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ORIGINAL ARTICLE

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COVID-19 occurrence and symptoms depending on vaccination status: a retrospective single-centre analysis of 27,209 patients

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ABSTRACT

Introduction: Widespread immunization is critical to bringing the COVID-19 pandemic to an end. The objective of this cross-sectional data analysis was to investigate the impact of vaccination on the frequency of COVID-19 occurrence and the presence of its symptoms and clinical presentations.

Material and methods: This was a retrospective, cross-sectional study, analysing medical records of patients hospitalized at the Dr Antoni Jurasz University Hospital No. 1 in Bydgoszcz in the years 2019–2021. The analysis considered age, sex, vaccination status, the result of the reverse transcription polymerase chain reaction (RT-PCR) test for the detection of SARS-CoV-2 RNA, and disease symptoms and clinical presentations in accordance with ICD-10 codes.

Results: The study group consisted of 27,209 patients. There were 1,393 persons (5.12%) who tested positive for COVID-19. The vaccinated patients accounted for 17.3% (n = 4,704). Those vaccinated were significantly less likely to test positive for COVID-19 (3.93% *vs.* 5.38%; $p < 0.0001$). Among unvaccinated patients with a positive test result for COVID-19, symptoms and/or clinical presentations occurred in 359 study participants (29.72%), while in vaccinated COVID-19-positive patients only in 49 persons (26.49%). The symptoms that occurred in both vaccinated and unvaccinated patients were mainly respiratory and circulatory. The most common clinical presentation, both in the group of vaccinated and unvaccinated patients, was viral pneumonia, not elsewhere classified (J12), which occurred in 17.30% and 9.19% of patients, respectively ($p = 0.005$). Other symptoms and clinical presentations showing a statistically significant difference in the frequency of occurrence between the groups were pneumonia in diseases classified elsewhere (J17; $p = 0.019$) and abnormalities of breathing (R06; $p = 0.001$).

Conclusions: Vaccination against COVID-19 protects against symptomatic disease.

Keywords: SARS-CoV-2, COVID-19, vaccination, symptoms

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Introduction

A severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) identified at the end of 2019 gave rise to a pandemic of coronavirus disease 2019 (COVID-19) and resulted in 767,972,961 confirmed cases and 6,950,655 cumulative deaths worldwide as of July 12, 2023. As the global spread of the virus continues, the cumulative number of cases and deaths is still growing [1]. Because of the new coronavirus's fast dissemination and illness load, researchers and pharmaceutical companies were forced to develop vaccines quickly by employing preexisting or unique technology [2].

Vaccinations have been implemented in a vast number of countries following a series of efficacy and safety reviews. As of July 12, 2023, 50 vaccines have been approved, authorized, licensed, awarded emergency use authorization, or made accessible for use outside

of clinical trials by any process by a regulatory body, a national authority, or another institution. Additionally, 11 vaccines have been granted Emergency Use Listing (EUL) by the World Health Organization (WHO) [3]. According to the published findings of certain significant clinical trials, the Moderna and Pfizer vaccines have the highest efficacy rates, with a 90% protection rate [4]. According to published data, mRNA vaccines protect against COVID-19 symptoms in 95%, while vector vaccines are less effective, around 62% [5]. Widespread immunization is critical to bringing the COVID-19 pandemic to an end. Given the increased transmissibility of novel viral variations, even when accounting for the optimistic estimates of efficiency across current vaccines of approximately 80%, attaining herd immunity still demands a high rate of vaccine uptake [2, 5].

The objective of this cross-sectional data analysis was to investigate the impact of vaccination on the frequency of COVID-19 occurrence and the presence of symptoms and/or clinical presentations. This study is a single-centre analysis of hospital data from Bydgoszcz, Poland.

Material and methods

The authors conducted a retrospective, cross-sectional study, analysing medical records of patients hospitalized at the Dr Antoni Jurasz University Hospital no. 1 in Bydgoszcz in the years 2019–2021. The study group consisted of 27,209 patients. The analysis considered age, sex, vaccination status, the result of the RT-PCR test for the detection of SARS-CoV-2 RNA, and disease symptoms and clinical presentations in accordance with ICD-10 codes as described in Table 1. The analysis was carried out based on anonymized data (making it impossible to identify the patient) obtained from the OpenCare Gabinet hospital computer system. The persons included in the analysis did not bear any risk.

The statistical analysis was carried out using the Statistica 13.0 package (TIBCO Software Inc, California, USA). Variables were expressed as the number and the percentage and were compared using the χ^2 test. Results were considered significant at $p < 0.05$.

Results

The study group consisted of 27,209 patients hospitalized at the Dr Antoni Jurasz University Hospital no. 1 in Bydgoszcz, 44.26% of which were women. The participants were up to 103 years of age and the youngest were newborns. In the study group, there were 25,779 patients (94.74%) who tested negative for COVID-19, and 1,393 patients (5.12%) who tested positive; 37 persons (0.14%) obtained an inconsistent

Table 1. ICD-10 code descriptions

ICD-10 code	Disease
A08	Viral and other specified intestinal infections
A81	Atypical virus infections of the central nervous system
A85	Other viral encephalitis, not elsewhere classified
A86	Unspecified viral encephalitis
A87	Viral meningitis
A88	Other viral infections of the central nervous system, not elsewhere classified
A89	Viral infection of the central nervous system, unspecified
B08	Other viral infections characterized by skin and mucous membrane lesions, not elsewhere classified
B19	Unspecified viral hepatitis
I21	Acute myocardial infarction
I26	Pulmonary embolism
I41	Myocarditis in diseases classified elsewhere
I80	Phlebitis and thrombophlebitis
J00	Acute nasopharyngitis (common cold)
J01	Acute sinusitis
J02	Acute pharyngitis
J04	Acute laryngitis and tracheitis
J05	Acute croup laryngitis and epiglottitis
J06	Acute upper respiratory tract infection of multiple unspecified sites
J12	Viral pneumonia, not elsewhere classified
J16	Pneumonia due to another infectious agent, not elsewhere classified
J17	Pneumonia in diseases classified elsewhere
J20	Acute bronchitis
J80	Adult severe respiratory distress syndrome
J99	Respiratory disorders in diseases classified elsewhere
K77	Liver disorders in diseases classified elsewhere
K85	Acute pancreatitis
K93	Disorders of other organs of the gastrointestinal tract in diseases classified elsewhere
M63	Muscle disorders in diseases classified elsewhere
R05	Cough
R06	Breathing disorders
R09	Other symptoms and ailments related to the circulatory and respiratory systems
R11	Nausea and vomiting
R19	Other gastrointestinal and abdominal signs and symptoms
R42	Dizziness and giddiness
R43	Smell and taste disorders
R50	Fever of other and unknown origin
R51	Headache
R52	Pain, not elsewhere classified
R53	Malaise and fatigue
U04	Severe acute respiratory syndrome (SARS)

Table 2. Vaccination status and COVID-19 test results

Vaccination	COVID-19 negative		COVID-19 positive		P-value
NO	N	21,257	N	1,208	< 0.0001
	%	94.62%	%	5.38%	
YES	N	4,522	N	185	
	%	96.07%	%	3.93%	

Table 3. Presence or absence of symptoms and/or clinical presentation of COVID-19

Vaccination	Absence of symptoms/clinical presentation of COVID-19		Presence of symptoms/clinical presentation of COVID-19		P-value
NO	N	19,796	N	2,669	0.0012
	%	88.12%	%	11.88%	
YES	N	4,226	N	481	
	%	89.78%	%	10.22%	

test result, or such a test was not performed. The vaccinated patients accounted for 17.3% (n = 4,704), while the remaining 82.7% of patients were unvaccinated.

An analysis of the effectiveness of COVID-19 vaccination among 27,172 patients indicated that those vaccinated were significantly less likely to test positive for COVID-19. Just 3.93% of previously vaccinated patients contracted COVID-19, compared to 5.38% of unvaccinated patients who had the disease as shown in Table 2.

Among the vaccinated (n = 4,707) and the unvaccinated patients (n = 22,456), the number of persons with symptoms and/or clinical presentations of COVID-19 was 481 and 2,669, respectively. Symptoms and clinical manifestations of COVID-19 concerned unvaccinated patients (11.88%) significantly more frequently than vaccinated patients (10.22%), as indicated in Table 3.

Another aspect of the study was to analyse the percentage of symptomatic patients with a positive COVID-19 test, depending on whether the patients were vaccinated or not. 1,393 patients out of 27,172 tested positive for COVID-19. Among unvaccinated patients with a positive test result for COVID-19, symptoms and/or clinical presentations of COVID-19 occurred in 359 persons, while in vaccinated patients only 49 persons.

Among sick, unvaccinated patients, the most common diagnoses were: viral pneumonia, not elsewhere classified (J12), acute myocardial infarction (I21), and pulmonary embolism (I26). Among group of the vaccinated patients who tested positive for COVID-19, the most common diagnoses were: viral pneumonia, not elsewhere classified (J12), acute myocardial infarction (I21), pneumonia in diseases classified elsewhere (J17), abnormalities of breathing (R06). As can be seen, symptoms and clinical presentations of COVID-19 that occurred in both vaccinated and unvaccinated patients were mainly respiratory and circulatory. Gastrointestinal symptoms were less common. A detailed analysis of specific clinical presentations of COVID-19 in both groups is shown in Figure 1. The most common manifestation of COVID-19, both in the group of vaccinated and unvaccinated patients, was viral pneumonia, not elsewhere classified (J12), which occurred in 17.30% and 9.19% of patients, respectively. However, the aforementioned clinical presentations of COVID-19 occurred significantly more often among the unvaccinated group (p = 0.005). Other symptoms and clinical presentations of COVID-19 showing a statistically significant difference in the frequency of occurrence between vaccinated and unvaccinated patients were pneumonia in diseases classified elsewhere (J17; p = 0.019) and abnormalities of breathing (R06; p = 0.001).

Discussion

The COVID-19 pandemic has undoubtedly impacted the functioning and day-to-day patient care at medical facilities, including the Dr Antoni Jurasz University Hospital No. 1 in Bydgoszcz [6–9]. In the presented study analysing the group of 27,209 patients hospitalized at the aforementioned hospital between 2019 and 2021, it was found that those vaccinated were significantly less likely to test positive for COVID-19. This is consistent with previous research on general populations worldwide. Multiple studies evaluating vaccines' efficacy and effectiveness found that vaccination provides good outcomes and high protection rates against

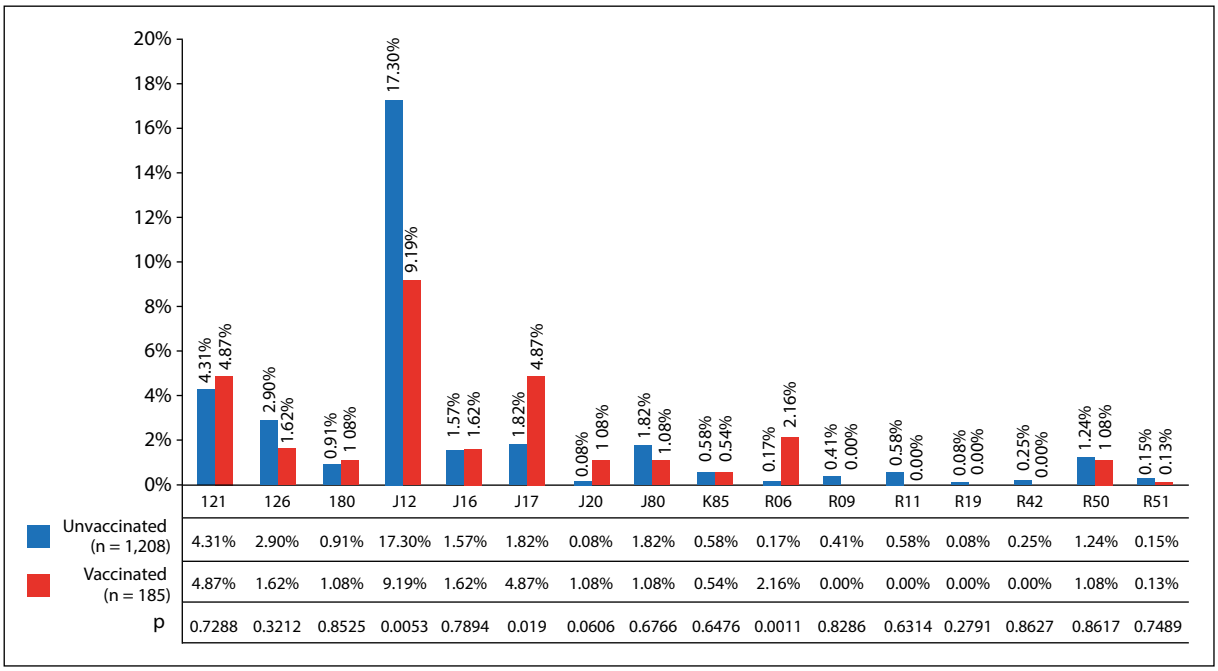

Figure 1. Symptoms and clinical presentations of COVID-19 among COVID-19-positive patients ICD-10 codes: I21 — Acute myocardial infarction; I26 — Pulmonary embolism; I80 — Phlebitis and thrombophlebitis; J12 — Viral pneumonia, not elsewhere classified; J16 — Pneumonia due to another infectious agent, not elsewhere classified; J17 — Pneumonia in diseases classified elsewhere; J20 — Acute bronchitis; J80 — Adult severe respiratory distress syndrome; K85 — Acute pancreatitis; R06 — Breathing disorders; R09 — Other symptoms and ailments related to the circulatory and respiratory systems; R11 — Nausea and vomiting; R19 — Other gastrointestinal and abdominal signs and symptoms; R42 — Dizziness and giddiness; R50 — Fever of other and unknown origin; R51 — Headache

COVID-19 [2, 10, 11]. The findings of this section of this study demonstrate the utility of vaccination in preventing COVID-19 illness, adding to the global vaccination research resources.

Additionally, according to the present study, the vaccinated patients experienced the symptoms and/or clinical presentations of the SARS-CoV-2 infection significantly less frequently than the unvaccinated patients. Previous studies in this field have shown that a full course of vaccination is an effective method of preventing both the symptomatic and asymptomatic cases of COVID-19 and vaccinated patients diagnosed with SARS-CoV-2 tend to experience a much milder form of the disease [12–14]. In addition, vaccination with even one dose of BNT162b2 or ChAdOx1-S vaccine allows to prevent the occurrence of serious disease symptoms in COVID-19 patients, protecting against the necessity of hospitalization, which is especially important among geriatric patients [15].

A subsequent objective of the present research work was to investigate the impact of COVID-19 vaccination on the presence of specific accompanying symptoms and clinical presentations in case of SARS-CoV-2 infection occurring. As previously mentioned, the accompanying symptoms in general were more common in patients suffering from COVID-19 who had not been vaccinated against it beforehand. The symptoms and clinical manifestations that occurred were varied but most often concerned the respiratory and circulatory systems. It has been proven that SARS-CoV-2 affects not only the respiratory system but also the brain, the circulatory system as well as the digestive system. Moreover, it has been observed that 75% of the tested COVID-19 patients had at least one comorbidity present [16]. In the present study, viral pneumonia was the most common of all the clinical presentations in both study groups. In general, most COVID-19 patients show moderately mild symptoms of infection, while 20% of patients have severe symptoms. Respiratory impairment is the most common manifestation of COVID-19, particularly in elderly patients with multiple morbidities [17]. Studies show that typical COVID-19 symptoms are non-specific and include fever, cough, and muscle pains; however, digestive symptoms such as nausea, vomiting, and diarrhoea are also described. A symptom worth mentioning that was not included in the current analysis but is also reported in scientific literature is ageusia i.e. loss of sense of taste [18]. As for the cardiac manifestations analysed in this study, myocardial injury is described as a prevalent complication in patients hospitalized for COVID-19 [19], which is consistent with the present findings.

The present study aimed to determine the impact of vaccination on the occurrence of the disease and its course in the case of COVID-19. Due to the large number of participants in the study (over 27,000 hospitalized patients), the analysis may be valuable material pointing to the effectiveness of vaccinations and their positive impact on the occurrence of additional symptoms and/or clinical presentations of infection. It remains crucial to keep medical literature up to date on the ongoing vaccination studies, particularly as they are evaluated in different populations, various age groups, and at different time points with new SARS-CoV-2 variants present. Over the past few years of the pandemic, knowledge about the virus has expanded significantly, as has information on the efficacy and safety of SARS-CoV-2 vaccines. According to the Bloomberg Vaccine Tracker [20], over a year into the global vaccination campaign, more than 12.7 billion doses have been administered worldwide; however, in Poland, as of today, only over 22 million people have been fully vaccinated, which constitutes just under 60% of the population [21].

The presented study has some limitations, which include being limited to one centre, lacking age-related analysis as well as being performed during a dynamically changing vaccination situation. The data was collected in the very first two years of the COVID-19 pandemic. During this time, the virus and vaccination situation was changing dynamically. In Poland, the first doses of vaccination (the so-called zero dose) were not immediately available to every citizen but only to healthcare workers. Additionally, when it comes to various age groups, particularly children, it was e.g. not until November 25, 2021, that the Food and Drug Administration (FDA) authorized the extension of the use of the Pfizer-BioNTech COVID-19 mRNA vaccine (BNT162b2) to children aged 5–11 years [22]. Meanwhile, it was also possible to get vaccinated with the third dose offered against the virus. In addition, the virus has mutated over time. Different variants of the virus appeared.

Nevertheless, thanks to the results of this study, it was possible to determine the significant impact that vaccination against COVID-19 had on the occurrence of the disease and its course among the patients of the Dr Antoni Jurasz University Hospital No. 1 in Bydgoszcz, Poland. The project's outcomes provided new evidence on vaccine effectiveness, showing that vaccination against COVID-19 protects against symptomatic disease. The authors strongly believe this will contribute to the popularization of vaccination.

Conclusions

Vaccination against COVID-19 protects against symptomatic disease.

Article information

Data availability statement: *The data that support the findings of this study are available from the corresponding author upon reasonable request.*

Ethics statement: *The study was approved by The Bioethics Committee of the Nicolaus Copernicus University functioning at Collegium Medicum in Bydgoszcz.*

Author contributions: *JK and MK were involved in planning and supervising the work. ZG, PR, and LW acquired and prepared the data. MK performed the statistical analysis. ZG, PR, LW, and KG wrote the manuscript with input from all authors. All authors discussed the results, provided critical feedback, and helped shape the research, analysis, and manuscript.*

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Conflict of interest: *KG, MK, and JK are employees of the hospital which is the subject of the article.*

Supplementary material: *None.*

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