

# ANALYSIS OF PEDESTRIAN BEHAVIOR IN THE CITY OF PILA

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## Resume

Every year, many people lose their health and/or lives on Polish roads. One of the reasons for this is behavior of pedestrians at pedestrian crossings, which affects the road safety. The aim of the article was to conduct experimental research, the idea of which was to study the behavior of pedestrians at pedestrian crossings in the city of Pila, the results of which can be applied to Poland. During the research, the behavior of pedestrians and the impact on the probability of a road accident were analyzed. Undoubtedly, the prevailing epidemic, during which people are in many respects limited, had an impact on the results obtained, therefore the number of people at the analyzed crossings may have decreased. The conducted research confirmed the Police statistical data that the most dangerous crossings for pedestrians are those without traffic lights.

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## Article info

Received 12 August 2021

Accepted 3 November 2021

Online 19 January 2022

## Keywords:

safety,  
pedestrians,  
pedestrian crossing,  
road traffic

Available online: <https://doi.org/10.26552/com.C.2022.2.F14-F26>

ISSN 1335-4205 (print version)

ISSN 2585-7878 (online version)

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## 1 Introduction

Every year many road accidents happen on Polish roads. Many people lose their lives or health. The reason, among others, is inadequate behavior of pedestrians at. Despite the construction of new, safer roads and pedestrian crossings, the number of road accidents continues to increase and about three thousand accident participants die each year. On average, forty-one thousand people are injured each year. The main causes of accidents are speed maladjustment to the prevailing road conditions or regulations, driving under the influence of alcohol and random events, as well as pedestrians who are not checking whether the crossing would be safe before actually entering the crossings (Table 1) [1].

One can study pedestrian behavior in several ways. The first is the direct observation of the road situation without the knowledge of the person observed in natural conditions, arranged observations that take place in natural conditions and in laboratory conditions. People participating in the pedestrian behavior research are aware of these observations, some situations are triggered on purpose. Arranged observations contain elements of danger, usually they are recorded in the form of a film, analysis of pedestrian crash data to determine information about pedestrian behavior before and after the accident [2]. Pedestrian behavior depends on many factors, such as street design, as well as

behavior of other pedestrians etc.

An example of pedestrian misbehavior is hesitation. There are times when a pedestrian is in front of a pedestrian crossing, stops in front of it, informing the driver that he may pass and then the pedestrian suddenly changes his mind and invades the crossing. Crossing the road in inappropriate places is also irresponsible behavior, especially since these are usually unlit places. Outside built-up areas, there are situations in which pedestrians do not know which side of the road they should be walking on. At the intersection with traffic lights, a situation occurs in which a pedestrian, despite the red light on, behaves irresponsibly and without hesitation enters the crossing. Going further in search of dangerous pedestrian behavior, one comes to a road situation in which part of the pedestrian crossing is occupied by vehicles parked along the road. In such places, pedestrians are not always clearly visible because they are partially or completely obscured by a vehicle parked along the road. The pedestrian is already at the crossing, but is not visible to drivers. People often forget about that and do not make sure whether they can continue to cross, [3-4].

The problem of pedestrian crossings and their safety was discussed in many publications. For example, the information related to the lighting of pedestrian crossings, the work takes into account the technical equipment of vehicles that affect the pedestrian safety

[5]. Detailed behavior of pedestrians, influencing the occurrence of a road accident with their participation, is described in [3]. The problem of the road safety including pedestrians was considered in publications [6-9]. Security is a human need [10]. The improvement of road safety is affected by many elements related not only to the promotion of proper behaviour among drivers [11-13], but also to the proper organisation of traffic, the appropriate technical condition of roads and vehicles [14-18]. The most commonly used models in security are: control, convergence, deviation and management models, derived from the general theory and latent conditions, pathological, vector-protection, energy flow and energy improvement models energy flow and energy enhancement models derived from epidemiological and energetic theories [19].

## 2 Analysis of the road incidents involving pedestrians

According to the police data, in 2013-2019 there were 232,170 accidents, 21,125 people died, 279,450 people were injured, there were 2,801,195 collisions. For comparison, in the analyzed period, there were 529 accidents in the Pila poviát, 88 people died, 683 were injured and 8,564 collisions occurred [1]. The data is presented in e Table 1.

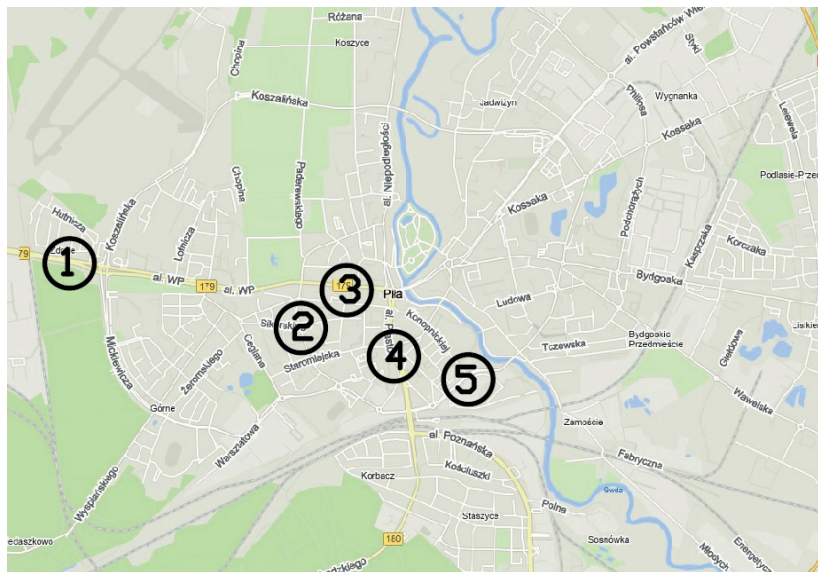
When analyzing the data, it can be seen that the number of accidents was the highest in 2013 and the lowest in 2019. Over the years, however, the number of collisions has increased. In 2013, there were 355,943 collisions and in 2019 - 455,454. The lowest number of collisions was recorded in 2014 - 348,028. The most

**Table 1** Number of road incidents in Poland and the Pila poviát in 2013-2019 [1]

Year	Poland				Pila Poviát				Percentage share of the Pila county in events in Poland, %			
	Number of				Number of				Number of			
	accidents	killed	injured	collisions	accidents	killed	injured	collisions	accidents	killed	injured	collisions
2013	35847	3357	44059	355943	116	14	168	1110	0.32	0.42	0.38	0.31
2014	34970	3202	42545	348028	106	14	132	1017	0.30	0.44	0.31	0.29
2015	32967	2938	39778	362265	75	8	95	1114	0.23	0.27	0.24	0.31
2016	33664	3026	40766	406622	85	19	122	1235	0.25	0.63	0.30	0.30
2017	32760	2831	39466	436469	56	12	66	1337	0.17	0.42	0.17	0.31
2018	31674	2862	37 359	436414	47	12	48	1335	0.15	0.42	0.13	0.31
2019	30 288	2 909	35 477	455454	44	9	52	1416	0.15	0.31	0.15	0.31
Sum	232170	21125	279450	2801195	529	88	683	8564	---	---	---	---
Average	33167	3018	39921	400171	76	13	98	1223	---	---	---	---

**Table 2** Number of road incidents in Poland and the Pila poviát with participation of pedestrians in 2013-2019 [1]

Year	Poland			Pila Poviát			Percentage share of the Pila county in events in Poland, %		
	Number of			Number of			Number of		
	accidents	killed	injured	accidents	killed	injured	accidents	killed	injured
2013	9 489	1 147	9 004	16	0	8	0.17	0.00	0.09
2014	9 106	1 127	8 592	15	0	16	0.16	0.00	0.19
2015	8 581	923	8 188	10	0	10	0.12	0.00	0.12
2016	8 461	868	7 974	6	0	6	0.07	0.00	0.08
2017	8 197	873	7 587	8	0	9	0.10	0.00	0.12
2018	7 548	803	6 918	10	1	9	0.13	0.12	0.13
2019	7 005	793	6 361	6	1	5	0.09	0.13	0.08
Sum	58 387	6 534	54 624	71	2	63	---	---	---
Average	8 341	933	7 803	10	0	9	---	---	---



**Figure 1** Locations of the tested crossings [21]

injured persons were recorded in 2013 - 44,059 and the least in 2019 - 35,477 people. The year 2013 was also the year of the highest number of deaths - 3,357 people and the lowest number of deaths was in 2017 - 2,831. It can also be seen that in the analyzed period, the number of injured exceeded the number of accidents. Based on the above data, it can be concluded that a similar relationship exists in the case of the Pila poviat.

According to the police data, in 2013-2019 there were 58,587 accidents with pedestrians, in which 6,534 people died and 54,624 were injured. For comparison, in the analyzed period, 71 accidents occurred in the Pila poviat, 2 people died and 63 people were injured. The data are presented in Table 2.

Analyzing the data, it can be noticed that the number of pedestrian accidents was the highest in 2013 and has decreased over the years, reaching a minimum in 2019. The number of injured as well as the number of accidents was the highest in 2013 - 9004 and the lowest in 2019 - 6361. Agagin, 2013 was also the year of the highest number of deaths - 1147, which decreased over the years. In turn, in the Pila poviat, the number of accidents involving pedestrians is decreasing year by year and the number of fatalities in 2018 and 2019 increased by 100% compared to 2013-2017. On the other hand, the number of injured was lowest in 2019 and highest in 2014.

According to the Police Headquarters statistics, in 2019 the most accidents involving pedestrians took place in places designated for crossing the road, i.e. at pedestrian crossings (11.4%), then at intersections (6%), sidewalks (1%), pedestrian roads and berms (0.2% of all road accidents in 2019) [1]. The most common causes of pedestrian accidents are: hitting the road directly in front of a moving vehicle, crossing the road at an unacceptable place, entering the road from the rear of the vehicle, obstacles and driving on a road with a red light [1, 3, 10].

### 3 Research

#### 3.1 Purpose and scope of the study

The aim of the research was to investigate the behavior of pedestrians in front of and at the pedestrian crossing in the city of Pila. Particular attention was paid to how pedestrians react to approaching a pedestrian crossing. Additionally, during the research, road traffic measurements were made around the tested pedestrian crossings.

The research was carried out on four pedestrian crossings in the analyzed city. Two of them, with the highest number of incidents, were selected based on the statistical data from the last three years, provided by the Pila County Police Headquarters [1]. The most dangerous in terms of the wounded and killed are the intersections at Aleja Wojska Polskiego 1 (provincial road 179) and at ul. Okrzei. The next two intersections were selected based on the amount of road traffic taking place there [20]. The first one is also located at Aleja Wojska Polskiego 2 (provincial road 179), but much closer to the city center. The next intersection is at Aleja Piastów Street, it is the city center (provincial road 180). Additionally, a pedestrian crossing in the "VIVO" gallery was examined. This passage is on the bike path. The tested crossings were marked by numbers from 1 to 4. The pedestrian crossing on the bicycle path was marked by number 5.

#### 3.2 Methodology of the conducted research

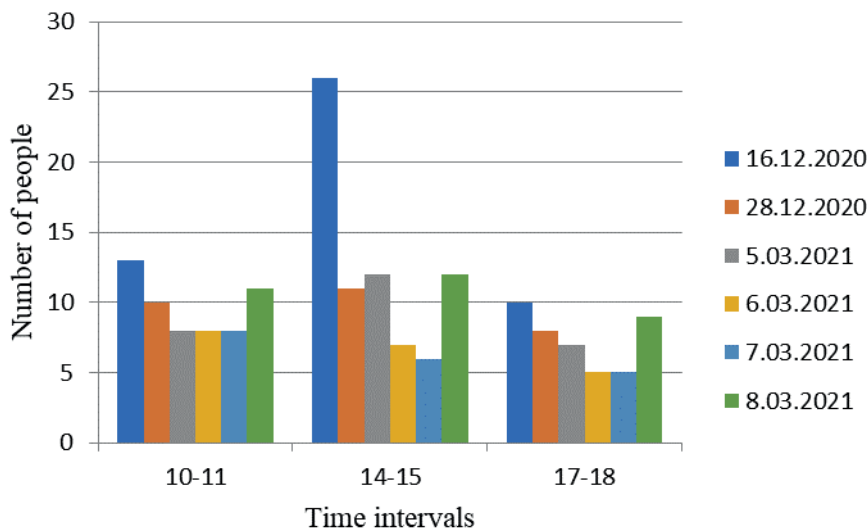
During the experimental research, the behavior of pedestrians was analyzed, attention was paid to how they behave when approaching the intersection, before the crossing itself and when crossing the road from one side to the other. Particular attention has been paid to

whether the pedestrian makes sure that the vehicle is not approaching the crossing. Another element was to pay attention to how many people use a mobile phone while staying within the crossing and at the crossing itself. As a result one can conclude that pedestrians do not pay attention to what is important, i.e. their safety. Another element that was noticed during the research was forcing the right of way by a pedestrian who, despite seeing an approaching vehicle, decided to invade the road anyway. The last element examined was a situation in which a pedestrian decides to walk without making sure that no vehicle is approaching. Additionally, on each crossing, the sum of vehicles passing through this crossing was counted. Each of the analyzed passages was tested on six different days at different times of the day in the following hours: 10-11, 14-15, 17-18.

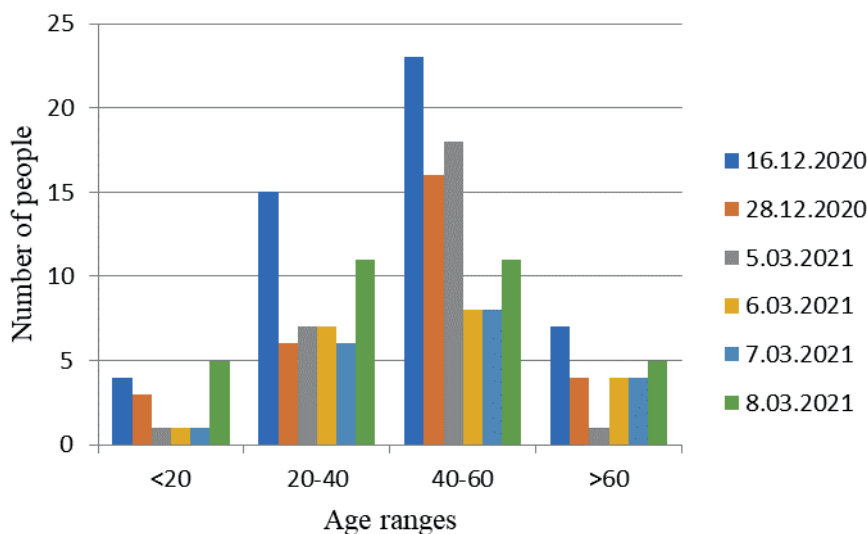
**4 Results**

The first test was the pedestrian crossing at Aleja Wojska Polskiego 1 (Figure 1 - item 1) located at the provincial road No. 179. At this pedestrian crossing, the ratio of the number of vehicles to pedestrians was 99:1. That depends on the location of the crossing. It is located further away from the city center, on the exit route from the city. Total of 176 people took part in the pedestrian crossing study and the number of vehicles in the study was 16193. In this case, there was the same number of male and female pedestrians.

Figure 2 presents data on the number of pedestrians at particular times of the day. By far the largest number of pedestrians at the crossing was on February 16, 2020, December 28, 2020, March 5, 2021 and March 8, 2021. This was recorded at 14 and 1 This may be because



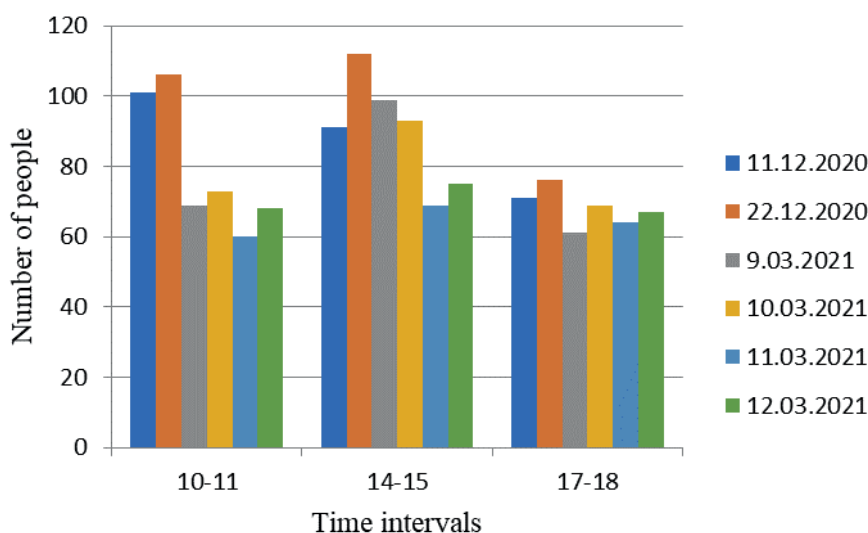
**Figure 2** Number of people in particular time periods at crossing #1



**Figure 3** The number of people in each age category at crossing #1

**Table 3** Test results at the intersection at Aleja Wojska Polskiego1 (crossing #1)

Sex	Men					Women					Average
	< 20	20-40	40-60	> 60	Average	<20	20-40	40-60	>60	Average	
Confirmation [%]	77.78	91.67	84.09	90.91	86.11	83.33	89.66	73.17	100.00	86.54	86.33
Failure [%]	22.22	4.17	11.36	9.09	11.71	16.67	6.90	19.51	0.00	10.77	11.24
Priority enforcement [%]	0.00	4.17	0.00	0.00	1.04	0.00	3.45	7.32	0.00	2.69	1.87
Taking care of the phone [%]	0.00	0.00	4.55	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.57

**Figure 4** Number of people in particular time intervals at crossing #2

people go home after work during these hours. In turn, on March 6, 2021 and March 7, 2021, the most people were recorded in the period 10-11.

Then, Figure 3 presents data on the age assumed by the researcher in the study participants. Most of the people were 40-60 years of age, then in the range of 20-40 and then < 20 and > 60 years of age. The age of the respondents was organoleptically approved at the time of preservation. This is due to the presence of nearby jobs.

Table 3 shows the results of the tests carried out at the intersection at Aleja Wojska Polskiego1. The obtained values were divided into age categories for women and men. Self-assessment accounted for 86.33% of all respondents at this intersection. The highest percentage when crossing the road after checking was found in women over 60 (100%) and the lowest in the 40-60 age group (73.17%) and also in women. When comparing the performance of men and women at the crossing, women were more alert.

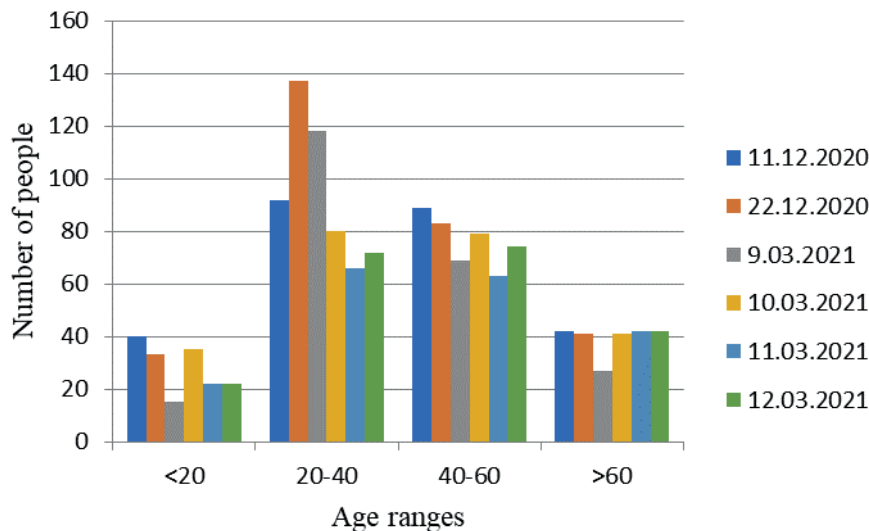
Taking into account another of the examined elements, i.e. entering a pedestrian crossing, it was 11.24% of the respondents who crossed without the prior checking. The highest percentage was reported for men aged up to 20 (22.22%). Comparing this to women over the age of 60, who did not tried to cross without making sure, the value is very high and in the future it might have dire consequences. In addition in the case

of the study of the number of unknown people, women obtained a lower percentage. This state was 11.24% and in men 11.71%.

The next analyzed fragment is the fragment marked by number 2 on the overview map (Figure 1). Passage at Stefana Okrzei Street is located near the city center. During the pedestrian crossing research, 1,424 people were tested, during this time 8,735 vehicles passed through the pedestrian crossing. In this case, the vehicle to pedestrian ratio was 86:14. This result may be influenced by the fact that Stefana Okrzei Street is not a voivodeship road. It is a lower capacity road. The number of women and men among the respondents was similar.

The number of pedestrians in the time intervals is shown in Figure 4. The results in the individual hourly intervals are similar. The highest number of people was observed in the time interval 14-15, with the exception of December 11, 2020. On that day, the highest number of people was recorded in the 10-11 range. This result may be influenced by the fact that people leave work between 14 and 15 and go back to their homes. The fewest people passed between 17 and 18., except on March 11, 2021, in the case of that day, the least people passed in the 10-11 time interval.

Among the respondents, the greatest number of people in each age category was in the 20-40 age group. In turn, the smallest number of people differed in the



**Figure 5** Number of people in each age category at crossing #2

**Table 4** Test results at the crossing at Stefana Okrzei Street (crossing #2)

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Confirmation [%]	85.56	89.45	92.74	88.79	89.13	88.31	93.24	92.24	90.60	91.10	90.12
Failure [%]	10.00	7.64	5.98	7.76	7.84	7.79	5.07	4.57	6.84	6.07	6.96
Priority enforcement [%]	1.11	1.09	1.28	3.45	1.73	1.30	0.34	1.83	2.56	1.51	1.62
Taking care of the phone [%]	3.33	1.82	0.00	0.00	1.29	2.60	1.35	1.37	0.00	1.33	1.31

age category under 20 and similarly in the age group over 60. The data is presented in Figure 5.

Analyzing the results of the research presented in Table 4 and referring to all the respondents, the percentage of pedestrians who checked themselves before entering the road was 90.12%. The lowest value was achieved in the age category up to 20 years among men, where it was 85.56%. The highest was recorded for women in the 20-40 age group, i.e. 93.24%. Comparing women and men, women (91.10% vs men - 89.13%) obtained a higher percentage of passes after the prior checking.

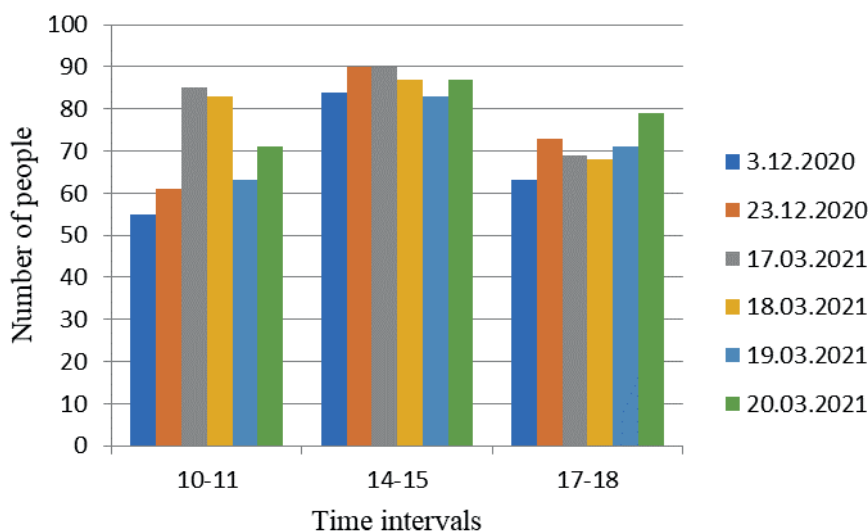
People who did not make sure before entering the pedestrian crossing, but entered it without paying attention to the traffic situation, accounted for 6.96% of all respondents. The lowest percentage was recorded in the group of women aged 40-60 (4.57%). The highest was obtained in the case of men up to 20 years old and amounted to 10%. After testing this behavior, women (6.07%) obtained a lower value than men (7.84%).

The next pedestrian crossing examined was also located at Aleja Wojska Polskiego 2 (Figure 1 - item 3), but this location is much closer to the city center compared to the previous analyzed crossing on this street. In the case of this pedestrian crossing, 1,361 pedestrians were tested. In the case of this crossing, the number of pedestrians is 7% and vehicles are 93%.

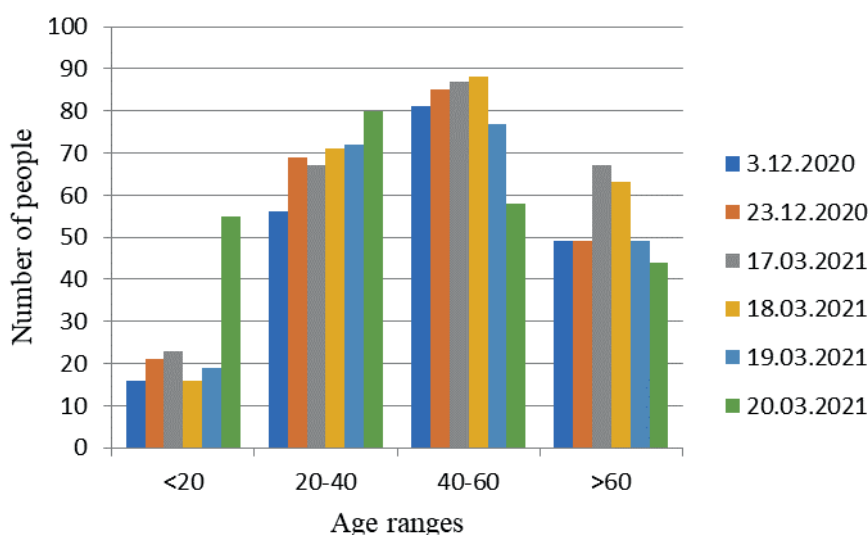
The location of the pedestrian crossing undoubtedly influenced such results. It is located much closer to the city center in the vicinity of apartment blocks. As in the previously analyzed places, the number of women and men was very similar.

The largest number of people using the examined crossing on each of the studied days was in the hour range from 14 to 15. The smallest number of people using the pedestrian crossing was in the period of 10-11 o'clock, which may result from the fact that during the period the epidemiological status of activities in schools or universities took place only online, so such a situation could lead to a decrease in the number of people crossing the street period during this period. On the other hand, the highest number of pedestrians in the 14-15 period may be due to the fact that many pedestrians come to or from work (Figure 6).

As shown in Figure 7, most people were 40-60 years old, then 20-40 years old, > 60 years old and the least < 20 years old. In each of the age categories, the number of people was similar. In one case, the number of people on one day (March 20, 2021) was much greater than on the other days. The case concerned the age category up to 20 years. The reason may be a day off from distance classes and sunny weather on that day. December 23, 2020 was also a day off, but on that day the weather conditions were much worse than March 20, 2021.



**Figure 6** Number of people in particular time intervals at crossing #3



**Figure 7** Number of people in each age category at crossing #3

Table 5 presents data for women and men in different age categories at the analyzed crossing. First, the data on making sure before crossing the road is presented. Out of all the people surveyed, 91.15% were self-reassurances. The group of men aged over 60 was distinguished by the highest percentage, it amounted to 96.65%. The lowest percentage was recorded for men up to the age of 20, it was 83.91%. The average percentage of women was 91.52%, which made men worse in this respect and obtained an average of 90.78%.

Then, data on people who did not make sure before entering the pedestrian crossing were presented, which constituted 6.65% of all surveyed people. Among those who did not check, the largest number was recorded among men in the age category up to 20 (10.34%) and among women in the same age category (7.94%). The lowest value was noticed in the case of men aged over 60, it was 3.35%. The data presented in the table below also shows that men (6.95%) more often than women (6.35%)

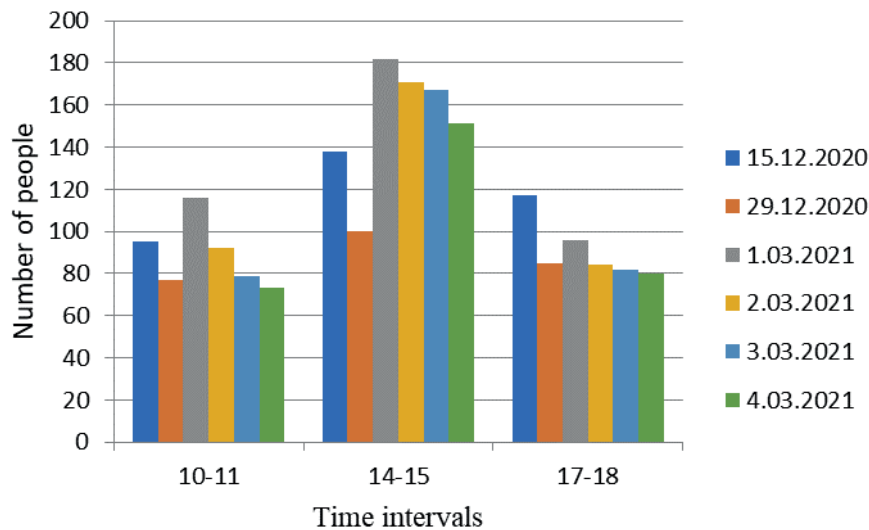
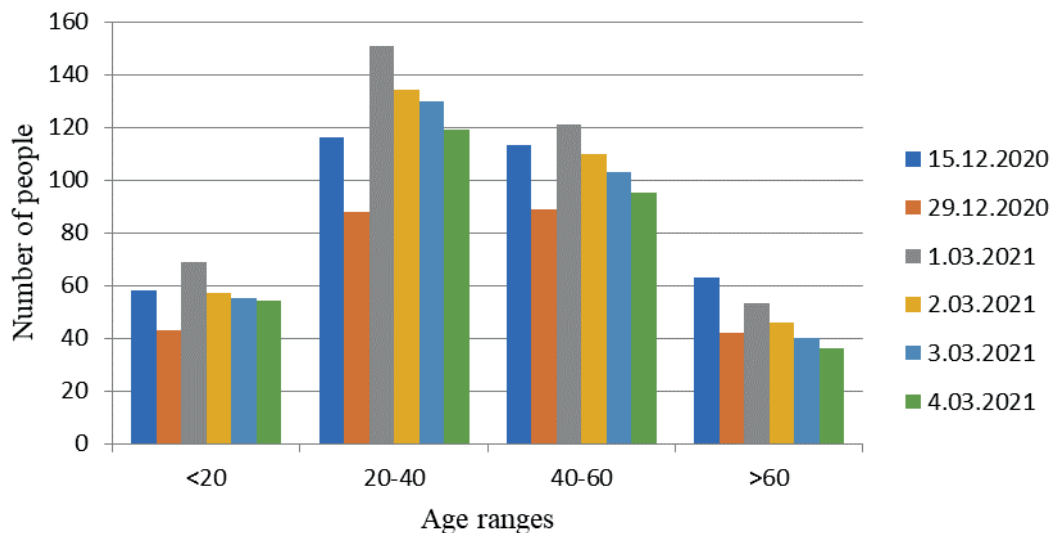
decide to intrude on a pedestrian crossing without first making sure.

The pedestrian crossing from Aleja Piastow was further examined. The crossing is located in the city center by the provincial road no. 180. A more precise location of the intersection is shown on the overview map (Figure 1 - no. 4). The total number of people tested at this pedestrian crossing was 1987 people and the number of vehicles passing through this crossing during the study was 18,047. In this case, the ratio of number of vehicles to number of pedestrians is: 90:10. When broken down into women and men, it can be seen that the number of women (52%) is greater than that of men (48%). The difference in favor of women was 4%.

The number of people at the pedestrian crossing at specified intervals and on two different test days is presented in Figure 8. Analyzing, it can be noticed that the number of people on 01/03/2021 was the highest than on the other test days. Most people used the crossing in

**Table 5** The results at the crossing at Aleja Wojska Polskiego2 (crossing #3)

Sex	Men					Women					Average
	<20	20-40	40-60	>60	Average	<20	20-40	40-60	>60	Average	
Confirmation [%]	83.91	90.50	92.06	96.65	90.78	92.06	90.70	93.87	89.44	91.52	91.15
Failure [%]	10.34	8.50	5.61	3.35	6.95	7.94	6.51	4.60	6.34	6.35	6.65
Priority enforcement [%]	0.00	0.00	0.93	0.00	0.23	0.00	0.47	0.38	4.23	1.27	0.75
Taking care of the phone [%]	5.75	1.00	1.40	0.00	2.04	0.00	2.33	1.15	0.00	0.87	1.45

**Figure 8** Number of people in particular time intervals at crossing #4**Figure 9** Number of people in each age category at crossing #4

the period 1415 This situation could be caused by the fact that some people attended or were from work. The smallest number of people was recorded between 10 and 11 o'clock.

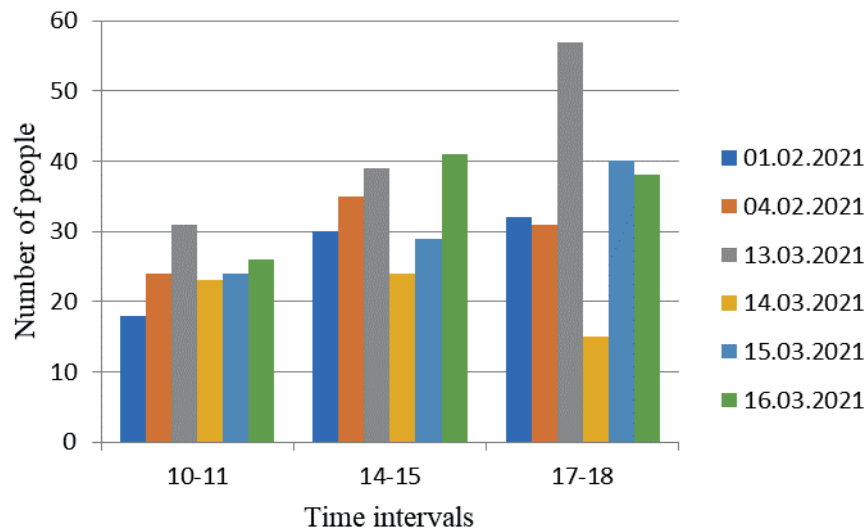
The lowest number of people was recorded in the age group under 20, followed by those over 60. In the remaining age categories, the number of people was very similar. However, more people were between the ages of 20 and 40 (Figure 9).

Out of all the respondents at this pedestrian crossing, 90.74% entered the n crossing after being checked (Table 6). In the age category up to 20, women enter 94.87% after checking. The lowest result was recorded in men over 60 years of age. It was 87.94%. Comparing the results of women and men, women obtained a more favorable average, ie 91.85% in men, the average was 89.63%.

Out of all the respondents, 6.38% entered the

**Table 6** Test results at the crossing at Aleja Piastow (crossing #4)

Sex	Men					Women					Average
	Age category	< 20	20-40	40-60	> 60	Average	< 20	20-40	40-60	> 60	
Confirmation [%]	90.56	88.58	91.44	87.94	89.63	94.87	91.77	90.00	90.78	91.85	90.74
Failure [%]	8.33	5.25	6.16	9.93	7.42	1.92	5.33	5.59	8.51	5.34	6.38
Priority enforcement [%]	1.11	2.78	2.05	2.13	2.02	1.28	1.69	2.65	0.71	1.58	1.80
Taking care of the phone [%]	0.00	3.40	0.34	0.00	0.93	1.92	1.21	1.76	0.00	1.22	1.08

**Figure 10** Number of people in each age category at crossing #5

crossing without first knowing that a vehicle was approaching. The highest percentage was achieved by men over 60 (9.93 %). In turn, the lowest result was obtained by the group of women up to 20 years of age, ie 1.92%. The average for women was 5.34% and for men 7.42%.

Among the respondents there were also people who forced priority (1.80 %). The highest percentage of reports after forced priority was in the 20-40 age group among men, it was 2.78%. In this behavior, the age category over 60 for women was the best, where the result was 0.71 %. Comparing women and men, the lower average was obtained by women, ie 1.58% and men by 2.02%.

In the case of this pedestrian crossing, the youngest age group of women used a telephone while crossing the road (1.92 %). In several age categories, no person dealing with the telephone was recorded. Among men, these are the following age categories: < 20, > 60 years, for women: > 60 years. Referring to the whole, 1.08% of the respondents used the telephone during the crossing. It is 1.22% for women and 0.93% for men.

The last of the pedestrian crossings tested was on the bicycle path marked by number 5 in Figure 1. During the study, 557 people were tested and 165 cyclists traveled along the bicycle path. In this case, the pedestrian-to-cyclist ratio was 77:23. Such a difference was undoubtedly influ due to the prevailing pandemic.

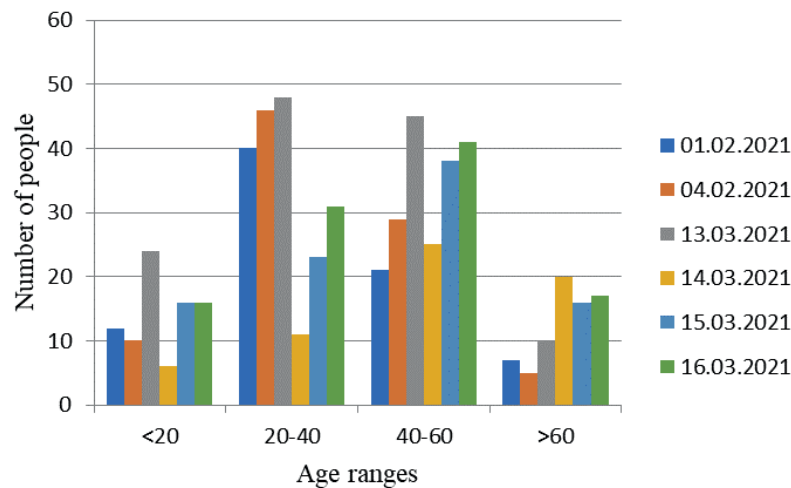
The vast majority of the respondents are women (63 %), 26% more than men (37 %). The location of the passage next to the shopping center may also affect the obtained result.

Most people used this crossing between 17 and 18 o'clock. On the other hand, the lowest number of people was between 10 and 11 (Figure 10). The smallest number of people in this hourly window may be due to the fact that the shopping center opens at 10.

Figure 11 presents data on the number of people in each age group at the examined crossing on six different days. The smallest number of people was recorded in age categories over 60 and then up to 20. Most people were in the 20-40 and 40-60 age group.

When conducting the research on a pedestrian crossing on a bicycle path, the same cases of behavior were investigated as at intersections located on the road. Of all those surveyed, 65.53% walked through the crossing after making sure there was no oncoming cyclist. As far as age categories are concerned, the group of men aged 20 obtained the lowest result (57.14 %). The highest result was recorded in the age category over 60 for men (74.19 %). Women obtained a higher percentage than men, amounting to 66.24% to 64.82% (Table 7).

The rest of the respondents were people who were not careful when entering the pedestrian crossing. The highest value was recorded for women aged over 60 and amounted to 36.36% and for women aged 20-40, 24.22%.



**Figure 11** Number of people in each age category at crossing #5

**Table 7** The results on the sidewalk in the “VIVO” gallery in percent (crossing #5)

Sex	Men					Women					Average
	< 20	20-40	40-60	> 60	Average	< 20	20-40	40-60	> 60	Average	
Confirmation [%]	57.14	66.20	61.76	74.19	64.82	59.18	72.66	69.47	63.64	66.24	65.53
Failure [%]	34.29	32.39	33.82	25.81	31.58	28.57	24.22	25.19	36.36	28.59	30.08
Priority enforcement [%]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taking care of the phone [%]	8.57	1.41	4.41	0.00	3.60	12.24	3.13	5.34	0.00	5.18	4.39

When comparing men and women, women were rated as better. Their percentage was 28.59%. This result is lower than that of men by more than 2.5%. For all the respondents at this intersection, 30.08% were unsure.

Further research has been carried out on how many people are forced to prioritize cyclists. Such behavior was not reported in any case. This result could have been influenced by the weather during the tests - the bicycle path on which the tests were conducted was not in the best condition, i.e. it was covered with snow, which meant that the number of cyclists had significantly decreased than if the tests had been carried out in better weather conditions.

The last behavior tested was to determine how many people deal with a mobile phone while walking. People dealing with the phone while crossing the pedestrian crossing accounted for 4.39% of the total number of people surveyed there. The highest value was obtained by women aged < 20 (12.24%). There were also age groups where this behavior was not reported. In the case of women and men, this is the age group over 60 (0%). Comparing women and men, men obtained a lower percentage - 3.6%, while for women 5.18%.

## 5 Research conclusions

Comparing all the tested crossings to ensure that pedestrians before entering the road obtained the best result, pedestrians using the intersection in Al. Wojska

Polskiego2 (Figure 1 - point 3). Over 91% of respondents at this crossing made sure before entering the crossing. Another result is 90.74% of people watching over the pedestrian crossing in Aleja Piastow. At the pedestrian crossing at Stefana Okrzei Street, the percentage of people who were checking the safety was 90.12%. Then there was a pedestrian crossing at Aleja Wojska Polskiego 1, on which 86.33% of all the pedestrians tested at this intersection made sure of safe crossing before actually entering. The worst result was obtained by pedestrians using the crossing located on the bicycle path by the “VIVO” gallery. This result was 65.53% (Table 8).

The greatest number of pedestrians who did not make sure before entering the pedestrian crossing was recorded at the intersection located on the bicycle path. Of all the surveyed pedestrians, as many as 30.08% of people were not sure if a cyclist was approaching. Pedestrians staying at the crossing in Aleja Wojska Polskiego 1 achieved the second high result - 11.24%. The second place was taken by the pedestrian crossing at Stefana Okrzei Street. Pedestrians using this crossing obtained the percentage of 6.96%. The result of 6.65% was recorded for pedestrians staying at the crossing in Aleja Wojska Polskiego 2. The lowest and, at the same time, the most favorable for safety result was recorded for pedestrians using the crossing in Aleja Piastow. It was 6.38%.

Another behavior noticed was forcing pedestrians to take precedence. Such behavior was not noted in any of

**Table 8** Comparison of the results on each of the tested crossings

Zebra crossing	Aleja Wojska Polskiego1	Aleja Wojska Polskiego2	Stefana Okrzei	Alei Piastow	next to the "VIVO" gallery.	Average
Confirmation [%]	86.33	91.15	90.12	90.74	65.53	84.77
Failure [%]	11.24	6.65	6.96	6.38	30.08	12.26
Priority enforcement [%]	1.87	0.75	1.62	1.80	0.00	1.21
Taking care of the phone [%]	0.57	1.45	1.31	1.08	4.39	1.76

**Table 9** Comparison of results by the analyzed road type

Zebra crossing	National Road	Local road	Bike path
Confirmation [%]	89.41	90.12	65.53
Failure [%]	8.09	6.96	30.08
Priority enforcement [%]	1.47	1.62	0.00
Taking care of the phone [%]	1.03	1.31	4.39

**Table 10** Comparison of results on each of the tested crossings broken down to age categories

Sex	Men					Women					
	Age category	< 20	20-40	40-60	> 60	Average	< 20	20-40	40-60	> 60	Average
Confirmation [%]		78.99	85.28	84.42	87.70	84.10	83.55	87.61	83.75	86.89	85.45
Failure [%]		17.04	11.59	12.59	11.19	13.10	12.58	9.61	11.89	11.61	11.42
Priority enforcement [%]		0.44	1.61	0.85	1.12	1.01	0.52	1.19	2.44	1.50	1.41
Taking care of the phone [%]		3.53	1.53	2.14	0.00	1.80	3.35	1.60	1.92	0.00	1.72

the surveyed pedestrians (0%) at the pedestrian crossing in the "VIVO" gallery. This happened because when the pedestrian approached the crossing, there was no cyclist nearby. The weather had an impact on the traffic on the cycle path. The next result was obtained by pedestrians using the crossing in Aleja Wojska Polskiego2, with a percentage result of 0.75%. The second result was recorded for pedestrians using the pedestrian crossing at Stefana Okrzei Street. The recorded result was 1.62%. At the intersection located at Aleja Piastow, a percentage of 1.8% was recorded among all those surveyed at this intersection. The highest percentage of this behavior was recorded at the intersection at Aleja Wojska Polskiego2 - 1.87%.

The last pedestrian behavior surveyed was to check how many pedestrians were using the mobile phone while crossing. The highest percentage was recorded among pedestrians using the crossing on the bicycle path, it was 4.39%. In the case of crossing in Aleja Wojska Polskiego 2, pedestrians obtained 1.45%; at the crossing at Stefan Okrzei it was 1.31%, while the result of 1.08% was recorded at the intersection in Aleja Piastow. The lowest result and at the same time the most advantageous in terms of safety, was recorded at the intersection at Aleja Wojska Polskiego 1 - 0.57%.

Based on the obtained results, it can be concluded that the most dangerous pedestrian crossing in Pila is located at Aleja Wojska Polskiego1, which is also reflected in reality. According to the data of the Pila County Police Headquarters [1], a large number of

incidents involving pedestrians took place at this intersection. Pedestrians examined at this intersection obtained the least favorable results in terms of safety. Very often their behavior was improper, they did not focus on the crossing, which led to a situation where they entered the crossing without making sure about safe crossing.

Comparing the results of the national and local road surveys it can be seen that they are similar in terms of the criteria analysed: confirmation, failure, priority enforcement and taking care of the phone. However, fewer people were chacking the safety when crossing the cycle path and more people used the phone when crossing it (Table 9).

Taking into account the data in Table 10, women are more confident in crossing than men. The situation is similar in the case of people over 60 years of age. The most dangerous category at pedestrian crossings are young people up to 20 years of age who are entering the crossing without caution and use the mobile phone very often when crossing. Police campaigns promoting the safe crossing of pedestrian crossings should be targeted at this group of people.

## 6 Summary

In conclusions, authors can state that their research was conducted objectively and that they obtained the reliable results. The behavior of pedestrians

at a pedestrian crossings has been observed. The research was carried out on the most dangerous pedestrian crossings in the city of Pila and the extent to which pedestrians contributed to a road accident was determined. The prevailing epidemic has undoubtedly influenced the results, due to the fact that people were limited in many respects, therefore the number of

people at crossings may have been lower than in the normal conditions. The conducted research confirmed the statistical data that the most dangerous crossings for pedestrians are those without traffic lights. For that reason, it is justified to continue the Police action for safety at pedestrian crossings. The authors plan to repeat the research once the pandemic is over.

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