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CHANGE IN THE MOBILITY OF POLISH RESIDENTS DURING THE COVID-19 PANDEMIC

Piotr Gorzelńczyk 

Stanisław Staszcz University of Applied Sciences in Pila, Pila, Poland

*E-mail of corresponding author: piotr.gorzelaneczyk@puss.pila.pl

Resume

The aim of the article is to analyze the mobility of Polish residents and a change caused by the COVID-19 pandemic. For this purpose, a questionnaire study was conducted on changes in the mobility of Polish residents before and during the COVID-19 pandemic. It was carried out in December 2020, when the second wave of cases of the above-mentioned virus was ongoing in Poland. During the study of Polish residents, questions were asked about the purpose of their trip, means of transport, distance to the destination and duration of the trip, as well as the place of making purchases before and during the pandemic. In addition, respondents were asked whether the COVID-19 pandemic had affected their mobility. During the COVID-19 pandemic, the mobility of citizens, especially in the cities, has changed. Instead of using the public transport, they used cars, bicycles and walk.

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1 Introduction

With the development of civilization, more and more cars are registered each year (Figure 1), as more and more people use private cars to quickly reach their destination, mainly work or school. Over the last 10 years, the number of registered cars in Poland has increased by almost 50%. Efficient and fast communication is very important due to the ability to easily change position and move from place to place in a short time. Many elements affect efficient communication.

The transport needs of residents depend on the efficient communication of residents. One can divide their activities, among others on: professional, social, existential and physical. The activity of the inhabitants depends, among others, on the place of residence. Various activities occur in large cities, others in small cities and thus affect the direction of mobility. In addition to the above-mentioned activities, the way and place of movement of Polish residents changed a lot in March 2020, when the first cases of COVID-19 appeared in Poland. The number of cases of this virus was increasing day by day. In December 2020 it was almost 1.2 million cases and almost 26,000 people have died (Figure 2).

COVID-19 is an infectious disease caused by the

acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the seventh coronavirus that can be transmitted from person to person [3]. On March 11, 2020, the World Health Organization (WHO) classified the COVID-19 epidemic as a global pandemic [4]. The new form of the coronavirus has reached the economic world and society on an unprecedented scale since the Great Depression (1929-1933) and is an epidemic compared to the Spanish flu of 1918 [5-6]. The spread of COVID-19 has limited the economic activity and has led to a significant threat to the financial stability of many countries around the world [7].

The development of the COVID-19 pandemic has reduced the mobility of people around the world on an unprecedented scale, Warren and Skillman [8]. Measures have been put in place to restrict travel, movement and participation in activities in many countries around the world as yet unseen [9]. These include, among others: staying at home, distance education, closed public institutions and workplaces, canceled mass events and public gatherings, as well as restrictions on public transport, affected about 90% of the world's population [10]. In articles [11-13] is indicated a significant relationship between the human mobility and the tightening of government restrictions to contain the COVID-19 pandemic. Mobility restrictions varied by nation and region due to their initial mobility

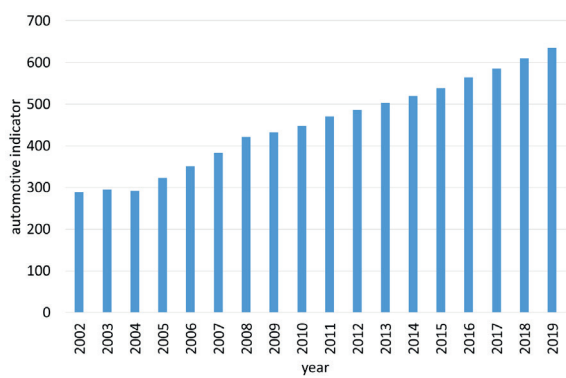


Figure 1 Automotive index in 2002 ÷ 2019 [1]

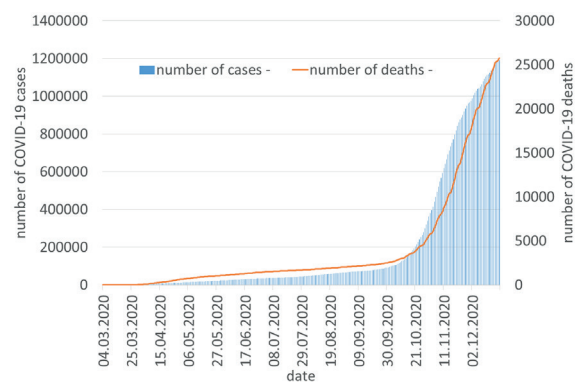


Figure 2 Diseases and deaths caused by COVID-19 in Poland [2]

structure [14]. Schlosser et al. [15] found that the COVID-19 pandemic caused a reduction in long-distance travel, which influenced the spread of the epidemic by “flattening” the epidemic curve and delaying spread to geographically distant regions.

Mobility is defined differently by different authors. Szołtysek [16] treats mobility as a daily, routine movement and activities resulting from the reorganization of the personal life, which may include changing the place of residence or work. It can be equated with the movement and any activity of people performed by means of transport outside the place of residence [17-18]. On the other hand, Menes [19] presents mobility as mobility related to the daily movement of residents, mainly to work or school.

In accordance with the Treaty on the Functioning of the European Union [20] and the resulting EU transport policy, mobility is understood as an element of human activity that depends on the person traveling, the person managing the infrastructure and other users of the transport system related to this mobility [21-22]. The concept of sustainable development is closely related to the issue of mobility and covers the following issues: economic, environmental and social [23-26].

When analyzing the mobility of inhabitants, transport challenges should be taken into account, which in the 2011 White Paper [27] and in the Action Plan on Urban Mobility [28]. Bearing in mind the behavior of urban residents, a policy of sustainable transport development in urban areas should be created. This policy creates plans for development of sustainable transport in cities where sustainable urban mobility is the most important element. It is the main goal of the transport policy of the 21st century [25-26, 29-30]. A transport sustainability plan requires, inter alia, restrictions on the use of passenger cars in daily travel to increase the use of public transport, bicycles or walking [31].

To sum up they assumed that mobility can be treated as a daily movement of inhabitants related to their existence. He assumed it in the article. Before COVID-19 pandemic went off he conducted research on this field. It was made in 2019 [32].

2 Study of changes in the mobility of Polish residents caused by COVID-19

2.1 Purpose and scope of research

The aim of this article was to assess changes in the mobility of Polish residents caused by the introduction of COVID-19. The obtained research results may constitute the basis for adopting the mobility directions of the inhabitants of Poland, when a similar situation arises in the future. Due to the prevailing pandemic, the study was conducted using the survey method on a representative group of Polish residents in December 2020.

2.2 Research methodology

The study was conducted using a questionnaire. Initially, a preliminary study was conducted, which helped to refine the questions in the survey. The only possible form of conducting this type of research during the prevailing COVID-19 pandemic. The research was conducted in an open manner, while maintaining the anonymity of the respondents. It was preceded by a pilot study aimed at fully understanding the questions asked by the respondents. Then, the actual research was carried out using the Internet. The questionnaire included 18 questions about age, sex, number of inhabitants, place of residence, level of education, manner of performing professional work and professional status. The main questions in the survey were concerned with the destination of Polish residents, means of transport, distance to the destination and duration of the trip, as well as the place of shopping before and during the pandemic. They were also asked if the respondents had plans to change their communication habits in the event of another pandemic. At the end of the survey, respondents had the opportunity to express their views on mobility before and during the outbreak. For the sake of the correctness of the research results, the questionnaire was addressed to various groups of recipients. Incomplete surveys have been rejected. An

important step during the research was the calculation of the sample selection. For Poland (38162000 residents), assuming a confidence level of 90% and a maximum error of 5%, the required number of people in the study was 384 respondents. Therefore, the survey was conducted with the participation of 1130 people [33-34].

2.3 Research object

The subjects of the research were the inhabitants of Poland, taking into account the place of residence, sex, number of inhabitants and their status on the labor market. The study was conducted on a group of

Table 1 Socio-demographic characteristics of survey respondents

Category	number	%	Female		Male	
			number	%	number	%
Sex:						
Female	647	57.26	--	--	--	--
Male	483	42.74	--	--	--	--
Age:						
under 18 years	55	4.87	7	1.08	48	9.94
18-25 years	120	10.62	63	9.74	57	11.80
26-35 years	306	27.08	185	28.59	121	25.05
36-45 years	358	31.68	213	32.92	145	30.02
46-55 years	181	16.02	114	17.62	67	13.87
over 55 years	110	9.73	65	10.05	45	9.32
Place of residence:						
urban area	616	54.51	336	51.93	280	57.97
rural area	514	45.49	311	48.07	203	42.03
Educational level:						
no education	6	0.53	3	0.46	3	0.62
primary	53	4.69	8	1.24	45	9.32
basic vocational	11	0.97	6	0.93	5	1.04
secondary technical	99	8.76	51	7.88	48	9.94
secondary	120	10.62	61	9.43	59	12.22
higher	841	74.42	518	80.06	323	66.87
Status on the labour market:						
pupil	71	6.28	16	2.47	55	11.39
student	49	4.34	27	4.17	22	4.55
employed	935	82.74	551	85.16	384	79.50
unemployed	22	1.95	15	2.32	7	1.45
pensioner	19	1.68	15	2.32	4	0.83
other	34	3.01	23	3.55	11	2.28
Number of inhabitants:						
up to 5.000	463	40.97	275	42.50	188	38.92
5.000 - 10.000	116	10.27	72	11.13	44	9.11
10.000 - 15.000	49	4.34	32	4.95	17	3.52
15.000 - 20.000	42	3.72	23	3.55	19	3.93
20.000 - 50.000	57	5.04	42	6.49	15	3.11
50.000 - 100.000	129	11.42	80	12.36	49	10.14
100.000 - 150.000	31	2.74	25	3.86	6	1.24
150.000 - 200.000	14	1.24	5	0.77	9	1.86
200.000 - 500.000	23	2.04	14	2.16	9	1.86
over 500.000	206	18.23	79	12.21	127	26.29

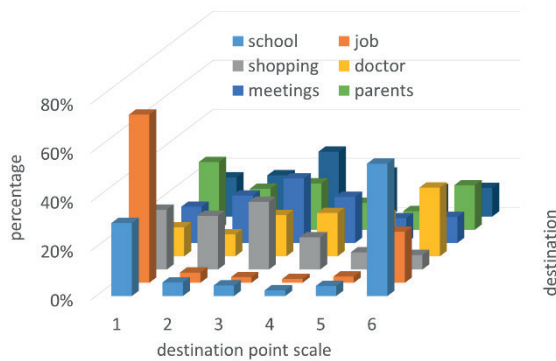


Figure 3 Purpose of daily travel before the pandemic

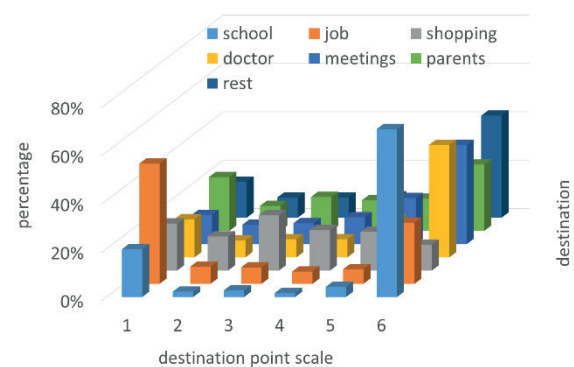


Figure 4 The purpose of daily travel during the pandemic

3,598 respondents, but only 1,130 correctly completed questionnaires were used for further analysis. Women constituted 57% of the respondents and men 43%. Most people were adults. 37% of them were young people aged 18-35. Respondents aged 36-55 accounted for almost 48% and 10% were over 55 years old. Almost 5% of people were under 18 years of age. The majority of women (33%) and men (30%) were aged 36-45 years.

Most of the respondents lived in cities with up to 5,000 inhabitants, almost 41% of the respondents and over 500,000 – 18%. The remaining 41% of respondents lived in cities of 5-500 thousand. 55% of the respondents lived in the city and 45% in the countryside. The majority of women (43%) and men (39%) lived in cities with up to 5,000 inhabitants (Table 1).

Another question was related to the statute on the labor market. Over 83% are working people and 6% are pupils. 85% of women and 80% of men were working. The remaining group consisted of, respectively: the unemployed, students, working students, retirees and pensioners, people running a business and farmers.

Among the respondents, over 74% were people with higher education. 80% of the women surveyed had a tertiary education, compared to 67% of the men. Currently, the respondents work in a traditional way, 44% in the workplace, 21% remotely. On the other hand, 35% replied that they work as a hybrid. To the question: Has your professional situation changed after the outbreak of the coronavirus epidemic? 78% of respondents said they did not.

Table 2 Purpose of women's daily travel before and during the pandemic

Destination	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
school	31.07	5.41	4.02	2.63	4.02	52.86	16.54	2.32	2.94	2.01	4.79	71.41
work	71.25	3.71	2.32	1.08	2.32	19.32	49.77	6.80	7.88	5.26	7.11	23.18
shopping	28.28	22.57	25.81	11.44	5.72	6.18	20.40	12.36	22.87	16.69	17.16	10.51
doctor	10.05	8.35	20.71	20.40	18.24	22.26	13.60	7.42	9.89	8.35	18.08	42.66
meetings	14.84	19.94	28.44	17.77	9.89	9.12	11.44	6.18	8.19	10.20	18.70	45.29
parents	29.83	18.24	17.31	9.43	7.42	17.77	21.48	11.90	12.98	12.36	14.53	26.74
leisure	14.37	17.62	28.59	16.23	11.90	11.28	12.06	6.96	7.42	8.81	17.31	47.45
max	71.25	22.57	28.59	20.40	18.24	52.86	49.77	12.36	22.87	16.69	18.70	71.41

Table 3 Purpose of men's daily travel before and during the pandemic

Destination	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
school	28.36	5.59	4.55	2.07	4.35	55.07	24.22	2.48	2.69	1.45	3.11	66.05
work	63.35	4.97	2.28	2.28	3.11	24.02	48.24	7.87	5.59	5.80	5.18	27.33
shopping	18.63	21.33	28.99	15.32	9.32	6.42	18.22	17.18	22.98	16.98	13.87	10.77
doctor	14.70	8.90	11.80	13.04	15.53	36.02	19.46	6.42	4.55	6.21	12.84	50.52
meetings	13.66	18.01	25.05	19.05	11.39	12.84	13.25	10.56	9.94	13.25	20.29	32.71
parents	24.84	14.49	20.29	12.01	8.70	19.67	22.77	9.52	15.53	12.63	12.01	27.54
leisure	16.98	16.36	25.26	18.22	10.56	12.63	18.63	10.77	9.73	8.90	17.18	34.78
max	63.35	21.33	28.99	19.05	15.53	55.07	48.24	17.18	22.98	16.98	20.29	66.05

2.4 Results

The first substantive question of the survey was to indicate the purpose of daily travel, before and during the pandemic. In this case, the respondents had the

option to choose one of seven answers, specifying the importance of the target. In the analyzed case: 1 was the most common target, 6 the rarest. Before the pandemic, the most important destination for the respondents was work, then shopping, social meetings, a doctor and

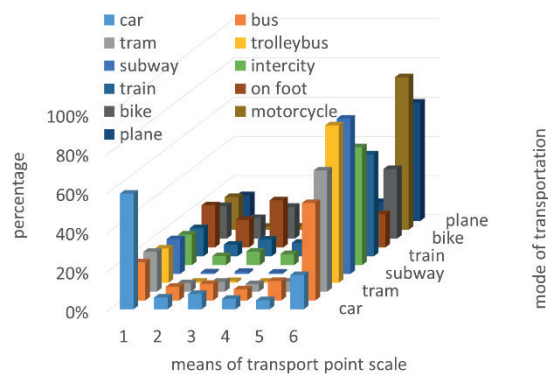


Figure 5 Means of transport before the pandemic

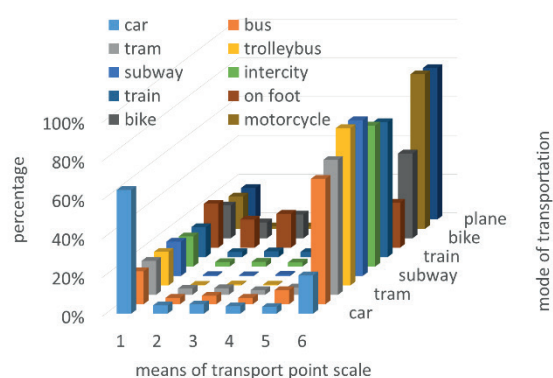


Figure 6 Means of transport during the pandemic

Table 4 A means of transporting women before and during the pandemic

Means of transport	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
car	63.68	4.79	7.26	3.86	4.79	15.61	69.40	3.71	4.33	2.32	2.47	17.77
Bus	17.16	8.04	7.42	5.41	9.12	52.86	14.99	2.47	3.55	2.94	7.11	68.93
Tram	18.70	4.33	3.71	3.09	4.33	65.84	15.61	3.55	1.55	2.16	3.25	73.88
Trolleybus	14.99	0.93	0.77	0.62	0.62	82.07	14.84	0.46	0.46	0.31	0.62	83.31
Metro	15.15	1.39	0.62	0.31	0.46	82.07	15.15	0.77	0.15	0.46	0.15	83.31
Intercity transport	13.60	5.10	7.73	4.79	6.80	61.98	13.60	2.32	2.01	2.16	4.33	75.58
Train	13.76	5.72	7.73	6.80	11.13	54.87	14.22	2.01	2.47	1.08	6.18	74.03
By foot	22.87	14.84	23.03	11.59	8.96	18.70	23.96	13.45	16.54	10.82	9.12	26.12
Bike	13.76	9.43	16.85	10.36	9.89	39.72	13.91	6.65	13.29	7.88	9.43	48.84
Motorbike	14.06	1.24	1.55	0.62	1.24	81.30	13.91	1.08	1.39	0.31	0.46	82.84
Plane	12.21	2.78	8.04	5.41	9.89	61.67	13.45	1.70	0.77	0.62	2.47	80.99
max	63.68	14.84	23.03	11.59	11.13	82.07	69.40	13.45	16.54	10.82	9.43	83.31

Table 5 A means of transporting men before and during the pandemic

Means of transport	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
car	51.35	7.87	8.28	7.25	5.59	19.67	55.90	5.18	5.18	5.59	5.80	22.36
Bus	22.57	7.25	9.52	6.63	10.56	43.48	20.91	4.55	4.76	4.14	8.70	56.94
Tram	23.60	4.76	6.42	4.14	5.80	55.28	21.33	2.48	5.59	3.31	4.55	62.73
Trolleybus	21.53	0.41	1.04	0.21	0.41	76.40	18.63	14.08	24.64	14.91	12.84	14.91
Metro	21.53	0.62	1.86	1.04	0.62	74.33	22.15	0.21	0.62	0.83	1.04	75.16
Intercity transport	19.46	4.35	6.21	6.63	7.25	56.11	19.46	2.69	2.90	2.07	6.00	66.87
Train	16.36	6.42	9.52	7.66	13.25	46.79	18.43	3.52	3.93	4.14	7.66	62.32
By foot	18.63	14.08	24.64	14.91	12.84	14.91	20.50	15.32	18.63	12.84	12.84	19.88
Bike	20.29	11.80	15.53	11.18	10.14	31.06	21.33	9.94	10.97	8.28	11.39	38.10
Motorbike	21.53	2.07	1.45	1.66	0.83	72.46	21.53	1.66	1.24	1.04	0.00	74.53
Plane	15.73	5.80	6.00	5.59	10.56	56.31	21.53	1.04	1.86	1.24	2.28	72.05
max	51.35	14.08	24.64	14.91	13.25	76.40	55.90	15.32	24.64	14.91	12.84	75.16

finally school. However, during the pandemic, a different hierarchy of respondents' goals emerged. In the first place, there is still work and shopping, while socializing has passed and the school has moved up. During the pandemic, the respondents dropped out of visiting a doctor, resting or visiting their parents. The above data correspond to the previous questions concerning the age and professional situation of the respondents. The above data are presented in the Figures 3 and 4.

The main purpose of women's trips was work. This was 71% before the pandemic and 50% during the pandemic. The same was true for men: before the pandemic, work accounted for 63% and during the pandemic 48%. This is confirmed by the age of the respondents and also by the fact that 35% of them worked in a hybrid mode (Table 2, 3).

Then, respondents were asked which means of transport they use. As in the previous case: 1 was the most common target, 6 the rarest. When asked, before the pandemic, the respondents most often used the car and walked and least often - trolleybus and motorbike. Not much has changed during the pandemic and respondents chose the car and walked over it. However, it can be noticed that the respondents gave up public transport as much as possible. The above results are mainly concerned with the activity of people, such as the workplace or school and shopping. The data is presented in Figures 5 and 6. Due to the pandemic, more men and women started using their own cars instead of public transport (Table 4, 5).

Another question was about the distance from home to destination before and during the pandemic. Most of the respondents before the outbreak of the pandemic indicated a distance of 1-5km (26%) as the main goal, this is due to the workplace and the additional goal was a distance of more than 20km (36%), mainly trips related to leisure and family visits. After the outbreak of the pandemic, a distance of 1-5km appeared as the main and additional destination. This is largely due to commuting and shopping. Following the outbreak of the pandemic, respondents gave up visiting relatives and resting, spending most of their time at home. The data is shown in Figure 7. Before the swap, women were 1-5km

away from their main destination, while men were more than 20km away. During the pandemic, women's distance remained the same, while men's decreased to 5km (Table 6).

Another question was how long it would take to travel to the primary and secondary destinations before and during the pandemic? In this case, before the outbreak of the pandemic, most people reached their primary destination, usually work, within 15-30 minutes (32%) and the secondary destination, shopping, within 15 minutes (41%). During an epidemic and a decrease in traffic on the roads, the time for both cases is up to 15 minutes. A small number of respondents targeted more than 2 hours. This correlates with the distance of the place of residence from the primary and secondary travel destination, as shown in Figure 8. For the main goal before the pandemic outbreak, women had up to 15 minutes (33%) and men between 15 and 30 minutes (35%). During the pandemic, the main target for women and men was up to 15 minutes (41%) (Table 7).

The next questions were about where to shop before the pandemic. When asked about this question, before the pandemic was announced, the respondents indicated large stores as the most popular place to buy: a supermarket, hypermarket, market and the third place was only the internet, while after the epidemic was announced, the respondents most often made purchases on the Internet and in the local stores. This is confirmed by responses to the reduction in distance and time to destination after the declaration of a pandemic. The data is presented in Figures 9 and 10. Before the pandemic, women shopped mainly in supermarkets and hypermarkets, but during the pandemic the situation changed and more women shopped online (Table 8). There was a similar situation among men (Table 9).

Subsequent questions were related to the change of communication habits in the event of another pandemic (Figure 11). This question was answered by the largest number of respondents, almost 77%, (woman 75.73%, men 78.05%). These are the people who use the car most often because of the comfort, safety, isolation from other people, or the inability to use public transport, especially in rural areas and the pandemic did not affect

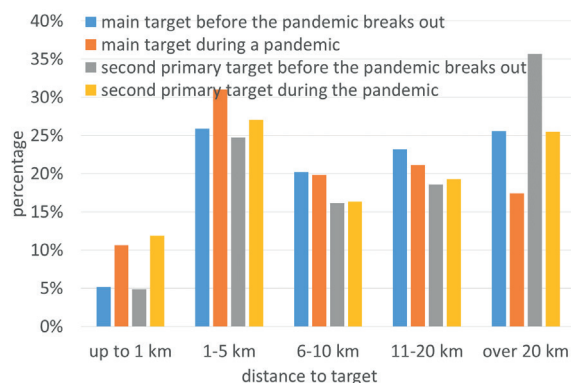


Figure 7 Distance to destination before and during the pandemic

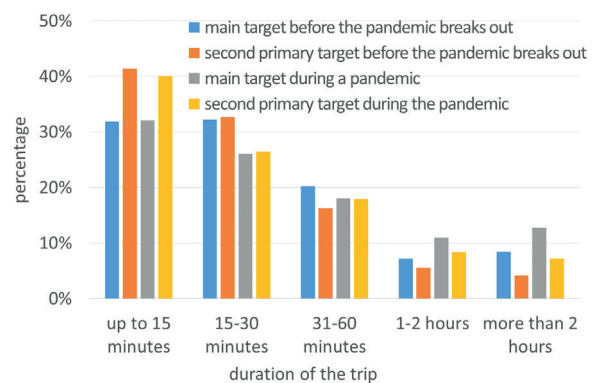


Figure 8 Duration of the trip before and during the pandemic

Table 6 Distance to target for female and male before and during the pandemic

Distance	Female					Male				
	do 1 km	1-5 km	6-10 km	11-20 km	pow. 20 km	do 1 km	1-5 km	6-10 km	11-20 km	pow. 20 km
primary objective before the outbreak of a pandemic	5.26	27.51	20.09	22.57	24.57	4.97	24.43	20.50	23.60	26.50
second main objective before the outbreak of a pandemic	4.48	22.10	14.68	19.47	39.26	5.59	29.19	18.01	18.01	29.19
primary objective during the pandemic	9.58	32.46	20.87	20.56	16.54	11.80	28.99	19.25	21.74	18.22
second main objective during pandemic	11.59	25.97	17.00	20.09	25.35	12.01	28.99	15.73	17.81	25.47

Table 7 Distance to travel time for female and male before and during the pandemic

Travel time	Female					Male				
	up to 15 minutes	15-30 minutes	31-60 minutes	1-2 hours	over 2 hours	up to 15 minutes	15-30 minutes	31-60 minutes	1-2 hours	over 2 hours
primary objective before the outbreak of the pandemic	32.61	31.53	18.39	7.88	9.58	30.23	35.20	22.98	5.59	6.00
second main objective before the outbreak of the pandemic	28.59	25.35	18.86	11.28	15.92	37.06	28.16	17.18	10.35	7.25
primary objective during the pandemic	41.27	32.61	14.99	6.80	4.33	40.58	34.58	17.39	3.73	3.73
second main objective during the pandemic	36.79	26.89	18.55	9.43	8.35	43.69	26.71	16.77	7.45	5.38

the way of traveling in this case. Furthermore, some of the respondents have changed the way of traveling since the epidemic was introduced, i.e. for 9 months. First of all, fearing for their health, it was abandoning the public transport in favor of a car, some were even forced to buy a car, bicycle or walk. However, especially persons from large cities, that were forced to use the public transport due to the lack of parking spaces at work. In addition, about 11% of respondents said that in the event of a prolonged pandemic, they would change their mobility

in the main one and adequately measured their decision to the existing situation.

The next question was an open-ended question in which respondents had the opportunity to determine the impact of how the coronavirus changed their mobility. Most of the respondents wrote that its impact was significant. Apart from the comments mentioned in the above question, it is worth noting that there has been a decrease in the number of public transport passengers. They mainly use cars or other means of



Figure 9 Place of shopping before the pandemic

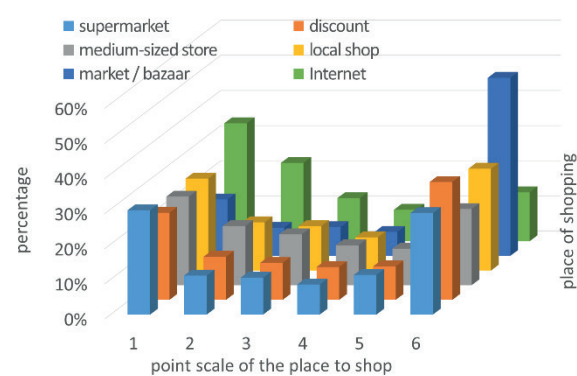


Figure 10 Place of making purchases during the pandemic

Table 8 Women's shopping space before and during the pandemic

place of shopping	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
super- and hypermarket	38.02	10.82	11.28	10.51	9.58	19.78	30.14	9.27	9.74	7.73	10.97	32.15
discount store	27.36	12.83	10.97	8.19	10.51	30.14	23.34	11.59	8.66	8.81	10.05	37.56
medium-sized shop. so-called market	29.52	18.24	18.24	8.50	8.96	16.54	25.04	16.85	14.99	10.20	11.13	21.79
estate shop	22.41	13.76	12.83	10.36	13.29	27.36	27.67	12.36	11.13	9.27	9.27	30.29
marketplace/bazaar	14.99	10.05	14.06	10.36	14.68	35.86	14.06	7.42	9.89	6.49	9.89	52.24
Internet	19.63	14.53	22.87	17.47	12.06	13.45	38.95	23.03	9.74	7.73	6.96	13.60
max	38.02	18.24	22.87	17.47	14.68	35.86	38.95	23.03	14.99	10.20	11.13	52.24

Table 9 Men's shopping space before and during the pandemic

place of shopping	Before the pandemic, %						During the pandemic, %					
	1	2	3	4	5	6	1	2	3	4	5	6
super- and hypermarket	31.06	15.32	13.04	10.97	11.18	18.43	28.78	13.66	11.80	9.94	11.80	24.02
discount store	27.33	13.66	14.29	10.77	8.70	25.26	16.36	17.81	23.19	13.87	15.73	13.04
medium-sized shop. so-called market	25.88	18.84	17.18	12.22	10.35	15.53	25.26	15.73	15.11	13.66	9.32	20.91
estate shop	20.29	14.29	15.53	13.25	10.97	25.67	22.57	16.15	13.66	10.97	9.73	26.92
marketplace/bazaar	17.81	9.94	10.35	9.32	14.49	38.10	19.88	8.49	6.83	7.25	10.77	46.79
Internet	16.36	17.81	23.19	13.87	15.73	13.04	26.71	20.91	15.11	10.56	12.84	13.87
max	31.06	18.84	23.19	13.87	15.73	38.10	28.78	20.91	23.19	13.87	15.73	46.79

individual communication, including by bike or walking. This is due to the safety of passengers, the introduction of restrictions on the number of people in the vehicle and in some cases also the increase in ticket prices and the liquidation of connections. The above state is also confirmed by the author's observations regarding public transport.

A smaller number of people, due to work and study at home, as well as the closure of cultural institutions and restaurants, as well as restraining from travel and social visits, limited their mobility to a practically minimum. They also reduced the frequency of purchases:

once every few days instead of everyday purchases. The air transport in the initial phase of the pandemic has practically been extinguished to zero. All over the world, many airlines have suspended regular flights. This situation caused a radical decline in tourist and business traffic not only in Poland, but all over the world.

The respondents also stated that in cities, COVID-19 affected the mobility of residents, while in rural areas, slightly, because the primary means of transport there is a car. The above state is also confirmed by the author's observations.

The next step was to correlate the answers given

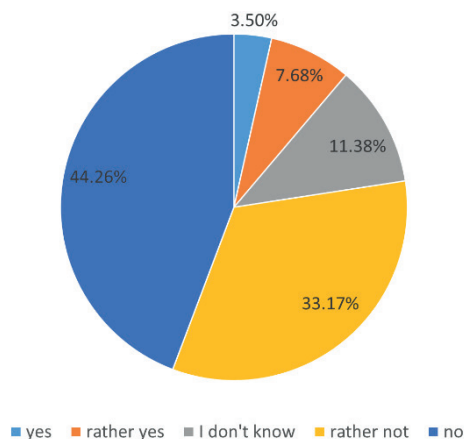


Figure 11 Changing communication habits

Table 10 Correlation of answers given by gender

Criterion	df	α	χ^2	χ^2_d	Conclusion
Age range	5	0.05	50.26	11.07	There is a correlation
Place of residence	1	0.05	4.07	3.84	There is a correlation
Number of residents	9	0.05	50.64	16.92	Correlation exists
Education	5	0.05	48.48	11.07	Correlation exists
Labour market status	5	0.05	42.36	11.07	Correlation exists
Occupational situation after the coronavirus outbreak	1	0.05	0.01	3.84	No correlation
Professional work	2	0.05	11.16	5.99	Correlation exists
Change in communication habits	4	0.05	5.18	9.48	no correlation

where:

df - the degrees of freedom,

α - the significance level,

χ^2 - the Chi-square statistic,

χ^2_d - the critical Chi-square value.

by the respondents according to their gender. Based on the research, it can be concluded that the gender of the respondents depended on the age range, place of residence, population, education, labour market status and professional work (Table 10).

In the next step, correlations were made between the factors found in the questionnaire. Based on the Table 11, a very strong positive correlation can be found between the following factors: main destination before and during the pandemic ($r = 0.9823$, $p < 0.001$), mode of transport before and during the pandemic ($r = 0.9953$, $p < 0.001$) and travel time to destination before and during the pandemic ($r = 0.9879$, $p < 0.001$).

In contrast, a very strong negative correlation is found between the following factors: mode of work and education ($r = -0.9598$, $p = 0.002$), main destination before pandemic and distance to main destination before pandemic ($r = -0.9756$, $p = 0.001$), main destination before pandemic vs distance to main destination during pandemic ($r = -0.9959$, $p < 0.001$), age vs travel time before pandemic ($r = -0.9804$, $p = 0.001$) and age vs travel time during pandemic ($r = -0.9756$, $p = 0.001$).

Based on e Table 11, there is no correlation between the following factors: main destination before the pandemic and education ($r = -0.0930$) and labour

market status ($r = -0.0947$); main destination during the pandemic and population ($r = 0.0898$) and education ($r = -0.0676$); mode of transport before the pandemic and labour market status ($r = -0.0917$) and main destination during the pandemic ($r = -0.0211$); mode of transport during the pandemic and main destination before the pandemic ($r = 0.0515$) and during the pandemic ($r = -0.0765$); distance to the main destination before the pandemic and labour market status ($r = -0.0226$); distance to the main destination during the pandemic and age ($r = 0.0593$) and place of shopping during the pandemic and labour market status ($r = -0.0350$).

2.5 Discussion of the results

At the beginning of the announcement of the epidemic, the mobility of residents practically decreased. Currently, the difference is not very noticeable, but the travel times in rush hour traffic have shrunk slightly. In the evenings and on weekends, it increased in turn. This is mainly due to working and distance learning up to the afternoon hours.

Most of the respondents use a car, but quite often, due to the prevailing situation, they choose an active

Table 11 Correlation factors in the survey (bp- before the pandemic; dp- during the pandemic)

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 age	1															
2 number of inhabitants	-0.69 97	1														
3 education	-0.27 53	-0.12 40	1													
4 labour market status	0.44 88	-0.23 88	-0.28 14	1												
5 way of working	-0.10 97	0.68 43	-0.95 98	0.16 33	1											
6 main destination bp	-0.49 66	0.21 89	-0.09 30	-0.09 47	-0.88 11	1										
7 main destination dp	-0.36 03	0.08 98	-0.06 76	-0.11 41	-0.92 50	0.98 23	1									
8 mode of transport bp	-0.51 98	0.87 15	-0.35 36	-0.09 17	0.79 69	0.10 78	-0.02 11	1								
9 mode of transport dp	-0.52 77	0.86 78	-0.31 23	-0.14 47	0.79 19	0.05 15	-0.07 65	0.99 53	1							
10 distance to main destination bp	0.37 04	-0.82 05	0.59 29	-0.02 26	-0.97 56	0.47 51	0.63 23	-0.89 99	-0.9 045	1						
11 distance to main destination dp	0.05 93	-0.58 56	0.53 42	-0.25 77	-0.99 59	0.69 85	0.82 75	-0.70 57	-0.71 24	0.94 36	1					
12 time of travel to destination bp	-0.98 04	0.83 61	-0.68 89	-0.22 61	0.29 67	0.56 09	0.39 32	0.76 96	0.74 04	-0.46 18	-0.18 17	1				
13 travel time to main destination dp	-0.95 74	0.90 59	-0.71 64	-0.21 88	0.49 02	0.42 65	0.24 81	0.85 80	0.83 31	-0.59 28	-0.32 58	0.98 79	1			
14 shopping place bp	-0.26 79	0.72 10	-0.52 49	0.29 80	0.84 36	0.38 25	0.29 93	0.79 27	0.74 84	-0.74 97	-0.56 14	0.90 41	0.94 71	1		
15 shopping place dp	-0.28 40	0.42 69	0.55 32	-0.03 50	0.82 88	0.14 64	0.15 51	0.27 47	0.28 18	-0.92 65	-0.77 61	0.55 25	0.66 87	0.35 05	1	
16 change in COVID habits	0.46 08	-0.59 50	0.92 84	-0.31 81	-0.41 39	-0.63 71	-0.56 46	-0.57 18	-0.51 64	0.34 07	0.14 51	-0.91 07	-0.87 85	-0.94 49	-0.77 49	1

lifestyle: walking or cycling, walking, giving up the public transport for safety reasons. The most important destination for respondents before the pandemic was work, then shopping, socializing, a doctor and finally school. In the midst of the pandemic, it is still mostly work and shopping, while socializing has gone and the school has moved up. During the pandemic, the respondents did not visit the doctor, rest or visit their parents. They cover the distance of up to 5km and it takes them up to 15 minutes and they do their shopping less often, once every few days in smaller stores and on the Internet.

In addition, the study found a strong negative correlation between: mode of work and education; main

destination before the pandemic and distance to the main destination before the pandemic; main destination before the pandemic and distance to the main destination during the pandemic; age and travel time before the pandemic; and age and travel time during the pandemic.

3 Summary

After the outbreak of the COVID-19 epidemic, the mobility of Polish residents has changed, especially in cities where there was public transport and people stayed at home or started using their own cars. In smaller towns and villages, where there is no public transport,

people still mainly use cars because they are dependent on it. The above statement is confirmed by the results of the surveys. Based on the research, it can be concluded that the gender of the respondents depended on the age range, place of residence, population, education, labour market status and professional work. In addition, respondents were asked whether the COVID-

19 pandemic had affected their mobility. During the COVID-19 pandemic, the mobility of citizens, especially in the cities, has changed. Instead of using public transport, they use cars, bicycles and walk. In smaller towns and villages, the communication behavior of the inhabitants has practically not changed, as they mainly use cars.

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