedestrian fatalities in the European Union occurs in children younger than 10 years of age and adults older than 65 years of age. Of all traffic fatalities in EU countries, the proportion of pedestrian fatalities is about 15-22%; in Poland, it is more than 30% [1, 2]. Improvements made by vehicle manufacturers over the last few years have enhanced the protection of vehicle users. Currently there is not enough safety measures for pedestrians, cyclists, and motorcyclists and they become majority of injured or killed [2]. Pedestrians have the highest ratio of deaths to injuries of all groups of road users (twice as high as for motorcyclists, and over four times higher than for motor vehicle occupants). 80% of pedestrians and cyclists are hit by cars, lorries and buses. Crashes involving pedestrians occur frequently at facilities designed especially for them such as pedestrian crossings, mostly on roads in built-up areas. These facilities are not good enough to prevent crashes. There should be additional strong law requirements for stopping or lowering speed to reduce speed on that section of the road for safety pedestrian crossing [3]. The factors identified to affect pedestrian accidents are complex such as motorized vehicles' speed, lack of protection of pedestrians and poor visibility (no reflective materials), road design and infrastructure, lack of street lighting, parked vehicles [4] and factors related to driver and pedestrian behaviours themselves. Besides official police reports on numbers of accidents, fatalities, and casualties, monitoring and gathering data on road users' performances and attitudes can help to understand the causes of road crashes, frequently allow assessments of road traffic systems, allow monitoring of their progress, and measure the impacts of interventions for before and after comparisons [5].

Car drivers and pedestrians are separate groups of road users. These roles are interchangeable with drivers' becoming pedestrians and vice versa. More detailed accidents studies are required to learn more about factors influencing the risk of pedestrians on the road. To gain more insight into pedestrians' and drivers' knowledge of road traffic laws, their risks, and expectations, about it is important to obtain their opinions and social attitudes. Pedestrian crossings were chosen as a site of survey due to the high exposure of pedestrian in these sections of the road.

The aim of the survey of pedestrians and car drivers' attitudes was to gain knowledge and opinions of road safety at areas of pedestrian crossings in Poland in 2018. A quantitative analysis was carried out based on motorists' and pedestrians' needs assessments, and of the problems they faced when attempting to crossroads safely. Altogether, 400 pedestrians and 400 car drivers were surveyed in four voivodships of Poland in 2018. This study was the second edition of nationwide research first implemented in 2015, with the largest sampling size covered commissioned by the National Road Safety Council in Poland as a monitoring system of road users' performance.

2. SURVEY OF ROAD USERS' ATTITUDES

Road users' behaviours can be determined from data from roadside observations or questionnaire surveys (performance and attitudes). Surveys on attitudes of pedestrians and drivers provide their

perception of road safety (risk factors, traffic laws, knowledge, support of road safety policies). Frequently expressed opinions do not translate to behaviours on the road. Surveys on attitudes are carried out in the form of individual interviews (face to face) and online self-reported questionnaires. Surveys of road users' attitudes enable comparison of measurements and are conducted at the national or European level. Collection of comparable data using a uniform sampling method and inclusion of identical questions in a single country or across countries over period of time can provide scientific input to road safety policy makers.

In this article, surveys of pedestrians and car drivers' attitudes were conducted at areas of pedestrian crossings, and an analysis of opinions was performed in Poland and other countries. A good example of this practice was the SARTRE project, then the ESRA project, in which the results obtained from Poland were compared to the average results obtained in the EU.

The first European cross-national survey of knowledge of road traffic laws and risks using a cost-effective method of gathering reliable information on people' attitudes (questionnaires) were called SARTRE (Social Attitudes to Road Traffic Risk in Europe), which was started in 1991; then, three more surveys were conducted in 1996, 2002 and 2010 [6].

The SARTRE 4' survey of self-reported opinions in face-to face interviews conducted in Poland in 2010 showed that only 22% of pedestrians felt safe while crossing the road at pedestrian paths, 46% felt somewhat safe and 32% did not feel safe at all. In the surveys conducted in the EU, pedestrians reported rather aggressive behaviours of car drivers because they did not give way at pedestrian crossings. According to opinions of 32,7% pedestrians, motorist's failure to give way at pedestrian crossings was ranked as a fourth of the most aggressive car driver behaviour [7].

Inspired by SARTRE, the ESRA survey (E-Survey of Road user's Attitudes) filled the gap that emerged after the SARTRE project. ESRA was a joint international initiative of research centers and road safety institutes across the world. Every 3 years, they carry out surveys on road users for their opinions on road safety in 38 countries. Based on a common questionnaire, data were gathered online. Two editions of global ESRA 1 in 2015 and ESRA 2 in 2018 were conducted. The result of each edition was presented as a series of thematic reports summarizing the survey in individual countries. Poland's Country Fact Sheets in 2015 showed self-declared risky behaviour of pedestrians at zebra crossings: 82.8% of respondents crossed the road at places other than the nearby pedestrian crossing at least once in the last 12 months (compared to 87.4% in all of the EU); 46.3% crossed the road when the pedestrian crossing light was red (compared to the EU average of 66.6%) and 39.5% were distracted because they were text messaging/emailing or checking social media (e.g. Facebook, Twitter, etc.) (compared to the average of 38.2% for all of the EU). Results from SARTRE 4 in 2010 compared to ESRA 1 in 2015 showed a considerable increase in distractions in traffic in the form of listening to music through headphones while walking on the street or cycling. Most pedestrians in 2010 did not use MP3/iPod/music devices. In 2015, about two out of three pedestrians (younger than 34 years of age) reported that they listened to music through headphones [8]. Data of ESRA 2 collected from 48 countries in 2018 showed self-declared opinions of most common pedestrian risky behaviours. Regarding crossing road outside the pedestrian crossing, 70% of respondents stated they had behaved this way at least once in the last 30 days. 56% of respondents declared that they had read a text message on the phone or checked social media while walking on the street. Surveyed respondents declared that they listen to music through headphones relatively frequently. A total of 51,8% of the respondents in Europe and 35.5% of the respondents in Poland admitted crossing the road at a red light at least once in the last 30 days (9). Responses on pedestrian behaviours in the questionnaire survey of Poland Country Fact Sheets in 2018 showed that 69% of the respondents had crossed the road at places other than the nearby pedestrian crossing (distance < 30m) in the last 30 days (compared to 74% in all of the EU); 35% of the respondents crossed the road when the pedestrian light was red (to EU of 51,8%) and 51,9% were distracted because they were text messaging/emailing or checking social media while walking (average for all EU was 58,7%). 36,7% admitted to walking while wearing headphones admitted (average for all EU was 33, 4%). Comparison of data in 2015 and 2018 in Poland indicated a decrease in risky behaviours by pedestrians while crossing the street but increasing distracting by listening to mobile phones [9].

Another survey to determine how familiar road users were with traffic regulations on giving way in different situations was conducted in Australia. In addition, surveys were conducted on pedestrians who crossed the road and on car drivers in parking lots near the pedestrian crossing. Each questionnaire included basic questions to obtain information about the respondent (age, economic status, frequency of crossing the road (for pedestrians) and length of holding driving license (for a driver)). In addition to questions, illustrations were attached to the questionnaire showing various types of pedestrians–driver encounters on the road. Respondents indicated who has priority in each situation on the road [10].

There were many others research projects like SARTRE carried out at the national level to determine road users' perception of traffic situations [11, 12]. Regarding age and gender of pedestrians crossing the road research showed that young pedestrians (up to 25 years old) declared more risky behavior than demonstrated in actual situations [13].

3. METHODS AND MATERIAL

The aim of this study was to determine attitudes of pedestrians and drivers on pedestrian–driver encounters on the road network in Poland. These encounters affect road safety, and high numbers of injuries and deaths occur on crosswalks. For the quantitative analysis of the opinions, questions were posed face to face during interviews of pedestrians and car drivers at study site locations at crosswalks in four voivodships of Poland in 2018. Selection of voivodships for research that was representative for the entire country was made due to the analysis of the general state of road safety and accidents involving pedestrians in Poland in 2017. Data of each individual voivodship in Poland were analyzed for road safety indicators and changes in these over the recent years; number of accidents involving pedestrians; and proportion of accidents involving pedestrians among the total number of accidents in the voivodship.

In 2017, in all, there were 8 197 accidents involving pedestrians in 16 voivodships in Poland. In four voivodships selected for research, there were 3 677 accidents (accounting for 45% of all accidents involving pedestrians in Poland). In 2017, 873 pedestrians died in Poland, and in the four voivodships, 412 dead pedestrians died. This meant that nearly 50% of fatalities in this group of road users occurred on the roads of the four voivodships chosen. In 2017, 7 587 pedestrians were injured in Poland [14]. Selection of voivodship for research was based on proportion of accidents involving dead pedestrians out of the total number of accidents with fatalities: very high (29% - 31%), high (25% - 28.9%), medium (21.9% - 24.9%) and small (18% - 21.8%). This reflected voivodship of Silesia (29.1%), Mazovian (27.8%), Greater Poland (23.2%), and Lodz (21.5%).

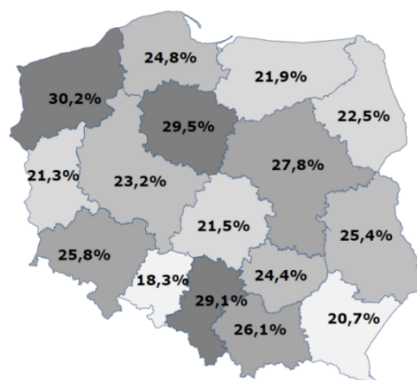


Fig. 1. Proportion of accidents involving pedestrians out of the total number of accidents in each voivodship of Poland in 2017 [14]

This study was performed in real-life field conditions (on-site) in 51 locations of four selected areas of Poland in 2018. The criteria of real-life field conditions were the same in each voivodship. On-site research was carried out on road sections with permitted speed limits of 50 km/h and 70 km/h both in

built-up and non-built-up areas in large cities and small towns at the area of pedestrian crossings outside intersections and at intersections with and without traffic lights.

Altogether, there were 51 real-life observation fields at the area of pedestrian crossings to carry out surveys on driver–pedestrians encounters (in large cities: 11 for both drivers and pedestrians; in small towns: 11 measurement points for drivers and 10 measurement points for pedestrians; at non-built-up areas, there were 8 measurement points). Altogether, there were 30 observation fields on roads to carry out surveys on pedestrians and 22 observation fields to carry out surveys on drivers. 800 drivers and pedestrians were questioned during surveys carried out on 51 observation fields in four voivodships. During onsite observations, behaviours of more than 22 000 pedestrians and more than 310 000 car drivers were recorded for analysis. The survey aimed to find out the opinions of drivers and pedestrians in pedestrian crossings. The methodology used was first adopted in 2015 and then repeated in 2018 in this study. The research was empirical in nature and was conducted onsite near pedestrian crossings. The research method was based on the theory of probability and the random selection of people for the research. In-depth quantitative research was carried out. Quantitative analysis (QA) is a technique that uses mathematical and statistical modelling, measurement, and research to understand behaviour. Quantitative analysts represent a given reality in terms of a numerical value.

The focus was on using special research techniques to better and more accurately understand the analyzed phenomenon, i.e., the behaviour of pedestrians and drivers. The research was conducted in narrower groups in relation to drivers and pedestrians, separately in the areas of large cities, small towns or outside built-up areas. Based on the selected research sample, conclusions were drawn with respect to the population of drivers or pedestrians. The size of the research sample was determined with the assumed confidence level of 95% and a maximum error not exceeding 3%. The methodology of questionnaire surveys was first adopted in 2015, and then repeated in 2018 in this research. The survey on attitudes focused on quantitative analysis of PAPI (Paper & Pen Personal Interview). Specialized interviewers (group of three pollsters in each voivodship) conducted interviews in person at onsite research fields using specially prepared questionnaires. The interviewers asked the questions and noted the answers on a sheet with a printed questionnaire. Pedestrians and drivers were interviewed close to the zebra crossings in large and small towns, outside built-up areas. The minimum research sample for each voivodship was 100 questionnaires for pedestrians and drivers. The surveys on attitudes were complemented by the onsite observation study of driver–pedestrian encounters observed.

Surveys of pedestrians' attitudes focused on the problems that they faced on the roads and knowledge of rules for safe crossing on pedestrian crossings. Data were collected at the area of zebra crossings. The characteristics of the interviewed group were as follows:

- respondents' sex - equal distribution of men and women,
- age group – the largest group was between 20 and 40 years old and
- length of holding driving license – most pedestrians hold the driving license.

Questionnaires on drivers' attitudes included the problems that drivers encounter when crossing pedestrian crossings, the rules involving passing crossings and giving way to pedestrians at crossings. Surveys on drivers' opinions were conducted in and outside built-up areas, small towns, in places where drivers can easily be interviewed (gas stations, parking lots). The characteristics of the surveyed drivers were as follows:

- gender of the respondent –there were more men (over 60%) than women,
- age range - the largest group of respondents were aged between 20 and 40 years and
- the average annual mileage reported by drivers was between 5 000 and 15 000 km.

Pedestrians and drivers were questioned separately. During face-to face survey, interviewers used printed questionnaires to ask questions and noted the answers on a sheet.

Pedestrians' survey design

On-street pedestrian surveys were divided into six different sections to obtain pedestrians' opinions and knowledge regarding crossing the roads (knowledge of traffic rules at zebra crossings and

problems that they face while walking across the street). They were asked if they support the requirement for a car driver who is approaching zebra crossing to reduce speed in order to not put crossing or entering pedestrians at risk. Each survey had its own study site location.

The questions focused on the following:

Section 1

Demographic information about age (less than 20, between 20 and 40 years old, between 40 and 60 years old, 60+).

Section 2

Gender (M, F).

Section 3

Do you have current driving license? (Yes, No).

Section 4

What problems do you have at crosswalks (max 3 answers)?

1. Drivers of motor vehicles do not stop before the pedestrian crossing.
2. Too long waiting time to cross.
3. Incorrect, aggressive car drivers' behaviour.
4. Too short a green light signal (with signalized crossings).
5. Poor/restricted visibility at the crossing (parked vehicles).
6. Too long pedestrian crossing.
7. Road design, infrastructure errors/wrong marking.
8. No signalized crossings (crossing without signalization).
9. Improper maintenance/ damages; and
10. Others.

Section 5

What are the obligations of a pedestrian while crossing the road (how pedestrians should or should not behave)? (Can provide several answers)

1. Obligation to behave with extreme caution.
2. Obligation to use pedestrian crossings.
3. He or she must not step on the road directly in front of the oncoming vehicle/or other obstacles limiting visibility.
4. He or she cannot stop.
5. He or she cannot run.
6. I do not know.

Section 6

Do you support the requirement for a car driver who is approaching zebra crossing to reduce speed in order to not put crossing or entering pedestrians at risk? (Answer: yes, or not).

Both, pedestrians, and car drivers were asked the same, quoted above question.

Car drivers' survey design

On-street motorists' survey was divided into six sections to obtain motorists' opinions about knowledge of traffic rules at the zebra crossings, issues they face while approaching zebra crossings. Each survey had its own number of study site location.

The questions were as follows:

Section 1

Demographic information about age (less than 20, between 20 and 40 years old, between 40 and 60 years old, 60+).

Gender (M, F).

Section 2

How many kilometers do you drive per year? (Less than 5000km, between 5000 and 15000 km; between 15000 and 30000 km, more than 30 000 km).

Section 3

What problems do you face while walking on the zebra crossing? (Max 3 answers)

1. Improper/risky behaviours of pedestrians.
2. Improper/risky/aggressive behaviours of drivers.
3. Poor/limited visibility at the area of zebra crossings (e.g., parked vehicles).
4. Design/infrastructure errors/wrong markings.
5. Poor maintenance/damages.
6. Too short green signage (for crosswalks with signalization).
7. Bad lighting; and
8. Others.

Section 4

What are the obligations of car drivers while approaching a zebra crossing (how driver should or should not behave)? (Can provide several answers)

1. Be especially careful at the crossing.
2. Decrease speed if the pedestrian is on or approaching zebra crossings.
3. Decrease speed generally/irrespective of the presence of pedestrians.
4. Giving way to a pedestrian who is walking on a zebra crossing.
5. Giving way irrespective of the presence of pedestrians.
6. Giving way to wheel chaired pedestrians.
7. Cannot overtake another vehicle.
8. Cannot overtake another vehicle that has stopped to give way to a pedestrian; and
9. Use marking when appropriate.

Section 5

Do you support the requirement for a car driver who is approaching zebra crossing to reduce speed in order to not put crossing or entering pedestrians at risk? (Answer: yes, or not).

Section 6

In addition to the questions, there were illustrations in the survey showing various types of pedestrians-driver encounters on the road (Fig. 2). The interviewed drivers had to provide their opinions and indicate in which situation they should or should not stop, i.e. give way to pedestrians. The goal of this survey was to find out how familiar drivers are with traffic regulations in terms of the priority of road users in different situations. The survey presents 4 situations where the pedestrian's position was different in relation to the crossing:

- A. pedestrian approaching the crossing,
- B. pedestrian waiting before the crossing,
- C. pedestrian entering the crossing and
- D. pedestrian crossing the zebra.

The drivers interviewed were to indicate how they would behave when approaching a crossing from two opposite directions marked on the illustration as direction X and direction Y.

Based on the surveys, the attitudes of drivers and pedestrians were analyzed, and cameras were used to record the actual behaviours of drivers and pedestrians. Verification of onsite research fields to conduct a quantitative study on the attitudes of drivers and pedestrians in four voivodships (related to the proportion of fatal accidents involving pedestrians) ensured the representativeness of the sample per 100 questionnaires for each road user group in each voivodship. The analysis of the cumulative results enabled collection of data to draw comprehensive conclusions. According to the description of the methodology, collected data should be treated as appropriate for the assessment of the situation in the entire country. Research material collected at the area of pedestrian crossings of various types of roads and road sections of 4 selected voivodships presented the situation for the entire country and represent the characteristics of pedestrian and vehicle traffic.

4. RESULTS

The results from the survey on the attitudes of pedestrians and car drivers conducted in 2018 were compared to previous research of this kind from 2015. Presented in the article declared opinions of

pedestrians and car drivers from survey were compared to video recorded behaviours from the site study location of zebra crossings. According to the results of the survey on pedestrians' attitudes in 2018, the main problems identified were vehicles not stopping to allow safe crossing and long waiting time to cross the street. There were some differences in the answers provided by pedestrians from large cities versus pedestrians from small towns and non-built-up areas. In terms of the problems faced while crossing, 81% of the pedestrians from small towns mentioned that drivers did not stop at pedestrian crossings and 45% reported risky behaviours of drivers. Long waiting time to cross a street was reported as a problem by 53% of pedestrians from large cities, while only 40% of pedestrians from small towns reported this problem. Short green pedestrian signage at the crosswalk was a problem reported by 30% of respondents from big cities; for 98% of pedestrians from small towns, the duration of the green signage was not a problem. The lack of signalized crossings was a problem for 8% of pedestrians from large cities and for only 5% of pedestrians from small towns. According to pedestrian' declared opinions the design and infrastructure errors nor poor road maintenance were not a problem for pedestrian safety. An additional question in the interviews was related to pedestrians' safety, wherein higher restrictions should be imposed on drivers who fail to slow down when approaching pedestrian crossings, posing a risk to pedestrians. 78% of pedestrians expressed the opinion that the law is not restrictive enough when it comes to drivers' obligations towards pedestrian safety.

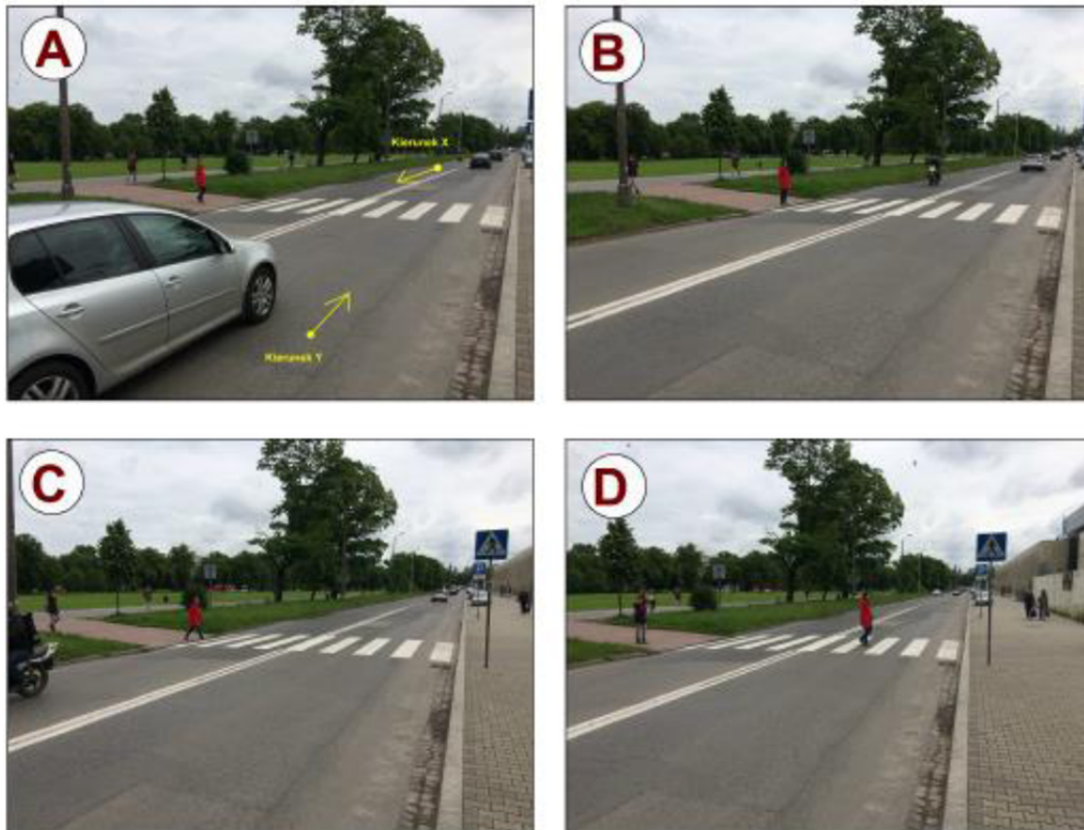


Fig. 2. Roadside situations presented to drivers during a questionnaire survey [14]

Time evolution of results from survey on pedestrians' attitudes at pedestrian crossings during 2015 (as a pilot study) and 2018 in Poland showed:

- Car drivers not stopping for pedestrians at non signalized crossings was the biggest problem reported by 68% of pedestrians from large cities in 2015 and 81% of pedestrians from small towns and non-built-up areas in 2018.
- The problem of too long a waiting time was reported by pedestrians in large cities in 2018 (53%) than in 2015 (15%).

- Risky and incorrect car drivers' behaviours were indicated by 45% surveyed pedestrians in 2018 and only by 5% in pilot research in 2015.
- Restricted visibility of crossing due to, e.g., parked vehicles was reported by more pedestrians in 2018 than in 2015 [16].

The results of the survey on drivers' attitudes based on the drivers' self-declared opinions in 2018 indicated that 52% of the drivers pointed out pedestrians' incorrect and risky behaviours as a problem on crosswalks. At the same time, drivers critically assessed their own behaviour; more than half of them (76%) indicated risky driving behaviours as the cause of risks to pedestrians. Only a few drivers (5%) reported design errors or poor road maintenance as a risk for pedestrian while crossing. 78% of questioned motorists supported the requirements for car drivers who are approaching zebra crossing to reduce speed in order to not put crossings or entering pedestrians at risks. Apart from questions in the survey, some illustrations showed various road situations of pedestrian–driver encounters at the area of zebra crossings (Fig. 2). The drivers interviewed had to describe and indicate in which situations they should or should not stop, i.e., give way to pedestrians. The goal of this survey was to find out whether drivers are familiar with traffic rules related to pedestrians' safety. Opinions expressed by drivers in relation to the situations presented in questionnaire on 4 different pedestrians' behaviours at crosswalk (approaching, waiting, entering, crossing) and cars (drivers coming from direction X or Y) indicated that they had knowledge of traffic regulations on giving way to road users in different situations. In terms of specific situations when pedestrians were on the drivers' road section (applicable to drivers coming from the X direction, Fig. 2, picture B), the following results were obtained:

- 76% of respondents stated that they would give way to a pedestrian who approaches the zebra crossing (situation A).
- 85% of respondents stated that they would give way to a pedestrian who is waiting at the zebra crossing (situation B).
- 8% of respondents stated that they would not give way to pedestrians (situation C).

In terms of drivers' behaviours when a pedestrian is on the opposite road section (applied to drivers coming from Y direction (Fig. 2, picture A), the following results were obtained:

- 70% of respondents stated that they would give way to pedestrians who approach the zebra crossing located on the opposite road section to driver (situation A).
- 72% of respondents stated that they would give way to pedestrians who are waiting in front of the crossing (situation B).
- 83% of respondents stated that they would give way to pedestrians entering the crossing (situation C).
- 6% of the respondents stated that they would not give way to pedestrians who leave the crossing (situation D).

Quantitative analysis to examine drivers' knowledge with respect to the rules on pedestrian crossing while a pedestrian approaches or crosses the zebra crossing showed that most of the surveyed drivers followed the traffic laws.

Results on drivers' self-assessment based on questionnaires compared to recorded observations of drivers' behaviours according to real traffic situation depicted on four illustrations indicated that drivers' awareness (attitudes) was not always consistent with the actual recorded behaviour on the road.

Comparison of driver's actual behaviour to their declared opinions in 2018 showed the following:

- 69% of drivers coming from the Y direction in real life did not stop to give way to a pedestrian who was approaching the crosswalk on the other side of the road section (Fig. 2, picture A); 70% of drivers in questionnaire would not give a way to pedestrian at the area of zebra in that road situation.
- during observations, more drivers coming from the X direction in the situation pictured in A, B and C on the road gave way to pedestrians than showed survey results on motorists's declared attitudes and opinions (Fig. 2).

- results were opposite to the situation when drivers were coming from the Y direction pictured in A, B and C on the road (Fig. 2.): more drivers declared giving way to pedestrians than what was recorded on camera during observations.

Comparison of driver's actual behaviour to their declared opinions on specific road situation of giving way to pedestrians at crosswalk pictured on Fig. 2 made over period of time (results from pilot study in 2015 versa research in 2018) showed the following:

- most motorists in both surveys reported stopping and giving way to pedestrian who was approaching, waiting, or entering the zebra crossing.
- in 2015, only 20% of observed motorists stopped to give way to a pedestrian who was waiting to cross the road (applied to situations when drivers were coming from the X direction, Fig. 2 picture B). However, the actual behaviours were different to what was stated: in 2015, 89% of respondents declared that they give way to pedestrians waiting before the crossing. These proportions changed in 2018, respectively, to 78% and 85%.
- in 2018, more than 30% of observed motorists and 70% of drivers interviewed coming from the Y direction (Fig. 2 picture A) stopped for pedestrians who were approaching the zebra crossing. In 2015 less than 1% of drivers stopped before zebra in those road situations, which meant almost no car driver gave way to pedestrian approaching zebra from opposite road section but 33% of motorist declared in questionnaire to do this.

A survey of pedestrians' and car drivers' attitudes at the area of pedestrian crossings conducted over period of time showed changes in risk perceptions and needs of both groups of road users. The results could be valuable for policy makers to implement effective interventions aimed at improving road safety while eliminating pedestrian fatalities.

5. DISSUSSION AND CONCLUSION

Research in road traffic safety is used to carry out preventive activities for more safety of all road users. Problem of pedestrians' safety requires more attention and in-depth analyses. In this context, it is essential to perform analyses and compare self-declared attitudes and the actual behaviours of both pedestrians and drivers. Using developed methodology for roadside observations and questionnaires survey on car drivers and pedestrians allow to carry out systematic analysis over period of time for risk perception assessment. Results of research allow to introduce changes and then evaluate their effects.

Improvements for pedestrian safety require more detailed study today specially at the area of zebra crossing. Statistical analysis shows that pedestrians account for almost 30% of all fatalities; more than 60% of accidents with pedestrians occur at crossings. Surveys on attitudes and observations of road safety to perform assessments of pedestrian needs are widely performed across countries with the aim of lowering the number of injuries and deaths among vulnerable road users.

This paper presents results on road users' attitudes from questionnaire surveys of drivers and pedestrians at areas of pedestrian crossings where there are many accidents with pedestrians and high number of fatalities. In this paper, findings based on data from roadside observations and questionnaire surveys in 2018 that were part of a large research project on safety performance indicators to evaluate trends at crosswalks commissioned by the National Road Safety Council in Poland are presented. During pilot study in 2015 was used methodology to carry out questionnaire survey and behaviour observation in road study location first applied at crosswalks in urban areas in two voivodships of Poland. Next questionnaire survey and observation study according to the same methodology were conducted in four voivodships of Poland in 2018. This paper sums up the outcomes from questionnaires of pedestrians and drivers and presents mutual expectations and evaluation of actual behaviours.

Analysis on pedestrians and car driver' attitudes and behaviours are conducted in other countries. Project Pedestrian Survey: Identifying pedestrian knowledge, perceptions of attitudes on road safety in Baku, Azerbaijan was carried out between 2016 and 2017. The study used a mixed-methods approach with qualitative and quantitative tools to examine pedestrians' knowledge, perceptions, and attitudes

with respect to road safety [18]. The results obtained from the study in Baku confirmed the results obtained in Poland: respondents indicated that both car drivers and pedestrians act irresponsibly, leading to risky situations on the road. 40% of pedestrians in Baku reported that speeding and aggressive driving and drivers not following the traffic rules were the main problems posed to pedestrian safety. According to 34% of Polish pedestrians from large cities and 45% of pedestrians from small towns, car drivers' risky behaviours at crosswalks represent one of the main risk factors to pedestrians. They had fairly good knowledge of traffic rules to allow pedestrians cross the road, but they violate the signs and pedestrian crossing regulations. According to the pedestrians' opinions expressed in questionnaire in Baku and in Poland, they would like to have longer pedestrian green light (longer crosswalk time) and better lightning of pedestrian's crosswalks.

Pedestrian surveys for obtaining perspectives of pedestrians with respect to their experiences and needs at crosswalks locations in Washington D.C in 2004 were published in *On-Street Pedestrian Surveys of Pedestrian Crossing Treatments* [19]. Comparison of published results indicated that marked signalized crossings for more than 66% of the questioned pedestrians in Washington D.C. were unsafe due to cars not stopping for pedestrians. Other problems that they indicated were high traffic volume; high-speed traffic and motorists who were not watching out for pedestrians. The results of the Polish survey indicated that for 64% of pedestrians from large cities and 81% of pedestrians from small towns, the greatest safety concern were drivers who did not stop before zebra crossings for safe pedestrian crossings. In Baku, 19,7% of respondents indicated that drivers should be penalized more often for not giving way to pedestrians wanting to cross the street, where appropriate. A comparison of the results of Polish surveys from 2015 and 2018 shows a clear change in the perception of the importance of giving way to pedestrians approaching pedestrian crossings. In 2015, only 20% of drivers gave way to pedestrians, and in 2018, over 70% drivers gave way to pedestrians. 90% of Polish pedestrians in self-declared questionnaires said they must be extremely careful when crossing.

78% Polish pedestrians and 72% of motorists according to their declared opinion supported the requirement for car driver who is approaching zebra crossing to reduce speed in order to not put crossing or entering pedestrians at risks. The results of survey confirmed support for introduction of law to give way to pedestrians while approaching the crosswalks. Results presented in this article were taken into consideration by policy makers to change Polish traffic regulations for greater pedestrian safety at crossings since 2021. First, before introduction of new traffic regulations, awareness and educational campaigns should be carried out to change drivers' behaviours when they approach zebra crossings.

ESRA1 and ESRA2 surveys on road users' attitudes are repeated every three years, which shows that scientific research is important to perform assessments of traffic situations across countries. This article presents the results of the newest study performed in 2018, which will be "before" measurement, to compare with the next study in the future. The next, repeat in the future research according to developed methodology will show if introduced new regulation on pedestrian safety at crosswalks in 2021 would change attitudes and behaviours of motorists and pedestrians.

References

1. Polskie Obserwatorium Bezpieczeństwa Ruchu Drogowego. [In Polish: Polish Road Safety Observatory]. Available at: <https://www.obserwatorium.brd>].
2. Pedestrian and Cyclist. 2018. ERSO. Available at: https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/ersosynthesis2018-pedestrianscyclists.pdf.
3. Wittink, R. 2001. *Promotion of mobility and safety of vulnerable road users: final report of the European research project PROMISING (Promotion of Measures for Vulnerable Road Users)*. D-2001-3. SWOV Institute for Road Safety Research, Leidschendam. Available at: <https://www.swov.nl/sites/default/files/publicaties/rapport/d-2001-03.pdf>.

4. Road Safety Knowledge System. Available at: https://ec.europa.eu/transport/road_safety/specialist/knowledge/pedestrians_en.
5. Özkan, T. & Lajunen, T. & El. Chliaoutakis, J. & Parker, D. & Summala, H. Cross-cultural differences in driving behaviours: A comparison of six countries. *Transportation Research Part F*. 2006. Vol. 9(3). P. 227-242.
6. ESRA initiative: Towards global monitoring and analysis of road safety performance. IATSS Research 44. 2020. P. 163-165.
7. SARTRE 4. *Final Report*. Available at: https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/projects_sources/sartre4_final_report.pdf.
8. Project and the results of ESRA 2015. Available at: <https://www.esranet.eu>.
9. ESRA2 Thematic Report No 10 Pedestrians. Main responsible organization for this report ITS Poland. D/2020/0779/32. Report number: 2020-T-06-EN 18/11/2020.
10. Hatfield, J. & Fernandes, R. & Job, R.F.S. & Smith, K. Misunderstanding of right-of-way rules at various pedestrian crossing types: Observational study and survey. *Accid. Anal. Prev.* 2007. Vol. 39. No. 4. P. 833-842.
11. Schlembach, Ch. & Furian, G. & Brandstätter, Ch. Traffic (safety) culture and alcohol use: cultural patterns in the light of results of the SARTRE 4 study. *European Transport Research Review*. 2016. Vol. 8. Art. no 7.
12. Tom, A. & Granié, M.A. Gender Differences in Pedestrian Rule Compliance and Visual Search at Signalized and Unsignalized Crossroads. *Accid Anal Prev.* 2011. Vol. 43(5). P. 1794-801. DOI: doi: 10.1016/j.aap.2011.04.012.
13. Papadimitriou, E. & Lassarre, S. & Yannis, G. Pedestrian risk taking while road crossing: a comparison of observed and declared behavior. *ELSERVIER Transportation Research Procedia* 2016. Vol. 14. P. 4354-4363.
14. Police Headquarter, Road accidents in Poland in 2017.
15. Secretariat of the National Road Safety Council: Status of road traffic safety and undertaking activities in this subject in 2017.
16. Dąbrowska-Loranc, M. & Skoczyński, P. & Zielińska, A. & Sicińska, K., et al. *Badania zachowań pieszych i relacji pieszy-kierowca wrzesień - grudzień 2018 r.* Krajowa Rada Bezpieczeństwa ruchu drogowego. 2018. [In Polish: *Study on behaviour of pedestrians and driver-pedestrians encounters September - December 2018*. The Secretariat of the National Road Safety Council].
17. Jamroz, K. & Budzynski, M. & Gaca, S. & Kiec, M., et al. *Metodologia systematycznych badań zachowań pieszych i relacji pieszy-kierowca*. Krajowa Rada Bezpieczeństwa Ruchu Drogowego. 2015. [In Polish: *Methodologies for systematic studies of pedestrian behaviour and pedestrian-driver relations*. Secretariat of the National Road Safety Council].
18. Pedestrian Survey: Identifying pedestrian knowledge, perceptions of attitudes on road safety in Baku, Azerbaijan in 2016/2017. Available at: <https://www.easst.co.uk/wp-content/uploads/2017/10/AMAK-Pedestrian-Survey-Final-Report.pdf>.
19. Fitzpatrick, K. & Ullman, B. & Trout, N. *On-Street Pedestrian Surveys of Pedestrian Crossing Treatments*. Office of Highway Safety Pedestrian Survey Report N. Washington Street Wilmington, DE 19801 302-655-1552. Available at: https://nacto.org/docs/usdg/on_street_pedestrian_survey_fitpatrick.pdf.