Open Access Article

Ann. Acad. Med. Siles. (online) 2025; 79: 368–378
eISSN 1734-025X
DOI: 10.18794/aams/211012
www.annales.sum.edu.pl

PRACA ORYGINALNA
ORIGINAL PAPER

Environmental study analyzing the knowledge of vaccinated patients about complications after vaccination against COVID-19: A preliminary report

Badanie środowiskowe analizujące wiedzę zaszczepionych pacjentów na temat powikłań po szczepieniu przeciwko COVID-19 – doniesienie wstępne

Maria Stachura[1], Adriana Biela[1], Zuzanna Puszczewicz[1], Julia Wypyszyńska[1], Natalia Zaboklicka[1], Tomasz Męcik-Kronenberg[2]

[1]Students' Scientific Club, Department of Pathomorphology, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland

[2]Department of Pathomorphology, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland

ABSTRACT

INTRODUCTION: The aim of this study is to analyze the knowledge of vaccinated Poles about the side effects of COVID-19 vaccination in the light of misinformation about vaccines, their mechanism, and complications.
MATERIAL AND METHODS: The authors created an anonymous online survey. The study group consisted of 2,345 people and included 1,468 people vaccinated against COVID-19.
RESULTS: Vaccine leaflets, social media, and doctors were listed as the most frequent sources of information about vaccines. When asked about the possibility of developing COVID-19 as a result of vaccination, 55.18% of the respondents answered that it is not possible. Only 2.72% of the respondents claimed that complications will occur after each vaccine and booster dose. According to the respondents, the most common complication following the Comirnaty vaccine is muscle pain; after the Vaxzevria vaccine it is fever. In the case of the Moderna and Janssen vaccines, most did not know the answer.
CONCLUSIONS: The respondents knew the most about the side effects related to the Comirnaty vaccine and the least about the Janssen and Moderna ones. In the case of the Vaxzevria vaccine, the respondents pointed to thromboembolic events as one of the most common complications. The most common source of information was the vaccine leaflet. Fears about complications were declared by the highest number of people vaccinated with the Janssen vaccine.

KEYWORDS

SARS-CoV-2, COVID-19, vaccine

Received: 24.01.2023 **Revised:** 14.08.2025 **Accepted:** 17.09.2025 **Published online:** 28.10.2025

Address for correspondence: Maria Stachura, Studenckie Koło Naukowe, Katedra i Zakład Patomorfologii, SPSK Nr 1 im. prof. S. Szyszko ŚUM, ul. 3 Maja 13/15, 41-800 Zabrze, tel. +48 32 370 45 46, e-mail: mariastachuraaa@gmail.com

Publisher: Medical University of Silesia, Katowice, Poland

STRESZCZENIE

WPROWADZENIE: Celem niniejszego badania jest analiza wiedzy zaszczepionych Polaków na temat powikłań po szczepieniu przeciwko COVID-19 w obliczu konieczności zwiększenia wiedzy na temat szczepionek, mechanizmu ich działania oraz powikłań.
MATERIAŁ I METODY: Autorzy stworzyli anonimową ankietę internetową. Badana populacja liczyła 2345 osób, w tym 1468 zaszczepionych przeciwko COVID-19.
WYNIKI: Jako najczęstsze źródła informacji o szczepionkach wskazywano ulotkę szczepionki, media społecznościowe oraz lekarza. Na pytanie o możliwość zachorowania na COVID-19 w wyniku szczepienia 55,18% respondentów odpowiedziało przecząco. Jedynie 2,72% ankietowanych twierdziło, iż po każdej dawce szczepionki wystąpią powikłania. Zdaniem ankietowanych najczęstszym powikłaniem po szczepionce Comirnaty jest ból mięśni, a po szczepionce Vaxzevria gorączka. W przypadku szczepionek Moderna i Janssen większość nie znała odpowiedzi.
WNIOSKI: Ankietowani wiedzieli najwięcej o powikłaniach mogących wystąpić po przyjęciu szczepionki Comirnaty, a najmniej o powikłaniach po szczepionkach Janssen i Moderna. W przypadku szczepionki Vaxzevria jako jedno z najczęstszych powikłań ankietowani wskazali incydenty zakrzepowo-zatorowe. Najczęstszym źródłem informacji o powikłaniach była ulotka dołączona do szczepionki. Obawy przed powikłaniami deklarowała największa liczba osób zaszczepionych szczepionką Janssen.

SŁOWA KLUCZOWE

SARS-CoV-2, COVID- 19, szczepionka

INTRODUCTION

In December 2019, the first cases of the severe acute respiratory disease COVID-19 caused by a new strain of coronavirus, SARS-CoV-2, were identified [1,2,3]. The first case in Poland was registered on March 4, 2020 [4]. On March 11, the World Health Organization (WHO) declared COVID-19 a pandemic [2,5].
Despite worldwide research programs aiming to find effective medication for COVID-19, there is still no standardized pharmacotherapy with high effectiveness proven by large-scale research [6,7]. Thus, vaccines play a significant role in decreasing COVID-19--related hospitalization and deaths [8,9,10,11].
In order to effectively fight the pandemic, most countries started the process of vaccinating their citizens [11,12,13]. The first country to launch a national vaccination program was the United Kingdom, on December 8, 2020 [14,15]. In Poland, the first person was vaccinated on December 27, 2020 [16]. As of March 29, 2022, 59.1% of Polish citizens were fully vaccinated [17]. In the European Union, Portugal has the highest vaccination rate, with 92.6% of its citizens having received two doses (as of March 29, 2022) [17]. Due to the acquired immunity against COVID-19 weakening over time, it is recommended to receive booster doses [18]. In Poland, the number of people who have received a booster dose exceeds 11 million citizens [19]. The National Vaccination Program was introduced to plan and control the process of voluntary vaccination among Polish citizens. It involves providing and distributing an adequate number of vaccines and controlling their safety and efficacy [20].
mRNA vaccines are currently available on the European market, including the Comirnaty vaccine (BioNTech/Pfizer) and the mRNA vaccine (Moderna). They work by delivering synthetic mRNA to the cytoplasm of the host cell, where the encoded SARS--CoV-2 antigen is translated, which is most often the S protein. This allows the antigen to be properly presented to the immune system and to induce an effective immune response [21,22,23]. In addition, viral vector vaccines are also available: Vaxzevria (AstraZeneca) and Janssen (Johnson & Johnson). These vaccines contain inactivated adenovirus, which acts as a vector carrying the genetic information necessary to synthesize the SARS-CoV-2 protein [21,22,24]. It is an antigen that induces an immune response based on cross-immunity [25]. The latest commercially available vaccine is the recombinant vaccine Nuvaxovid from Novavax, which contains purified SARS-CoV-2 S protein – or a fragment thereof – prepared using genetic recombination techniques [24,26]. The Sputnik V viral vector vaccine, Sinovac's inactivated Vero Cell vaccine, and the Vidprevtyn and Valneva vaccines are under phase review [26].
Despite the proven efficacy of all currently available COVID-19 vaccines and the existence of many public and social campaigns encouraging their adoption, vaccination programs both in Poland and around the world meet with reluctance, which may be related to the limited clinical trials on their safety or the existence of numerous conspiracy theories, as well as decreasing trust in vaccinations overall [13,27]. In recent years, the number of people in Poland confident about the safety of vaccination against other infectious diseases has been decreasing, in contrast to many other countries [28].
The main aim of this study was to assess the knowledge of vaccinated Poles about the side effects following COVID-19 vaccination. Secondary objectives are to determine whether the respondents' knowledge

of all vaccines is the same, which sources of information they most often use, and whether their sex, age, education level, or place of residence are related to their knowledge about vaccination.

MATERIAL AND METHODS

The research was conducted in the form of an anonymous online questionnaire addressed to the citizens of Poland. The surveys were collected from May to August 2021. The questionnaire was widely shared on online forums and social media platforms, mostly on Facebook groups with announcements. It consisted of a demographic section and the main section, the latter of which was divided into a part dedicated to all respondents and one only for those who had been vaccinated.

RESULTS

Demographic section

The population for our research consisted of people living in all Polish voivodeships. The final number of responses was 2,345. Most of them (1,851; 78.9%) were sent by women, while 470 (20%) were sent by men; the remaining 24 (1%) of our respondents chose not to share their sex. Based on Erik Erikson's stages of psychological development, we distinguished the following age groups in our questionnaire: ≤ 17 years old, 18–35 years old, 36–55 years old, 56–65 years old, and ≥ 66 years old [29]. The next question referred to the population of the town where our respondents lived. They could choose between the following: up to 50,000 citizens, up to 150,000, up to 500,000, and over 500,000 citizens. Lastly, we asked the respondents about their education level (Table I).

Table I. Characteristics of the study group

Parameters		Respondents [n (%)]
Gender	Women	1,851 (78.9)
	Men	470 (20)
	Did not share that information	24 (1)
Age	≤ 17 years old	89 (3.8)
	18–35 years old	1,468 (62.6)
	36–55 years old	660 (28.1)
	56–65 years old	85 (3.6)
	≥ 66 years old	43 (1.8)
Population of place of residence	< 50,000	1285 (54.8)
	50,000–150,000	428 (18.3)
	150,000–500,000	350 (14.9)
	> 500,000	282 (12)
Educational stage	Elementary	94 (4)
	Secondary	729 (31.1)
	Vocational	168 (7.2)
	Higher	944 (40.3)
	College student	410 (17.5)

Main section

Questions concerning all respondents

Out of 2,345 respondents, 805 (34.3%) had experienced a COVID-19 infection, of which 79.1% (637) were women and 19.9% (160) were men. People in the 36–55 age group were more likely to suffer from COVID-19 (35.91%), followed by the 18–35 age group (34.47%; Table II).

Table II. COVID-19 infection, by age group

Age group [years]	COVID-19 infection [% (n)]	
	Yes	No
≤ 17	31.46 (28)	68.54 (61)
18–35	34.47 (506)	65.53 (962)
36–55	35.91 (238)	64.09 (422)
56–65	29.41 (25)	70.59 (60)
≥ 66	18.60 (8)	81.40 (35)

In total, 703 respondents (29.28%) had been fully vaccinated. A single dose had been administered to 765 respondents (32.62%). Further in the article, both of these groups are referred to as "the vaccinated." Over one third of the respondents (877; 37.4%) were unvaccinated. We analyzed the relationships between vaccination rate, gender, and age group among our respondents (Table III).

Men and women were vaccinated to the same extent. The age group with the highest vaccination rate was ≥ 66. Due to the large amount of data obtained in the survey, the remainder of the article focuses on the vaccinated respondents.

Most of the respondents (901; 61.37%) were vaccinated with the Comirnaty vaccine. The second most common vaccine was Vaxzevria (297; 20.26%), followed by Moderna (137; 9.32%), and the least popular was Janssen vaccine (133; 9.05%).

Next, the vaccinated respondents answered questions about complications after COVID-19 vaccination. From that group, 694 (47.3%) admitted that they had experienced post-vaccination complications (Figure 1).

The most frequent answers were fatigue (25.72%), muscle pain (25.67%), and fever (19.06%). Our research also showed that 385 people (26.6%) were afraid of long-term complications that may occur after vaccine administration.

Next, the respondents were asked if they had sought information about complications from COVID-19 vaccination. Out of all the vaccinated respondents, 65.4% answered positively.

They were also asked about what sources of information they used. The most frequent answer was the vaccine leaflet (17.92%), followed by social media (15.54%), doctors (15.15%), official government websites (13.98%), internet forums (13.51%), conventional media (10.93%), and family and friends (10.86%).

Table III. Vaccination rate, gender, and age group

Parameters		Are you vaccinated? [% (n)]		
		No	Yes (1 dose)	Yes (fully)
Gender	Women	36.79 (681)	32.47 (601)	30.74 (569)
	Men	38.09 (179)	34.04 (160)	27.87 (131)
	Did not share	70.83 (17)	16.67 (4)	12.50 (3)
Age group [years]	≤ 17	65.17 (58)	33.71 (30)	1.12 (1)
	18–35	39.92 (586)	33.79 (496)	26.29 (386)
	36–55	30.91 (204)	29.70 (196)	39.39 (260)
	56–65	28.24 (24)	31.76 (27)	40.00 (34)
	≥ 66	11.63 (5)	37.21 (16)	51.16 (22)

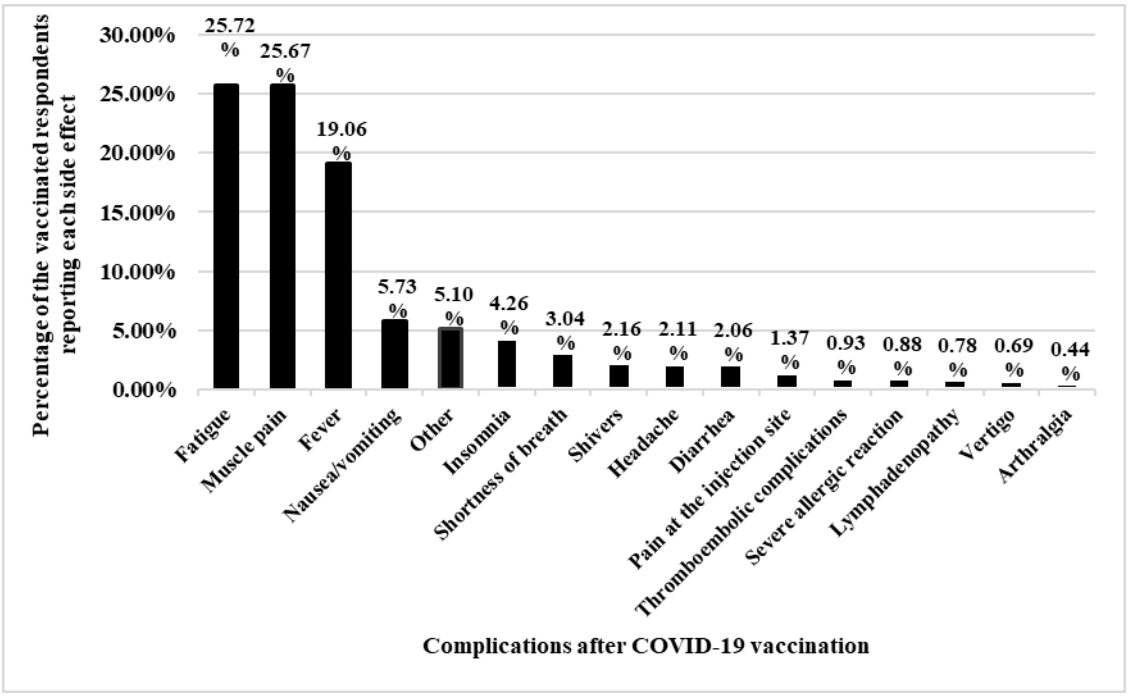

Fig 1. What side effects did you experience after receiving the COVID-19 vaccine? (%)

The respondents were then asked if SARS-CoV-2 infection might develop as a result of vaccination. Only 186 people (12.67%) chose the answer "yes"; 810 (55.18%) picked "no" and the rest of the respondents chose "I don't know."

On the next question, the majority of our respondents (1,300; 88.56%) stated that not every vaccinated person will develop complications. Only 40 of them (2.72%) thought that this was the case, while the rest selected "I don't know."

Next, we asked the interviewees if a severe allergic reaction might occur as a result of vaccination. The vast majority thought that this was possible (1,111; 75.68%), while 79 (5.38%) respondents answered negatively and 278 (18.94%) chose "I don't know."

To the question "Which vaccine is the safest in your opinion?" 618 (42.10%) respondents answered that the specific vaccine did not matter to them. For 712 respondents (48.50%), the safest one was the Comirnaty vaccine. The least safe vaccine, in the opinion of the majority of our respondents, was Vaxzevria.

The following questions examined the respondents' knowledge about the most common side effects that may occur after COVID-19 vaccination. They were allowed to choose more than one answer, so we present the results as the number and percentage. Detailed information is presented in Table IV.

The most commonly chosen complications for the Comirnaty vaccine were muscle pain (26.82%), fatigue (25.08%), and fever (22.99%). For the Moderna vaccine, 26.51% respondents did not know the most common complications. The next most frequent answers were muscle pain (20.38%), fatigue (19.94%), and fever (18.75%). Answers to the same question about the Janssen vaccine were similar, including "I don't know" (30.39%), muscle pain (17.80%), fatigue (17.54%), and fever (17.43%). Lastly, the most common complications after Vaxzevria in the respondents' opinion were fever

(21.07%), muscle pain (20.25%), and fatigue (18.72%). Moreover, the respondents more often reported thromboembolic complications as a frequent side effect of the Vaxzevria vaccine than other vaccines (323 vs. 64 for Comirnaty, 54 for Moderna, and 89 for Janssen; Figure 2).

To sum up, the most common responses to the questions about post-vaccination complications are shown in Figure 3.

We then analyzed the relationship between the incidence of complications among the respondents and their research of information on this topic. Side effects occurred more often among the respondents who had researched potential complications beforehand (50.52% vs. 41.14%).

Next, we analyzed the relationship between the sources of information accessed by the vaccinated respondents and the factors of sex, education, age, and place of residence. Women sought information on complications from COVID-19 vaccination slightly more often than men: 66% (777) and 61% (178), respectively. Representatives of both sexes most often sought information about post-vaccination complications from the vaccine leaflets. In addition, women used all sources of information listed in the survey more often than men.

Vaccinated individuals with elementary, secondary, and higher education, as well as current college students, sought information about complications with similar frequency: 67% (26), 65% (269), 68% (433), and 66% (180), respectively. In contrast, those with vocational education did so less frequently (51%; 52). People with higher education and enrolled in college most often used vaccine leaflets as a source of information about complications (35.60% and 35%, respectively). In contrast, the leaflet was least often used by people with vocational education (14.70%).

The age groups ≤ 17, 18–35, 36–55, and ≥ 66 searched for information on complications after vaccination with a similar frequency: 65% (20), 66% (584), 66% (300), and 63% (24), respectively. However, in the case of the 56–65 age group, this percentage was 52% (32). Social media was the most common source of information on complications after vaccination against COVID-19 in the ≤ 17 age group (35.5%). The vaccine leaflet was the most common source in the 18–35 and 36–55 groups, but the least common among the ≤ 17 and 56–65 groups.

Inhabitants of cities over 500,000 residents used social media (29.17%; 56), vaccine leaflets (36.98%; 71), official government websites (33.85%; 65), traditional media (21.88%; 42), family and friends (23.96%; 46), and family doctors/specialists (30.21%; 58) when looking for information about complications more often than representatives of other groups. As the size of the town grew, so did the percentage of people using leaflets and official government websites as sources of information on complications. Detailed information is presented in Table V.

Table IV. Post-vaccination complications, by vaccine brand

Post-vaccination complications	Brand of vaccine [% (n)]			
	Comirnaty (Pfizer/BioNTech)	Moderna	Janssen (Johnson & Johnson)	Vaxzevria (AstraZeneca)
Muscle pain	26.82 (898)	20.38 (565)	17.80 (485)	20.25 (768)
Fatigue	25.08 (840)	19.94 (553)	17.54 (478)	18.72 (710)
Fever	22.99 (770)	18.75 (520)	17.43 (475)	21.07 (799)
Nausea/vomiting	3.49 (117)	3.89 (108)	4.29 (117)	5.35 (203)
Thromboembolic complications	1.91 (64)	1.95 (54)	3.27 (89)	8.52 (323)
Severe allergic reaction	1.88 (63)	1.73 (48	1.69 (46)	2.53 (96)
Shortness of breath	1.79 (60)	1.77 (49)	2.09 (57)	3.35 (127)
Diarrhea	1.70 (57)	2.02 (56)	2.31 (63)	3.43 (130)
Insomnia	1.49 (50)	1.41 (39)	1.83 (50)	2.66 (101)
Arm ache	1.28 (43)	0.58 (16)	0.33 (9)	0.24 (9)
Swelling / pain at the injection site	0.75 (25)	0.50 (14)	0.37 (10)	0.29 (11)
Headache	0.51 (17)	0.18 (5)	0.26 (7)	0.26 (10)
I don't know	9.50 (318)	26.51 (735)	30.39 (828)	12.53 (475)
Other	0.81 (27)	0.39 (11)	0.40 (11)	0.80 (30)

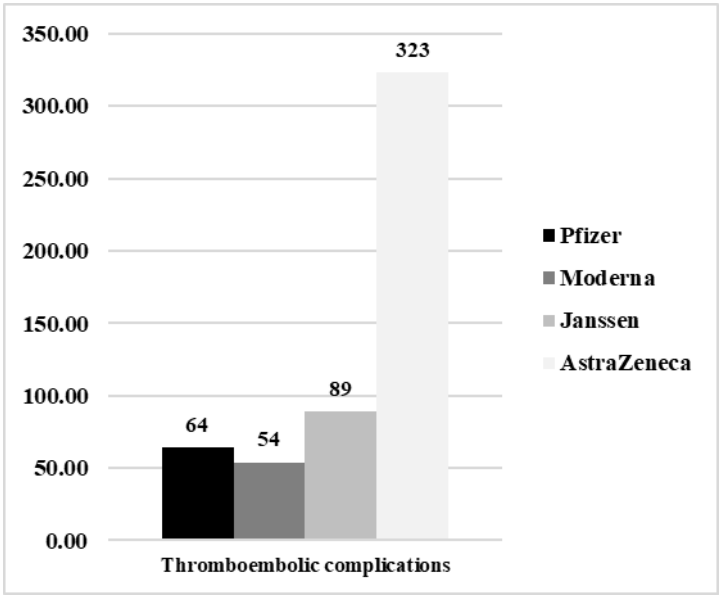

Fig. 2. Comparison of the number of thromboembolic complications reported as a complication of the vaccine

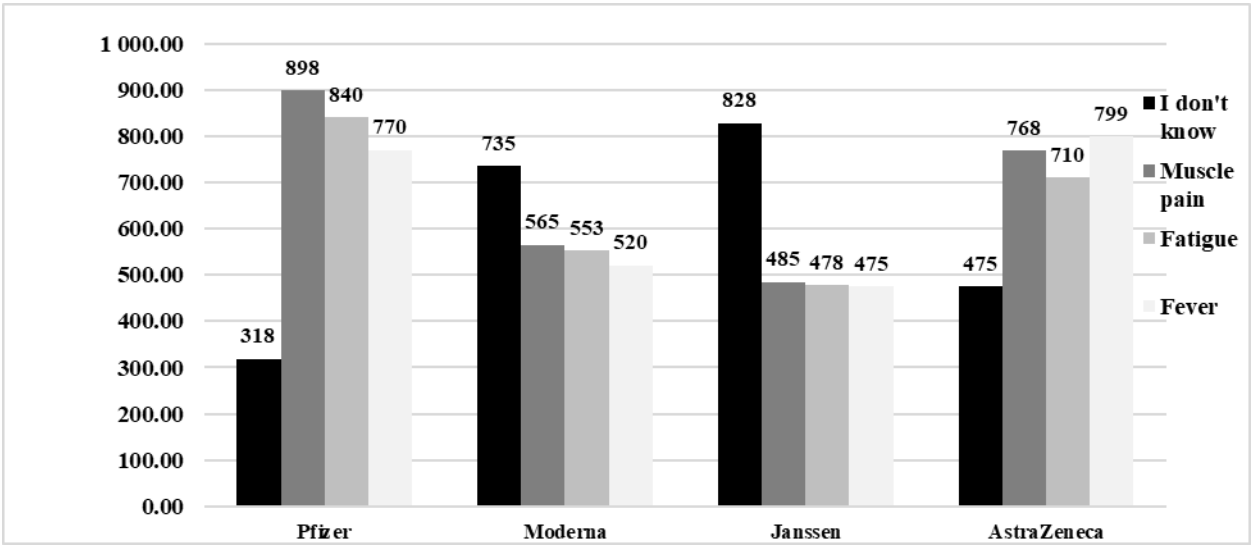

Fig. 3. Most common responses to the questions about complications after receiving a COVID-19 vaccine

Table V. Sources of information on vaccination complications, by sex, education, age, and place of residence [% (n)]

Parameters	Internet forums	Doctors	Family members/Friends	Conventional media	Official government websites	Vaccine leaflets	Social media
1	2	3	4	5	6	7	8
Sex							
Women	23.80 (279)	26.80 (313)	19.20 (225)	20.30 (238)	24.80 (290)	32.10 (376)	28.40 (332)
Men	23.00 (68)	24.40 (71)	17.90 (52)	13.70 (40)	22.70 (66)	27.10 (79)	22.40 (65)
Education							
Elementary	23.10 (9)	26.60 (10)	23.10 (9)	17.90 (7)	23.10 (9)	30.80 (12)	28.20 (11)
Secondary	27.40 (113)	26.00 (107)	19.20 (79)	20.10 (83)	21.80 (90)	26.20 (108)	29.40 (121)
Higher	22.90 (147)	27.60 (179)	20.60 (132)	21.40 (137)	26.00 (167)	35.60 (228)	27.90 (179)
College student	20.10 (55)	28.80 (79)	16.80 (46)	13.90 (38)	29.60 (81)	35.00 (96)	22.30 (61)
Vocational	21.60 (22)	12.70 (13)	11.80 (12)	14.70 (15)	10.80 (11)	14.70 (15)	25.50 (26)

cd. tab. V

1	2	3	4	5	6	7	8
Age group							
≤ 17	25.80 (8)	16.10 (5)	22.60 (7)	29.00 (9)	22.60 (7)	19.40 (6)	35.50 (11)
18–35	24.50 (216)	28.20 (250)	20.70 (183)	15.90 (140)	26.30 (232)	32.90 (290)	26.20 (231)
36–55	23.70 (108)	23.90 (110)	16.40 (75)	22.80 (104)	22.60 (103)	31.80 (145)	28.70 (131)
56–65	13.10 (8)	23.00 (14)	16.40 (10)	27.90 (17)	11.50 (7)	16.40 (10)	24.60 (15)
≥ 66	15.80 (6)	23.70 (9)	7.90 (3)	26.30 (10)	23.70 (9)	21.10 (8)	26.30 (10)
Population of place of residence							
< 50,000	22.34 (172)	25.84 (200)	18.57 (143)	18.44 (142)	21.82 (168)	29.22 (225)	26.88 (207)
50,000–150,000	29.41 (80)	23.16 (63)	16.54 (45)	21.32 (58)	23.53 (64)	30.51 (83)	26.84 (73)
150,000–500,000	20.94 (49)	28.21 (67)	18.80 (44)	16.24 (38)	26.07 (61)	34.19 (80)	26.50 (62)
> 500,000	23.44 (45)	30.21 (58)	23.96 (46)	21.88 (42)	33.85 (65)	36.98 (71)	29.17 (56)

Based on the three questions regarding complications after COVID-19 vaccines, we checked the relationship between the respondents' knowledge and level of education. First, we analyzed the responses to the question "Do you think that SARS-CoV-2 infection may develop as a complication after vaccination against COVID-19?" The correct answer to this question was "no," which was provided by the highest percentage of college students (186; 67.9%), followed by people with higher education, then secondary and elementary education, and with the lowest percentage by those with vocational education (25; 24.51%). Detailed results are presented in Table VI.

Table VI. Responses to the question "Do you think that SARS-CoV-2 infection may develop as a complication after vaccination against COVID--19?" by level of education

Educational level	Chosen answer [% (n)]		
	Yes	No	I don't know
Elementary education	2.56 (1)	46.15 (18)	51.28 (20)
Secondary education	12.14 (50)	45.87 (189)	42.00 (173)
Higher education	14.04 (90)	61.15 (392)	24.80 (159)
College student	9.49 (26)	67.90 (186)	22.63 (62)
Vocational education	18.62 (19)	24.51 (25)	56.86 (58)

Next, we analyzed the responses to the question "Do you think everyone receiving the COVID-19 vaccine will experience complications?" The correct answer to this question was "no," which was most frequently chosen by current students (256; 94.16%), followed by people with higher, elementary, or secondary education, and least often by those with vocational education (74; 72.55%). The answer "I don't know" was most often chosen by the respondents with vocational education, and least often by students, as in the previous question. Detailed data is presented in Table VII.

Table VII. Reponses to the question "Do you think that everyone receiving the COVID-19 vaccine will experience complications?" by level of education

Educational level	Chosen answer [% (n)]		
	Yes	No	I don't know
Elementary education	2.56 (1)	87.18 (34)	10.26 (4)
Secondary education	3.16 (13)	85.20 (351)	11.65 (48)
Higher education	2.50 (16)	90.95 (583)	6.55 (42)
College student	1.45 (4)	94.16 (258)	4.38 (12)
Vocational education	5.88 (6)	72.55 (74)	21.57 (22)

We analyzed the responses to the question "Can a severe allergic reaction occur after administration of the COVID-19 vaccine (regardless of its type and manufacturer)?" An affirmative answer, which was the correct one, was chosen by the greatest number of students (237; 86.50%) and people with higher education (518; 80.81%), followed by people with secondary education (275; 66.75%), vocational, and least often by those with an elementary-school education (22; 56.41%; Table VIII).

Table VIII. Responses to the question "Can a severe allergic reaction occur after administration of the COVID-19 vaccine (regardless of its type and manufacturer)?" by level of education

Educational level	Chosen answer [% (n)]		
	Yes	No	I don't know
Elementary education	56.41 (22)	15.38 (6)	28.21 (11)
Secondary education	66.75 (275)	7.52 (31)	25.73 (106)
Higher education	80.81 (518)	4.52 (29)	14.66 (94)
College student	86.50 (237)	3.28 (9)	10.22 (28)
Vocational education	57.84 (59)	3.92 (4)	38.24 (39)

The next area for analysis was the relationship between the concerns about complications and sex and age. Women expressed concerns about complications after COVID-19 vaccination more often than men: 29% (335) and 16% (48), respectively. Among the vaccinated respondents, those in the 56–65 age group (43%; 26) feared the potential complications the most. The least fears were expressed by the respondents in the 18–35 age group (24%; 210). Detailed data is presented in Table IX.

We then analyzed the relationship between the specific vaccine administered and the presence of fears about complications. Fears of complications after receiving the COVID-19 vaccine were declared by significantly more people vaccinated with the Janssen vaccine (33.83%; 45) than those vaccinated with other products. The least concerns were expressed by the group that received the Moderna vaccine (19.71%; 27), while among respondents vaccinated with products from Pfizer/BioNTech and AstraZeneca, the proportions were comparable (26.3% – 237 and 25.6% – 76, respectively; Figure 4).

Table IX. Relationship between age and the fear of complications after COVID-19 vaccination

Fear of complications	Age group [years]				
	≤ 17	18–35	36–55	56–65	≥ 66
Yes	32.26% (10)	23.81% (210)	27.85% (127)	42.62% (26)	31.58% (12)
No	67.74% (21)	76.19% (672)	72.15% (329)	57.38% (35)	68.42% (26)

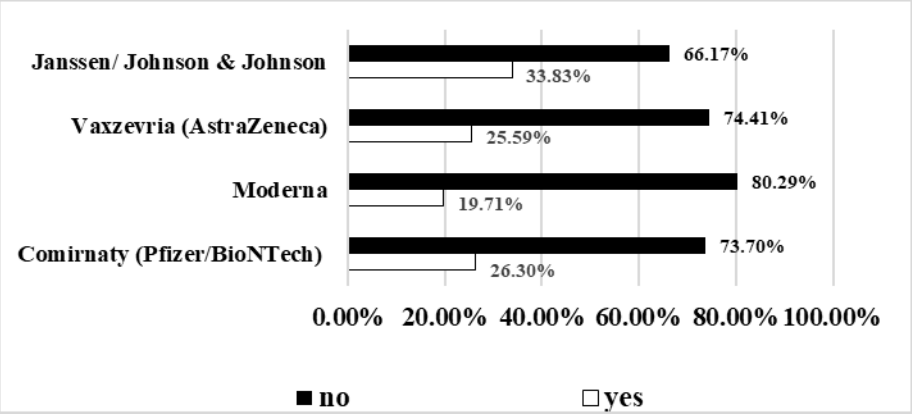

Fig. 4. Relationship between the brand of vaccine and the presence of fears about complication

DISCUSSION

Since the announcement that vaccines against COVID-19 were in development, the population has been polarized regarding their efficacy and safety. Suspicion towards vaccines was reinforced by numerous "fake news" reports and infographics of unverified information shared on social media and distributed in the form of leaflets and posters [30].

The COVID-19 incidence by group and the vaccination status by age and sex among our respondents coincided with the current epidemiological situation in Poland [19]. The vaccination rates also matched Polish statistics (58.96%; 22.59 million) [17]. Almost half of our vaccinated respondents (694; 47.3%) reported having experienced side effects from the vaccine. In comparison to other research, this number is higher than some [31] but lower than others [32,33]. This difference between the numbers of respondents who reported side effects may have been caused by the huge disparity in sample size in each study. The most frequently reported side effects – fatigue, muscle pain, and fever – corresponded with other publications [32,33,34].

Comparing the answers regarding the most common complications after the Comirnaty vaccine to its leaflet, the top three side effects mentioned by the respondents – muscle pain (898; 26.82%), fatigue (840; 25.08%), and fever (770; 22.99%) – were indeed listed as very common side effects, which may affect more than 1 in 10 people [35]. However, according to the "Report on Adverse Events Following Immunization (AEFI)," from Poland's National Institute of Public Health – National Institute of Hygiene (NIPH––NIH) – based on data collected between December 27, 2020 and August 29, 2021 – the most common AEFI following administration of the Comirnaty vaccine was redness and short-term pain at the injection site. This mild AEFI accounted for 80.5%

(4,076) of all Comirnaty vaccine adverse reactions reported to the NIPH–NIH [36,37]. The most frequently reported among severe AEFIs was fever (272; 64.9%). The next most common serious reaction was a severe injection site reaction (148; 20.2%) [36].

Most of the respondents (735; 26.51%) did not know the most common side effects of the Moderna vaccine. The most frequently chosen adverse reactions, as with the Comirnaty vaccine, were muscle pain (565; 20.38%), fatigue (553; 19.94%), and fever (520; 18.75%), which were listed as very common side effects in the vaccine leaflet [38]. In the NIPH–NIH report, the most frequently reported AEFI related to vaccination with Moderna was redness and short-term pain at the injection site, which accounted for 89.9% (1,073) of all AEFIs [36,37]. The most frequently reported serious AEFI was fever (37; 38.1%); another adverse reaction was severe injection site reaction, which accounted for 36.1% (35) of severe AEFIs [36].

When asked about the most common adverse reactions to the Janssen COVID-19 vaccine, most respondents did not know what complications were most commonly associated with this vaccine (828; 30.39%). The respondents identified muscle pain (485; 17.80%), fatigue (478; 17.54%), and fever (475; 17.43%) as the most common adverse reactions. In the Summary of Product Characteristics, muscle pain and fatigue were listed as very common adverse reactions, occurring in more than 1 in 10 individuals, while fever was a common adverse reaction, occurring in less than 1 in 10 vaccinated individuals [39]. The NIPH-NIH report indicated that for the Janssen vaccine, the most common AEFI was redness and short-term soreness at the injection site, accounting for 87.8% (475) of all reported AEFIs [36,37]. The most commonly recorded serious AEFIs were fever (18; 40%), severe injection site reaction (9; 20%), convulsions (9; 20%), and loss of consciousness (8; 17.8%) [37].

Our respondents considered fever (799; 21.07%]), muscle pain (768; 20.25%), and fatigue (710; 18.72%) to be the most common complications after Vaxzevria. These side effects were listed as very common adverse reactions in the Summary of Product Characteristics for Vaxzevria [40]. In the NIPH-NIH registry, the most common adverse reaction, as with other vaccines, was redness and short-term soreness at the injection site, accounting for 88.3% (3,814) of all recorded AEFIs [36,37]. Likewise, the most common serious AEFI caused by the Vaxzevria vaccine did not differ from those documented with other vaccines. Fever was the most common (272; 64.9%), followed by injection site reaction (113; 26.9%) and muscle and joint pain (73; 17.4%) [36].

Our research suggested that thromboembolic complications after receiving AstraZeneca were more frequent in comparison to other vaccines. This is confirmed by other studies, which show that the occurrence of thromboembolic disorders after receiving AstraZeneca is higher than for other vaccines, but is still not high enough to be classified as a very common complication [41,42]. It is worth noting that even despite the increased risk of a thromboembolic event after vaccination with Vaxzevria, it is still lower than in the case of COVID-19 infection [43].

Out of all vaccinated respondents, more women than men expressed concerns about potential side effects from vaccination. Interestingly, females were also more likely to report post-vaccination side effects, according to published research [31,32].

The respondents were asked three questions regarding the side effects of COVID-19 vaccination. The first was “Do you think that SARS-CoV-2 infection may develop as a complication after vaccination against COVID-19?” As none of the approved vaccines contain live SARS-CoV-2 virus, it is impossible to develop infection as a result of receiving the vaccine [44]. The next question was “Do you think anyone receiving the COVID-19 vaccine will experience complications?” As the statistics show, not every person will develop complications. The percentage of complications varies in different studies, depending on the type of vaccine and the characteristics of the study group [31,32,33,34]. Lastly, the interviewees were asked “Can a severe allergic reaction occur after administration of the COVID-19 vaccine (regardless of its type and manufacturer)?”

Severe allergic reactions may occur with any COVID-19 vaccine, regardless of its type or manufacturer [45,46]. The National Institute of Public Health – National Institute of Hygiene’s “Report on Adverse Events Following Immunization (AEFI) after COVID-19 Vaccines in Poland” between December 27, 2020 and August 29, 2021 provided the following numbers of serious allergic reactions reported as serious AEFIs: Pfizer vaccine – 53, AstraZeneca – 10, Janssen – 8, and Moderna – 2 [36,37].

It might be worth mentioning the fact that, because the questionnaire was completed by the respondents shortly after vaccination and some of them had only received one dose at that time, the actual side effects might have been slightly higher. The disparity between the number of women and men in this study might have also influenced some of the results.

There is still a need for observational research on the safety of each vaccine. The patients should be clearly

informed not only about the benefits they can gain from vaccination, but also the risk of postvaccination side effects.

CONCLUSIONS

1. The participants had the most knowledge about complications that may occur after vaccination with the Comirnaty vaccine.
2. The majority of respondents did not know what complications may occur after vaccination with the Janssen and Moderna vaccines.
3. In the case of the Vaxzevria vaccine, the respondents more often choose thromboembolic disorders as the most common complication in comparison to in other vaccines.
4. People with higher education and current college students used vaccine leaflets as a source of information about complications most often, while people with vocational education used them least often.
5. People with vocational education searched for information least frequently.
6. People in the 56–65 age group searched for information about complications after COVID-19 vaccination least often.
7. Social media was the most common source of information in the ≤ 17 age group.
8. Vaccine leaflets were the most common source of information in the 18–35 and 36–55 age groups.
9. College students and people with higher education most frequently mentioned vaccine leaflets, official government websites, and family doctors/medical specialists as sources of information.
10. Respondents with vocational education based their knowledge mainly on social media and internet forums.
11. Respondents in the 56–65 age group were the most concerned about complications after vaccination.
12. People vaccinated with the Janssen vaccine were definitely more concerned about complications from vaccination than participants vaccinated with other vaccines.
13. Complications after vaccination were more common in people who had searched for information about complications.
14. Along with increasing population in the place of residence, the percentage of people who used vaccine leaflets and official government websites as sources also increased.
15. Both sexes most often turned to vaccine leaflets for information about complications after vaccination.
16. Women searched for information about complications slightly more often than men and they used each source of information more often.
17. Women more often than men were more concerned about complications that may occur after vaccination.
18. College students, followed by people with higher education, were least likely to answer "I don't know" to the questions about complications after COVID-19 vaccination. This made these groups the most confident in their knowledge of the subject.

Authors' contribution

Study design – T. Męcik-Kronenberg, A. Biela, N. Zaboklicka, Z. Puszczewicz, M. Stachura, J. Wypyszyńska
Data collection – A. Biela, N. Zaboklicka, Z. Puszczewicz, M. Stachura, J. Wypyszyńska
Data interpretation – N. Zaboklicka, J. Wypyszyńska, M. Stachura, A. Biela, Z. Puszczewicz, T. Męcik-Kronenberg
Statistical analysis – J. Wypyszyńska, Z. Puszczewicz, A. Biela, N. Zaboklicka, M. Stachura
Manuscript preparation – M. Stachura, Z. Puszczewicz, A. Biela, J. Wypyszyńska, N. Zaboklicka, T. Męcik-Kronenberg
Literature research – Z. Puszczewicz, N. Zaboklicka, M. Stachura, J. Wypyszyńska, A. Biela

REFERENCES

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497-506. doi: 10.1016/S0140-6736(20)30183-5.
2. Listings of WHO's response to COVID-19. World Health Organization, 29 June 2020 [online] https://www.who.int/news/item/29-06-2020-covidtimeline [accessed on 7 September 2022].
3. Khan M, Adil SF, Alkhathlan HZ, Tahir MN, Saif S, Khan M, et al. COVID-19: A Global Challenge with Old History, Epidemiology and Progress So Far. Molecules. 2020;26(1):39. doi: 10.3390/molecules26010039.
4. Pierwszy przypadek koronawirusa w Polsce. Gov.pl – Serwis Rzeczypospolitej Polskiej / Ministerstwo Zdrowia, 04.03.2020 [online] https://www.gov.pl/web/zdrowie/pierwszy-przypadek-koronawirusa-w-polsce [accessed on 7 September 2022].
5. Habas K, Nganwuchu C, Shahzad F, Gopalan R, Haque M, Rahman S, et al. Resolution of coronavirus disease 2019 (COVID-19). Expert Rev Anti Infect Ther. 2020;18(12):1201-1211. doi: 10.1080/14787210.2020.1797487.
6. Tianyu Z, Liying G. Identifying the molecular targets and mechanisms of xuebijing injection for the treatment of COVID-19 via network pharmacology and molecular docking. Bioengineered. 2021;12(1):2274-2287. doi: 10.1080/21655979.2021.1933301.
7. Wadaa-Allah A, Emhamed MS, Sadeq MA, Ben Hadj Dahman N, Ullah I, Farrag NS, et al. Efficacy of the current investigational drugs for the treatment of COVID-19: a scoping review. Ann Med. 2021;53(1):318-334. doi: 10.1080/07853890.2021.1875500.
8. Christie A, Henley SJ, Mattocks L, Fernando R, Lansky A, Ahmad FB, et al. Decreases in COVID-19 Cases, Emergency Department Visits, Hospital

Admissions, and Deaths Among Older Adults Following the Introduction of COVID-19 Vaccine – United States, September 6, 2020–May 1, 2021. MMWR Morb Mortal Wkly Rep. 2021;70(23):858-864. doi: 10.15585/mmwr.mm7023e2.
9. Sansone E, Sala E, Tiraboschi M, Albini E, Lombardo M, Indelicato A, et al. Effectiveness of BNT162b2 vaccine against SARS-CoV-2 among healthcare workers. Med Lav. 2021;112(3):250-255. doi: 10.23749/mdl.v112i3.11747.
10. Meyer ED, Sandfort M, Bender J, Matysiak-Klose D, Dörre A, Bojara G, et al. Two doses of the mRNA BNT162b2 vaccine reduce severe outcomes, viral load and secondary attack rate: evidence from a SARS-CoV-2 Alpha outbreak in a nursing home in Germany, January-March 2021. medRxiv. 2021. doi: 10.1101/2021.09.13.21262519.
11. Levine-Tiefenbrun M, Yelin I, Katz R, Herzel E, Golan Z, Schreiber L, et al. Initial report of decreased SARS-CoV-2 viral load after inoculation with the BNT162b2 vaccine. Nat Med. 2021;27(5):790-792. doi: 10.1038/s41591-021-01316-7.
12. The Visual and Data Journalism Team / BBC News. Covid vaccines: How fast is progress around the world? BBC, 1 June 2022 [online] https://www.bbc.com/news/world-56237778 [accessed on 7 September 2022].
13. Sallam M. COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. Vaccines. 2021;9(2):160. doi: 10.3390/vaccines9020160.
14. Shakespeare gets Covid vaccine: All's well that ends well. BBC, 8 December 2020 [online] https://www.bbc.com/news/uk-55233021 [accessed on 7 September 2022].
15. Over 40 million people receive first dose of COVID-19 vaccine in UK. Gov.uk, 5 June 2021 [online] https://www.gov.uk/government/news/over-40-million-people-receive-first-dose-of-covid-19-vaccine-in-uk [accessed on 19 October 2021].
16. W Polsce ruszyły szczepienia przeciw COVID-19 – „to historyczny moment". Szczepienia.Info, 30 grudnia 2020 [online] https://szczepienia.pzh.gov.pl/w-polsce-ruszyly-szczepienia-przeciw-covid-19-to-historyczny-moment/ [accessed on 19 October 2021].
17. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Gavrilov D, Giattino C, et al. Coronavirus (COVID-19) Vaccinations – Statistics and Research. Our World in Data, 2020 [online] https://ourworldindata.org/covid-vaccinations [accessed on 29 March 2022].
18. Dawka przypominająca. Gov.pl – Serwis Rzeczypospolitej Polskiej / Ministerstwo Zdrowia [online] https://www.gov.pl/web/szczepimysie/trzecia-dawka [accessed on 7 September 2022].
19. Raport szczepień przeciwko COVID-19. Gov.pl – Serwis Rzeczypospolitej Polskiej / Ministerstwo Zdrowia [online] https://www.gov.pl/web/szczepimysie/raport-szczepien-przeciwko-covid-19 [accessed on 29 March 2022].
20. Narodowy Program Szczepień przeciw COVID-19. Gov.pl – Serwis Rzeczypospolitej Polskiej [online] https://www.gov.pl/web/szczepimysie/narodowy-program-szczepien-przeciw-covid-19 [accessed on 7 September 2022].
21. Hajissa K, Mussa A. Positive aspects of the mRNA platform for SARS--CoV-2 vaccines. Hum Vaccin Immunother. 2021;17(8):2445-2447. doi: 10.1080/21645515.2021.1900713.
22. Zhang NN, Li XF, Deng YQ, Zhao H, Huang YJ, Yang G, et al. A Thermostable mRNA Vaccine against COVID-19. Cell. 2020;182(5):1271--1283.e16. doi: 10.1016/j.cell.2020.07.024.
23. Bettini E, Locci M. SARS-CoV-2 mRNA Vaccines: Immunological Mechanism and Beyond. Vaccines. 2021;9(2):147. doi: 10.3390/vaccines9020147.
24. Podsumowanie – Szczepionka przeciw COVID-19. Szczepienia.Info [online] https://szczepienia.pzh.gov.pl/szczepionki/covid-19-2/ [accessed on 29 March 2022].
25. Dong Y, Dai T, Wei Y, Zhang L, Zheng M, Zhou F. A systematic review of SARS-CoV-2 vaccine candidates. Signal Transduct Target Ther. 2020;5(1):237. doi: 10.1038/s41392-020-00352-y.
26. Pytania i odpowiedzi na temat szczepionek przeciwko COVID-19 w UE. Komisja Europejska [online] https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response/safe-covid-19-vaccines-europeans/questions-and-answers-covid-19-vaccination-eu_pl#vaccination [accessed on 29 March 2022].
27. Jarynowski A, Skawina I. Attempt at profiling and regionalisation of COVID-19 vaccine campaigns in Poland – preliminary results. Eur J Transl Clin Med. 2021;4(1):13-21. doi: 10.31373/ejtcm/134674.
28. State of Vaccine Confidence in EU, 2018. Vaccine Confidence Project online https://www.vaccineconfidence.org/research-feed/the-state-of-vaccine-confidence-in-the-eu-2018 [accessed on 19 October 2021].
29. Etapy rozwoju człowieka – dorosłość. EDULIDER.pl [online] https://www.edulider.pl/edukacja/etapy-rozwoju-czlowieka-doroslosc [accessed on 19 October 2021].
30. Chou WS, Budenz A. Considering Emotion in COVID-19 Vaccine Communication: Addressing Vaccine Hesitancy and Fostering Vaccine Confidence. Health Commun. 2020;35(14):1718-1722. doi: 10.1080/10410236.2020.1838096.
31. Menni C, Klaser K, May A, Polidori L, Capdevila J, Louca P, et al. Vaccine side-effects and SARS-CoV-2 infection after vaccination in users of the COVID Symptom Study app in the UK: a prospective observational study. Lancet Infect Dis. 2021;21(7):939-949. doi: 10.1016/S1473-3099(21)00224-3.
32. Riad A, Hocková B, Kantorová L, Slávik R, Spurná L, Stebel A, et al. Side Effects of mRNA-Based COVID-19 Vaccine: Nationwide Phase IV Study among Healthcare Workers in Slovakia. Pharmaceuticals. 2021;14(9):873. doi: 10.3390/ph14090873.
33. Klugar M, Riad A, Mekhemar M, Conrad J, Buchbender M, Howaldt HP, et al. Side Effects of mRNA-Based and Viral Vector-Based COVID-19 Vaccines among German Healthcare Workers. Biology. 2021;10(8):752. doi: 10.3390/biology10080752.
34. Riad A, Pokorná A, Attia S, Klugarová J, Koščík M, Klugar M. Prevalence of COVID-19 Vaccine Side Effects among Healthcare Workers in the Czech Republic. J Clin Med. 2021;10(7):1428. doi: 10.3390/jcm10071428.
35. Comirnaty: COVID-19 mRNA vaccine / Product Information [Comirnaty : EPAR - Product information; annex IIIB]. European Medicines Agency [online] https://www.ema.europa.eu/en/medicines/human/EPAR/comirnaty [accessed on 7 September 2022].
36. Niepożądane odczyny poszczepienne po szczepionkach przeciw COVID-19 w Polsce: Raport za okres 27.12.2020–26.04.2021. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny [online] https://www.pzh.gov.pl/serwisy-tematyczne/niepozadane-odczyny-poszczepienne-covid-19/ [accessed on 19 October 2021].
37. 27.12.2020-07.10.2021 – bieżący raport dot. NOP [pdf]. [Accessed on website]: Gov.pl – Serwis Rzeczypospolitej Polskiej [online] https://www.gov.pl/web/szczepimysie/niepozadane-odczyny-poszczepienne [accessed on 19 October 2021].
38. COVID-19 Vaccine Moderna: COVID-19 mRNA vaccine / Product Information. European Medicines Agency [online] https://ec.europa.eu/health/documents/community-register/2021/20210106150575/anx_150575_pl.pdf [accessed on 7 September 2022].
39. COVID-19 Vaccine Janssen: EPAR – Product Information. Ulotka dla pacjenta. Europejska Agencja Leków [online] https://ec.europa.eu/health/documents/community-register/2021/20210311151284/anx_151284_pl.pdf [accessed on 7 September 2022].
40. COVID-19 Vaccine AstraZeneca: EPAR – Product Information. Ulotka dla pacjenta. Europejska Agencja Leków [online] https://ec.europa.eu/health/documents/community-register/2021/20210129150842/anx_150842_pl.pdf [accessed on 7 September 2022].
41. Schulz JB, Berlit P, Diener HC, Gerloff C, Greinacher A, Klein C, et al. COVID-19 Vaccine-Associated Cerebral Venous Thrombosis in Germany. Ann Neurol. 2021;90(4):627-639. doi: 10.1002/ana.26172.
42. Hunter PR. Thrombosis after covid-19 vaccination. BMJ. 2021;373:n958. doi: 10.1136/bmj.n958.
43. Hippisley-Cox J, Patone M, Mei XW, Saatci D, Dixon S, Khunti K, et al. Risk of thrombocytopenia and thromboembolism after covid-19 vaccination and SARS-CoV-2 positive testing: self-controlled case series study. BMJ. 2021;374:n1931. doi: 10.1136/bmj.n1931.
44. COVID-19. Centers for Disease Control and Prevention [online] https://www.cdc.gov/coronavirus/2019-ncov/vaccines/facts.html [accessed on 19 October 2021].
45. Sokolowska M, Eiwegger T, Ollert M, Torres MJ, Barber D, Del Giacco S, et al. EAACI statement on the diagnosis, management and prevention of severe allergic reactions to COVID-19 vaccines. Allergy. 2021;76(6):1629-1639. doi: 10.1111/all.14739.
46. Allergic Reactions Including Anaphylaxis After Receipt of the First Dose of Pfizer-BioNTech COVID-19 Vaccine — United States, December 14–23, 2020. MMWR Morb Mortal Wkly Rep. 2021;70(2):46-51. doi: 10.15585/mmwr.mm7002e1.