

Keywords: security; pedestrians; pedestrian crossing; traffic

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ANALYSIS OF PEDESTRIAN BEHAVIOR AT CROSSWALKS AND EVALUATION OF FUNCTIONING PEDESTRIAN CROSSINGS

Summary. Every year, on Polish roads, many deaths occur. In the best case scenario, only the vehicle is damaged. The number of road accidents is extremely high. Road safety is mainly affected by the reckless behavior of pedestrians at street crossings. Undoubtedly, road safety is an important issue. The aim of this article is to analyze the behavior of pedestrians at crossings and to evaluate the function of pedestrian crossings. For this purpose, a questionnaire study was conducted, in which respondents were asked whether they take precautions and whether they use cell phones at pedestrian crossings. Moreover, an assessment was performed of the safety of a selection of pedestrian crossings: whether they are well lit, and whether the respondents have been involved in a traffic accident. From the analysis of the survey, it can be concluded that the number of pedestrians taking precautions at pedestrian crossings averaged 86.46%; 25.69% of the respondents admitted that they have used a cell phone at a pedestrian crossing. In addition, the survey confirmed that the most dangerous pedestrian crossings are those that do not have traffic lights. It was also found that those who have a driver's license should actually be more vigilant at pedestrian crossings when driving.

1. INTRODUCTION

Every year, on Polish roads, many deaths occur. In the best case scenario, only the vehicle is damaged. The number of accidents is very high. They are mainly the result of the behavior of pedestrians at pedestrian crossings. Despite the construction of new, safer roads and pedestrian crossings, the number of road incidents is constantly increasing, and, every year, there are about three thousand casualties due to road accidents. On average, in Poland, forty one thousand people are injured annually [1]. The main causes of accidents are inappropriate of vehicle speed, not taking into account the current road conditions or regulations, drunk driving and random events. Safety is a basic human need [2]. The aim of this research is to assess the behavior of pedestrians at pedestrian crossings in the city of Pila and to evaluate their safety.

As the results of other observational studies conducted by authors during the pandemic indicate, the most dangerous crossing for pedestrians in the city of Piła is the crossing located at Wojska Polskiego Avenue, which is the site of the highest number of traffic incidents, as confirmed by the data from the Piła District Police Headquarters (Tab. 1). The behavior of pedestrians at the analyzed crossings was very often reckless; they did not look and listen for oncoming traffic, which led to situations in which they entered the crossing without taking the appropriate precautions [1]. There are no speed limits at the aforementioned crossings. Moreover, all crossings, except the one on Stefan Okrzei Street, also contain pedestrian refuge islands.

Table 1

Comparison of the results of the tested pedestrian crossings

Type of activity / Pedestrian crossing	Wojska Polskiego Avenue	Wojska Polskiego Avenue near the centre	Stefana Okrzei	Alei Piastów	next to the "VIVO" gallery	Arithmetic average
The pedestrian checks for oncoming traffic [%]	86,33%	91,15%	90,12%	90,74%	65,53%	84,77%
The pedestrian does not check for oncoming traffic [%]	11,24%	6,65%	6,96%	6,38%	30,08%	12,26%
Failure to yield right of way by the pedestrian [%]	1,87%	0,75%	1,62%	1,80%	0,00%	1,21%
Pedestrian using a phone at the crosswalk [%]	0,57%	1,45%	1,31%	1,08%	4,39%	1,76%

Pedestrian behavior can be studied in several ways. The first option is to directly observe situations on the road discreetly ensuring that the person being observed was unaware that he or she is being observed; the second option is to make observations that take place under both normal and laboratory conditions.

There are many examples of inappropriate pedestrian behaviors. One of them is too much hesitation on behalf of the pedestrian on whether to cross the road or to stop in front of the crosswalk. This occurs whenever a pedestrian approaches the crosswalk and then stops in front of it, yields the right of way to the driver, and then suddenly changes his or her decision, and unexpectedly starts to enter the crossing. Another example of irresponsible behavior is crossing the road in places that are not designated for that purpose; this is especially dangerous in unlit places. Outside built-up areas, there are places where pedestrians are not certain which side of the road should be used for walking. Moreover, at crossings with traffic lights, pedestrians behave irresponsibly by approaching the crosswalk without looking and listening for approaching traffic and crossing the street even when the red light is on. There are still more types of reckless behaviours displayed by pedestrians: on roads where part of the pedestrian crossing is covered by vehicles parked along the roadway, the pedestrian is not always clearly visible to drivers, because he or she is partially or completely obscured by the vehicles parked along the roadway, and yet, pedestrians often seem not to realize this and do not check for traffic before continuing to cross the road [3-5].

Safe road travel means following a number of established rules and regulations that should not be taken lightly [6]. Improved road safety is influenced by many elements related not only to the promotion of correct behavior among drivers [7-9] but also to the proper organization of traffic, and the condition of roads and vehicles [10-13]. Training and examinations for future drivers are of equal importance. Road safety is a field of scientific inquiry that includes not only the above-mentioned aspects but also issues related to traffic supervision, emergency medical services and transportation psychology [13, 14]. The problem of road traffic safety, including pedestrians, is discussed in the following publications [16-24].

2. MATERIALS AND METHODS

The city of Piła is a picturesque agglomeration located next to the River *Gwda*, on the edge of West Pomerania and Greater Poland. Half of the city's surface is covered by parks and forests, which fill in the areas between new residential districts. Nearby lakes emphasize the beauty of the city. The park area is a space of wonderful, natural landscapes that encourage active recreation. The city, thanks to its good location, is a significant intersection of transport paths in the country. Piła is also an intensively

developing center of economic activity. The leading branches of the local economy include electronics and electrical and printing industries. Piła is a town with approximately 74,000 inhabitants [25].

The purpose of this research is to analyze the behaviors of pedestrians moving through pedestrian crossings in the city of Piła. The study was conducted using a survey with a sample of 286 residents of Piła in April 2021. The survey consisted of 17 questions. The questions inquired whether the respondents were involved in a traffic accident in the past, whether or not they check for oncoming traffic when riding a bike and crossing the street using a bicycle path, whether they use a cell phone at crossings, which of the pedestrian crossings are the most dangerous for them and whether they are well lit. Due to the prevailing COVID-19 pandemic, an online survey distributed via email and social networking sites was utilized. The survey was conducted anonymously. Incomplete responses to the survey's questions were not included in the analysis.

The survey was preceded by a pilot study to ascertain whether the questions posed particular formal difficulties to the respondents (and if so, which ones) and to make necessary modifications to the questionnaire. Questions included in the survey allow the researchers to determine the behavior of city residents at pedestrian crossings. The results and conclusions of the study can be successfully extended to other pedestrian crossings, that is, not only the ones in the analyzed city of Piła but also to other cities in Poland. An important part of the research was to evaluate the sample selection. For the city of Piła (74000 residents), assuming a confidence level of 90% and a maximum error of 5%, the required number of people in the study was 270 respondents. Therefore, the survey was conducted with the participation of 286 people [26, 27]. In the survey, the majority of respondents were male (51%) and 49% were female. Most of the respondents were between the ages of 20 to 40 years (48%), followed by those who were 40-60 years old (22%), those who were younger than 20 years of age (17%) and those who were older than 60 years of age (13%). Most of the respondents lived in the city of Piła at the time of conducting the survey, comprising 68.58% of all the people included in the survey. 20.60% of the sample lived more than 20 kilometers away from the city center, and 7.87% of the sample lived between 5 and 10 kilometers from the city center constituted. The remaining respondents, which comprise 2.94% of the sample, resided between 11 and 20 kilometers away from the city center (Table 2). Despite living outside the city center, some respondents were familiar enough with it to provide correct answers and were able to evaluate e.g. which crosswalks in the city were the most dangerous in their opinion or suggest potential changes that could improve traffic safety. They were familiar with the city center because they commuted to work in Piła and before the pandemic, they used to commute to schools and universities.

Table 2

Place of residence of the respondents

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Living in Piła [%]	41,67%	47,17%	78,57%	90,91%	64,58%	81,82%	41,86%	66,67%	100,00%	72,59%	68,58%
5-10 km from the city center [%]	0,00%	5,66%	14,29%	9,09%	7,26%	0,00%	13,95%	20,00%	0,00%	8,49%	7,87%
11-20 km from the city center [%]	0,00%	7,55%	0,00%	0,00%	1,89%	0,00%	9,30%	6,67%	0,00%	3,99%	2,94%
More than 20 km from the city center [%]	58,33%	39,62%	7,14%	0,00%	26,27%	18,18%	34,88%	6,67%	0,00%	14,93%	20,60%

3. RESULTS

During the survey, respondents were asked if they had a driver's license. The majority of the respondents had a driver's license (66.63%). In terms of gender differences, 71.46% of men had a

driver's license and almost 10% less women than men had a driver's license (61.80%). The lowest number of licence holders was under 20 and over 60. This was the case for both men and women. These results can also be corroborated by the statistical data made available by the Central Statistical Office, which show that the lowest number of licence holders was under 20 and over 60 (Table 3).

Table 3

Respondents with a valid driver's license

Sex	Men					Women					Average
Age category	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes [%]	58,33%	92,45%	71,43%	63,64%	71,46%	54,55%	88,37%	90,00%	14,29%	61,80%	66,63%
No [%]	41,67%	7,55%	28,57%	36,36%	28,54%	45,45%	11,63%	10,00%	85,71%	38,20%	33,37%

The second question focused on the involvement of the respondents in a traffic accident involving pedestrians. Based on the results, it can be concluded that 77% of the respondent had never been involved in a traffic accident. Among men, the highest number of traffic accidents occurred among those between 40 and 60 years of age (35.71%). Among women, the highest number of accidents occurred among those older than 60 years of age (42.86%) (Table 4).

Table 4

Percentage of respondents involved in a traffic accident involving pedestrians

Sex	Men					Women					Average
Age category	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes [%]	12,50%	9,43%	35,71%	27,27%	21,23%	27,27%	11,63%	20,00%	42,86%	25,44%	23,33%
No [%]	87,50%	90,57%	64,29%	72,73%	78,77%	72,73%	88,37%	80,00%	57,14%	74,56%	76,67%

Moreover, an attempt was made to determine whether there was a correlation between having a driver's license and being involved in a traffic accident. Based on the analyses performed, it can be assumed that for a significance level of $\alpha=0.05$, there is no stochastic relationship between having a driver's license and being involved in a traffic accident ($D_{-2} < D_{-d}^2$) (table 5-6).

Table 5

Percentage of respondents who were involved in an accident according to their driving licence

Driver's license	Yes	No	Total rows
Yes	27,54	125,46	153
No	8,46	38,54	47
Sum in column	36	164	N=200

Table 6

Results of Chi-squared tests

df	α	D_{-2}	D_{-d}^2
1	0.05	0.05	3.841

where: df is the degree of freedom, α is the significance level, D_{-2} is the Chi-square statistic and D_{-d}^2 is the critical Chi-square value.

Furthermore, we analyzed whether there was a correlation between the sex of the respondents and their involvement in a traffic accident. Based on the analysis, it can be assumed that for the

significance level of $\alpha=0.05$, there is no correlation between the sex of the participant and involvement in an accident ($D_{-2} < D_{-d}^2$) (Tables 7-8).

Table 7

Involvement of respondents in accidents by sex

Sex	Yes	No	Total in rows
Women	20	78	98
Men	16	86	102
Total in column	36	164	N=200

Table 8

Results of Chi-squared tests

df	—	D_{-2}^2	D_{-d}^2
1	0.05	0.75	3.841

An attempt was also made to determine whether there was a correlation between the age of the respondents and their involvement in a traffic accident. Based on the performed analyses, it can be assumed that for a significance level of $\alpha=0.05$, the null hypothesis— that there is no stochastic relationship between the sex of respondents and involvement in accidents ($D_{-2} < D_{-d}^2$) – can be rejected. Considering this question, the alternative hypothesis –that there is a relationship between the age of the respondent and participation in a traffic accident –can be accepted (Tables 9-10).

Table 9

Involvement of respondents in a traffic accident by age

Age	Yes	No	Total rows
<20	6	29	35
20-40	10	86	96
40-60	11	33	44
>60	9	16	25
Total in column	36	164	N=200

Table 10

Results of Chi-squared tests)

df	—	D_{-2}^2	D_{-d}^2
3	0.05	10.71	7.815

Our next question focused on whether the people surveyed had ever been victims of a traffic accident. More than 12% of the respondents reported that they were victims of a traffic accident involving pedestrians, while 88% did not report this. The numbers of men and women were similar.

The answers to the question “what was the cause of the accident” in which the respondents were involved are presented in Fig. 1. 81% of the respondents did not provide an answer to this question as they had never been involved in any accident involving pedestrians. Those involved in the accident with the pedestrian said the cause of the accident was that the pedestrian entered without making sure how much as 9% first. A pedestrian failing to yield right of way was the next most common cause of accidents, 7%, followed by pedestrians entering the street crossing while using a cell phone, 3%. The above data are corroborated by the statistical data obtained from the Police department.

Table 11

Were the respondents victims of an accident involving a pedestrian?

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes [%]	8,33%	1,89%	21,43%	18,18%	12,46%	18,18%	4,65%	10,00%	14,29%	11,78%	12,12%
No [%]	91,67%	98,11%	78,57%	81,82%	87,54%	81,82%	95,35%	90,00%	85,71%	88,22%	87,88%

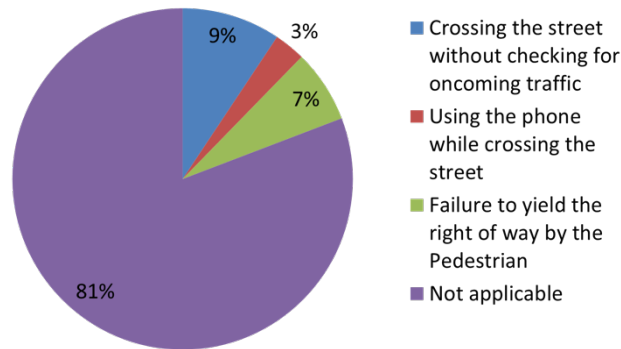


Fig. 1. Answers of the respondents

Table 6 presents the answers of respondents to the following question: “Do you look and listen for approaching traffic before entering a crosswalk?” The results show that 86.46% of the obtained answers were “Yes – always”. The answer sometimes was checked only by 13.54% of the respondents. The most positive aspect of the survey was the fact that none of the respondents checked the answer “no – never”. Among respondents between the ages of 40 and 60 years, both men and women chose the answer “yes-always” only. It is worth noting that 36% of women under the age of 20, marked the answer "yes sometimes". On comparing men and women, the results were similar; however, women answered 'yes-always' and 'yes-sometimes' more often than men. The data obtained from the present study do not corroborate the data obtained by the authors in previous research (tab. 1). This may be due to the fact that when conducting the current survey, the respondents had more time to answer the questions.

Table 12

Checking for oncoming traffic

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes, always [%]	75,00%	83,02%	100,00%	81,82%	84,96%	63,64%	95,35%	100,00%	92,86%	87,96%	86,46%
No never [%]	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Sometimes [%]	25,00%	16,98%	0,00%	18,18%	15,04%	36,36%	4,65%	0,00%	7,14%	12,04%	13,54%

The next question focused on pedestrians entering the pedestrian crossing without checking for oncoming traffic (Table 13). More than half of the respondents (57.62%) chose the option “no – never”. This result could be higher if some of the groups did not have such low values, i.e. age groups below 20 and above 60 for men and below 20 for women. The answer “sometimes” was chosen by 40.49% of the respondents. Among the respondents, 1.89% answered “yes-always”. When comparing men and women, with the only exception of the answer "Yes – always", women scored better.

Have you ever used a cell phone while entering a crosswalk? –was the next the question included in the survey. This question is of great importance due to the fact there are times when people enter a

pedestrian crossing without checking for oncoming traffic and are preoccupied with their cell phones at the same time (Table 14). The respondents most frequently selected the answer “sometimes” (48.91%). This was followed by “no – never” (48.62%) and “yes – always” (2.47%). The answer “yes-always” was chosen by 7.14% of men in the age category of 40-60 years. In a few categories, there were no respondents who chose this answer, i.e. men in the age category of >60 years and women <20, 40-60 and >60 years. The answer “no – never” was selected by all respondents (both men and women) in the age category of >60 years. The answer sometimes was selected by more than 90% of women under the age of 20 years. None of the people who were older than 60 years of age chose this answer. In terms of road safety, women scored better than men. The results were influenced by the number of people participating in the study in the age groups of <20 and between 20 and 40 years. According to the statistical data provided by the Central Statistical Office, younger people use phones and smartphones most frequently. The presented results corroborate the results obtained in the authors' previous research.

Table 13

Pedestrians entering the pedestrian crossing without checking for oncoming traffic

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Age category	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	Average
Yes, always [%]	0,00%	3,77%	0,00%	0,00%	0,94%	0,00%	4,65%	6,67%	0,00%	2,83%	1,89%
No never [%]	33,33%	58,49%	64,29%	45,45%	50,39%	27,27%	69,77%	76,67%	85,71%	64,86%	57,62%
Sometimes [%]	66,67%	37,74%	35,71%	54,55%	48,67%	72,73%	25,58%	16,67%	14,29%	32,32%	40,49%

Table 14

Using a phone while entering a crosswalk

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Age category	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	Average
Yes, always [%]	4,17%	3,77%	7,14%	0,00%	3,77%	0,00%	4,65%	0,00%	0,00%	1,16%	2,47%
No never [%]	12,50%	22,64%	42,86%	100,00%	44,50%	9,09%	41,86%	60,00%	100,00%	52,74%	48,62%
Sometimes [%]	83,33%	73,58%	50,00%	0,00%	51,73%	90,91%	53,49%	40,00%	0,00%	46,10%	48,91%

We also analyzed whether there was a correlation between the sex of the respondent and the usage of phones while entering a crosswalk. On the basis of the conducted analyses, it can be assumed that for a significance level of $\alpha=0.05$, the null hypothesis – that there is no stochastic relationship between the respondent's sex and the use of a cell phone while crossing the road – can be rejected ($D_{-2} < D_{-d} \frac{2}{d}$). For the question under consideration, it can be assumed that there is a relationship between gender and cell phone usage while crossing the street (Tables 15-16).

The current study also attempts to answer the question of whether there is a correlation between the age of the respondents and involvement in a traffic accident. On the basis of the performed analyses, it can be assumed that for a significance level of $\alpha=0.05$, the null hypothesis – which states that there is no stochastic relationship between the age of the respondent and the use of a cell phone while crossing the road ($D_{-2} < D_{-d} \frac{2}{d}$) – can be rejected. For the question under consideration, it can be assumed that there is a relationship between the age of the participants and cell phone usage while crossing the road (Tables 17-18).

The next question asked respondents which pedestrian crossing was the most difficult to cross. The vast majority of respondents felt that crosswalks without traffic lights were the most difficult to cross (70.61%). This was followed by crossings without pedestrian refuge islands (14.16%), followed by crosswalks with a pedestrian refuge island (12.21%) and crosswalks with traffic lights (3.02%). More than 90% of the respondents in the age group older than 60 years chose the answer “a crossing without traffic lights”. Crossing the street in these circumstances was least problematic for people between 20

and 40 years of age (56.60%) and for men and women who were between 20 and 40 years old (60.47%). On comparing men and women, it was women who obtained a higher average score, with a ratio of 72.35% to 68.87%. Crossing the street without a pedestrian refuge island was the biggest problem reported by men in the age group between 40 and 60 years (28.57%), while it was least problematic for women in the age groups >60, <20. 19.24% of males and 9.07% of females considered this type of crosswalk the most difficult to cross. Crossings with a pedestrian refuge island were most problematic for women between the age of 20 and 40 years (23.26%). However, they were the least problematic for men older than 60 years of age (0%). 16.31% of women found them to be the most problematic. Among men, only 8.11% found them to be the most problematic. Crossings with traffic lights were considered to be the most challenging for men between 40 and 60 years old (7.14%) and among women who were younger than 20 years old (9.09%). For a few of the analyzed groups, these crossings were not a problem at all. These groups were: men >60 years and women 20-40, 40-60, >60 years of age. Men scored an average of 3.77% and women 2.27% (Table 19).

Table 15

Using a phone while entering a crosswalk by gender

Sex	Yes	No	Sometimes	Total in rows
Female	2	49	45	96
Male	4	33	67	104
Total in columns	6	82	112	N=200

Table 16

Results of Chi-squared tests

df	α	D_{α}^2	D_{α}^2/d
2	0.05	8.03	5.99

Table 17

Using a phone while entering a crosswalk by age

Age	Yes	No	Sometimes	Total in rows
<20	1	4	30	35
20-40	4	29	62	95
40-60	1	23	19	43
>60	0	25	0	25
Total in columns	6	81	111	198

Table 18

Results of Chi-squared tests

df	α	D_{α}^2	D_{α}^2/d
9	0.05	56.23	16.92

According to the statistical data provided by the Piła District Police Headquarters, the highest number of accidents occurred at pedestrian crossings without traffic lights or even a pedestrian refuge island. The respondents' answers confirmed these data.

Furthermore, our questionnaire also inquired which of the pedestrian crossings in Piła were perceived as being the most dangerous. Among the obtained answers, there were four crossings that were previously scrutinized by the authors (Tab. 1). The statistical data provided by the District Police Headquarters in Piła also corroborated the answers of the respondents [1]. The respondents indicated the following crossings as being the most dangerous: the crossings on Aleja Piastów (32%), the

crossings on Aleja Wojska Polskiego (14%) and the crosswalk on Stefana Okrzei street (15%). Other crosswalks were selected by 29% of respondents, and no other crossings were mentioned by more than two respondents (Fig. 2).

Table 19
Most difficult crossings according to respondents

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Crossing without traffic lights [%]	70,83%	56,60%	57,14%	90,91%	68,87%	72,73%	60,47%	63,33%	92,86%	72,35%	70,61%
Crossing with traffic lights [%]	4,17%	3,77%	7,14%	0,00%	3,77%	9,09%	0,00%	0,00%	0,00%	2,27%	3,02%
Crossing with a refuge island [%]	8,33%	16,98%	7,14%	0,00%	8,11%	18,18%	23,26%	16,67%	7,14%	16,31%	12,21%
Crossing without a refuge island [%]	16,67%	22,64%	28,57%	9,09%	19,24%	0,00%	16,28%	20,00%	0,00%	9,07%	14,16%

Another question included in the survey asked the participants whether the pedestrian crossings in Piła were well lit. Most people said “no” (50.94%), and 49.06% answered “yes”. Most people in the age group over 60 years old considered the crossings to be well lit. Most women in the 20-40 age group answered “no” (67.44%). Data for this question are presented in Table 20. The above survey results are also confirmed by the authors' observations and by consultations with the District Police Headquarters in Piła.

Table 20
Are the pedestrian crossings in Piła adequately illuminated? (according to respondents)

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes [%]	58,33%	43,40%	35,71%	54,55%	48,00%	63,64%	32,56%	40,00%	64,29%	50,12%	49,06%
No [%]	41,67%	56,60%	64,29%	45,45%	52,00%	36,36%	67,44%	60,00%	35,71%	49,88%	50,94%

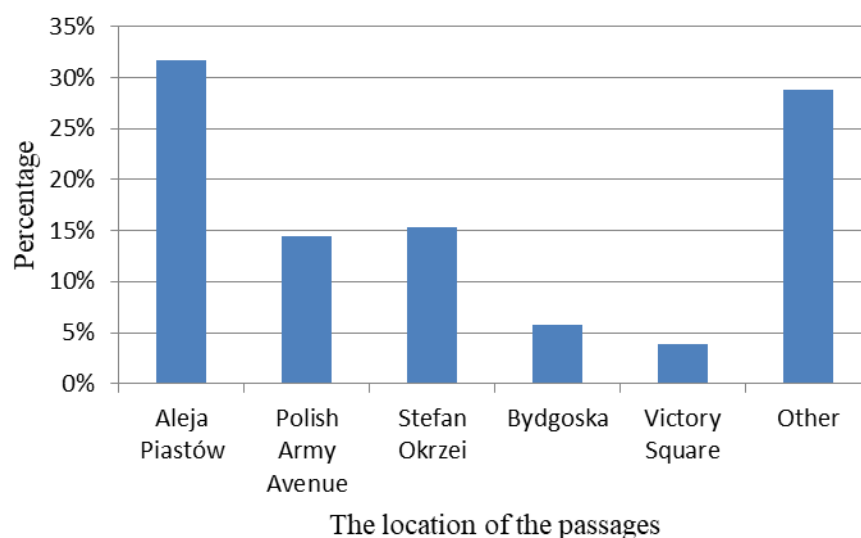


Fig. 2. The most dangerous crosswalks according to respondents

Yet another question asked respondents whether they check for oncoming traffic at pedestrian crossings located at a bike path. 70.92% of the respondents answered “yes – always”, followed by 28.08% who answered “sometimes” and 1% who answered “no – never”. Among men and women, the results for each answer were similar. The answer “yes” was most frequently marked among men aged

>60 years (90.91%) and women aged >60 years (100%). The least number of women marked the answer "yes" in the age group below 20 years (36%). "No – never" was chosen by as many as 5.66% of men in the 20-40 age group. In several categories, no such response was obtained. In the case of men, the age categories were <20, 40-60 and >60, and in the case of women, the age categories were <20, 40-60 and >60. The answer "sometimes" was chosen mainly by women in the age group up to 20 years (63.64%). In case of women who were older than 60 years of age, the answer "sometimes" was never chosen (Table 21).

Table 21
Checking for oncoming traffic when entering a pedestrian crossing located at a bicycle path

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Yes, always [%]	62,50%	49,06%	85,71%	90,91%	72,04%	36,36%	62,79%	80,00%	100,00%	69,79%	70,92%
No never [%]	0,00%	5,66%	0,00%	0,00%	1,42%	0,00%	2,33%	0,00%	0,00%	0,58%	1,00%
Sometimes [%]	37,50%	45,28%	14,29%	9,09%	26,54%	63,64%	34,88%	20,00%	0,00%	29,63%	28,08%

Among the respondents who answered the question on the factors that affect pedestrian safety, the most common response was that "pedestrian behavior" has the greatest impact on safety (29% of respondents). The behavior of drivers was indicated as a factor by 25% of the respondents, followed by the illumination of pedestrian crossings by 17% of respondents, pedestrians wearing reflective clothing by 12% and other factors by 17% of the respondents. The data are presented in Fig. 3.

Moreover, Figure 4 shows suggestions provided by the respondents regarding the improvement of traffic safety. Most respondents mentioned better designs of pedestrian crossings (68 people), followed by 22 people who chose further education for pedestrians and 43 people who provided other responses. Once again, a large number of respondents pointed out the poor design of crosswalks in Piła as one of the main culprits. The problem with the design of these crosswalks does not only concern the aspect of proper lighting and illumination but also the general quality of these crossings, including the way they are designed, the wear and tear, e.g. limited visibility of the "stripes" on the road at the crossing, increased traffic at a given crossing and no work done to improve the visibility of these crossings.

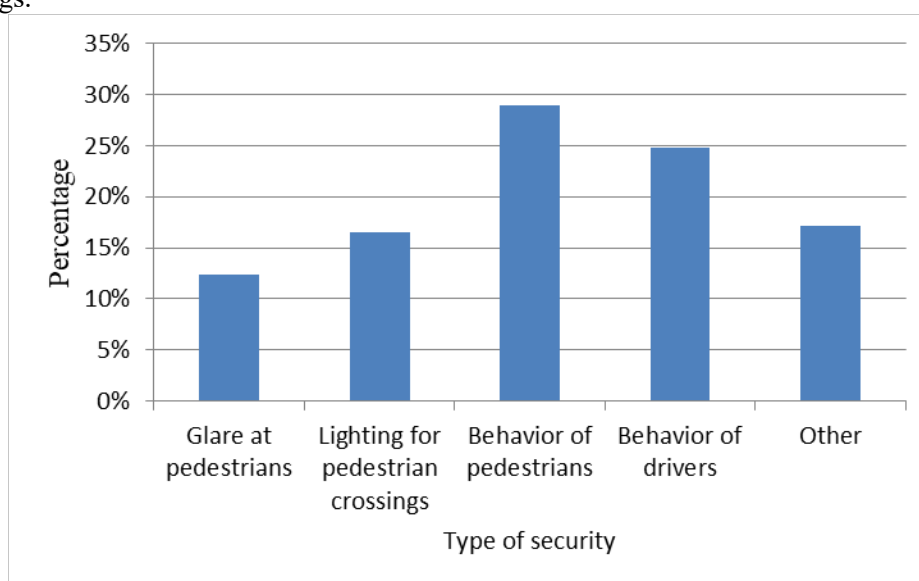


Fig. 3. Answers provided by respondents

Among other important factors, respondents drew our attention to the behavior of pedestrians and the behavior of drivers and cyclists, and to equipping pedestrians with reflective clothing, at least during the autumn and winter seasons.

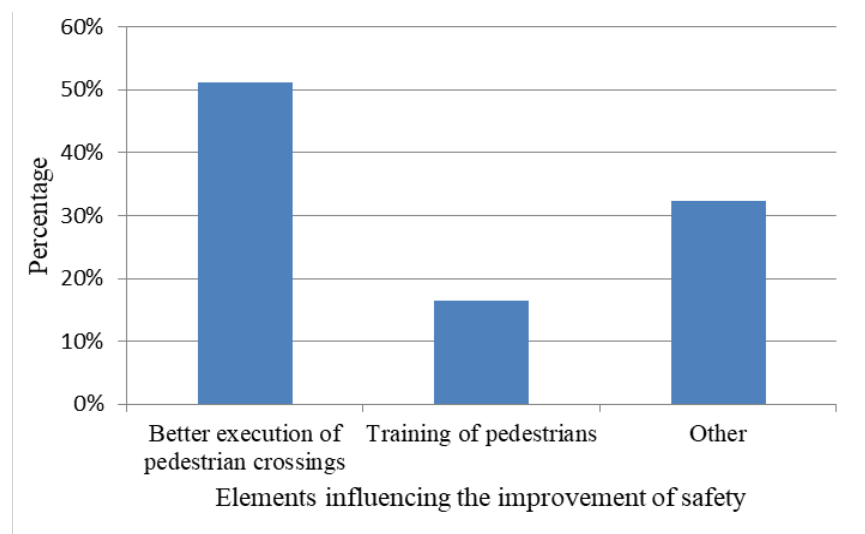


Fig. 4. Elements influencing the improvement of safety

4. CONCLUSIONS

Analyzing the current survey in conjunction with the results obtained from observational studies (tab. 1), one can notice that similar results were obtained on the influence of checking for oncoming traffic on general traffic safety. On average, 84.77% of pedestrians checked for approaching traffic while they were entering a pedestrian crossing, while in the case of the current survey, it was 86.46%. The average percentage of pedestrians who did not check for approaching traffic at the crossings was 12.26%, while in the case of our current respondents, it was 21.19%. Such differences in results could stem from a misunderstanding of the questions on behalf of the respondents. Comparing the data on cell phone usage while entering pedestrian crossings, those surveyed at pedestrian crossings obtained a result of 1.76%. In this case, there is also a huge difference between the answers of the survey's respondents and the results of the observational study. These results may have been influenced by the fact that most respondents were in the age groups of 20-40 and >20 years; however, while conducting the observational study of pedestrian behavior at pedestrian crossings, only a minority of the participants were younger people.

After additional analysis of the data, the following conclusions were arrived at:

1. The gender of the respondents has no influence on involvement with traffic accidents.
2. There is no correlation between having a driver's license and being involved in an accident.
3. The age of the respondents has an influence on involvement in an accident (there is a correlation between the dependent variables).
4. There is a strong correlation between the area of residence of the respondents and involvement in a traffic accident, especially when we consider the distance from the city center up to 20 km (ranges: city limits, 5 - 10 km from the city center, 11 - 20 km from the city center). When we include the group of people living more than 20 km from Piła, there is no correlation between the respondents' place of residence and involvement in accidents.

Moreover, having a driver's license influenced the answers provided by the respondents. People who were drivers chose more favorable answers regarding safety than people who were not familiar with driving. Those with a driver's license rein fact, due to their driving experience, more vigilant at pedestrian crossings. Moreover, pedestrians who have a driver's license behave more cautiously at pedestrian crossings than those without a driver's license [28].

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Received 03.07.2020; accepted in revised form 10.12.2021