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# Влияние вакцинации против новой коронавирусной инфекции на заболеваемость студентов университета

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**Обоснование.** Вакцинация в настоящее время признана наиболее эффективной стратегией борьбы с распространением новой коронавирусной инфекции. Однако случаи заражения вирусом SARS-CoV-2 после вакцинации (прорывные инфекции) зарегистрированы во всем мире.

**Цель исследования** — оценить влияние вакцинации против новой коронавирусной инфекции на заболеваемость студентов медицинского университета.

**Материалы и методы.** Проведено когортное исследование заболеваемости новой коронавирусной инфекцией среди 4876 и 4681 студента СЗГМУ им. И.И. Мечникова в периоды с 1 сентября по 15 декабря 2020 и 2021 гг. соответственно. Данные о вакцинации и вероятном месте заражения собраны методом опроса. Статистическая обработка данных проведена с использованием программы EpiInfo.

**Результаты.** За анализируемый период в 2021 г. выявлен 191 случай заражения COVID-19 среди студентов. Заболеваемость составила 4,08 на 100 студентов, в то время как в 2020 г. за аналогичный период она достигла 5,50 на 100 человек, несмотря на то, что среди жителей Санкт-Петербурга в 2021 г. она была в 1,75 раза выше, чем в 2020 г. Повторное заболевание выявлено у 35 (18,3 %) студентов, 18 из которых были вакцинированы против новой коронавирусной инфекции. Вероятное место заражения установлено у 36,1 % заболевших, в большинстве случаев им стала медицинская организация. К 15 декабря 2021 г. вакцинированы 62,8 % студентов. Заболеваемость среди вакцинированных студентов составила 2,72 на 100 человек, а среди невакцинированных — 4,94 на 100 человек. Фактором риска заболевания после вакцинации является контакт с источником инфекции: вакцинированные студенты указали на наличие такого контакта в 50 % случаев, невакцинированные — в 28,9 %. Чаще отмечены контакт с пациентом в медицинской организации и наличие контактов с несколькими источниками инфекции — 31,1 и 5,6 % соответственно.

**Заключение.** Вакцинация против новой коронавирусной инфекции — эффективное профилактическое мероприятие, которое имеет определяющее значение для коллективного иммунитета, формирование которого начинается с 70–80 % иммунизированных членов популяции. Фактором риска заболевания после вакцинации является близкий контакт с источником инфекции. Важными профилактическими мерами остаются ношение масок в общественных местах и социальное дистанцирование.

**Ключевые слова:** новая коронавирусная инфекция; прорывная инфекция; университет; вакцинация; фактор риска; студент.

## Как цитировать:

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# The impact of vaccination against the new coronavirus infection on the morbidity of university students

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**BACKGROUND:** Vaccination is currently considered the most successful strategy against the SARS-CoV-2 virus. However, cases of infection despite vaccination, so-called breakthrough infections, have been reported worldwide.

**AIM:** To evaluate the impact of vaccination against the new coronavirus infection COVID-19 on the morbidity of university students.

**MATERIALS AND METHODS:** The incidence of new coronavirus infection (COVID-19) among the students of North-Western State Medical University named after I.I. Mechnikov (further University) from September 1 to December 15, 2020 and 2021 was analyzed. There were 4876 and 4681 students under observation. Data on vaccination, probable site of transmission infection were collected by interviewing the ill people. Statistical processing of data was performed using EpiInfo software.

**RESULTS:** For the analyzed period 191 cases of COVID-19 among students were detected, the incidence of COVID-19 was 4.08 per 100 students, for the same period of the academic year 2020 it was 5.50, despite the fact that the incidence among St. Petersburg residents in 2021 was 1.75 times higher than in 2020. Re-infection was detected in 35 (18.3%) cases, 18 of whom were also vaccinated against COVID-19. A probable place of transmission infection was established in 36.1% of the cases, the most frequent being contact with a patient at their place of work in a health-care facility. By December 15, 2021, a total of 62.8% of students had been vaccinated against COVID-19. The incidence among vaccinated students was 2.72 per 100 students and 4.94 per 100 among unvaccinated students. A risk factor for breakthrough infections after vaccination was close contact with the source of infection: vaccinated persons had close contact in 50% of cases, compared with 28.9% of unvaccinated persons. The most important were contact with a patient in a health care setting and having multiple sources of infection, 31.1% and 5.6%, respectively.

**CONCLUSIONS:** Vaccination against COVID-19 was an effective preventive intervention. A risk factor for disease after vaccination is close contact with the source of infection. Establishment of collective immunity after vaccination is decisive for the vaccination-to-disease ratio, which starts to develop with 70–80% of vaccinated individuals. The use of a mask in public places and social distancing remain important preventive measures.

**Keywords:** new coronavirus infection; breakthrough Infection; University; vaccination; risk factors; student.

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## BACKGROUND

Vaccination is recognized to date as the most effective strategy to control the spread of the new coronavirus infection (COVID-19). However, cases of infection with the SARS-CoV-2 virus after vaccination (breakthrough infections) have been reported worldwide. The epidemiological efficacy of vaccination in different population groups is subject to further study both in Russia and in other countries.

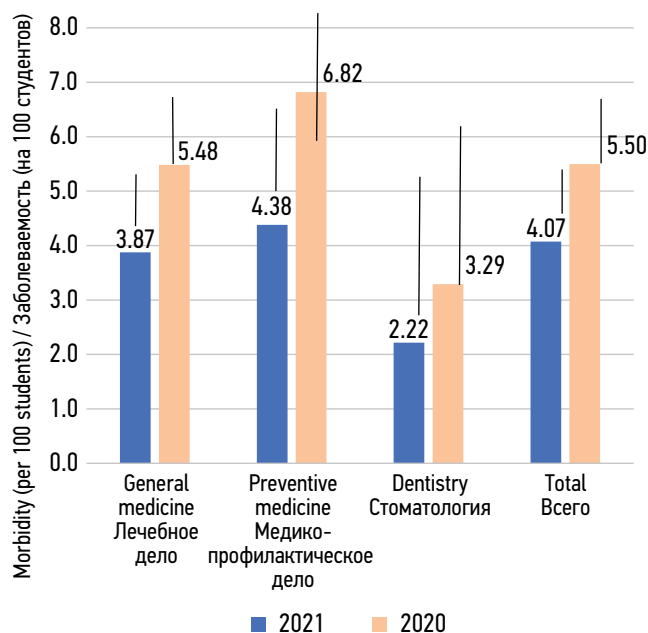
**The study aimed** to evaluate the impact of vaccination on the prevalence of COVID-19 among university students.

## MATERIALS AND METHODS

A cohort study was conducted among students of the North-Western State Medical University named after I.I. Mechnikov in the periods from September 1 to December 15, 2020, and 2021. These monitoring periods were chosen due to the start of the vaccination campaign at St. Petersburg in mid-December 2020. The study included a total of 4876 and 4681 full-time students in 2020 and 2021, respectively. A survey method was used in collecting data on vaccination and the probable place of infection among cases. The incidence of COVID-19 by years among vaccinated and unvaccinated students was analyzed by calculating the cumulative incidence with the determination of 95% confidence intervals (CI). Final-year students were excluded from the study in 2020, likewise first-year students in 2021. Vaccination efficacy and infection risk factors were assessed in a cohort study from September 1 to December 15, 2021, using relative risk (RR), 95% CI, and significance level ( $p$ ). The vaccinated group included students with 21 days or more after the repeated dose of Gam-COVID-Vac (Sputnik V), and 28 days or more after vaccination with Sputnik Light. The EpiInfo program was used to perform statistical data processing.

## RESULTS AND DISCUSSION

Over the period analyzed, in 2021, a total of 191 cases of COVID-19 were detected among students, and the incidence was 4.08 per 100 students (95% CI 3.55–4.69). This result is statistically significantly lower than the indicator for the same period in 2020, namely 5.50 per 100 students (95% CI 4.89–6.17), despite the fact that in 2021, the number of registered cases of the disease among residents of St. Petersburg was 1.75 times higher than in 2020 (240,359 and 137,636 cases, respectively). In 2020 and 2021, the highest incidence of COVID-19 was noted at the Faculty of Preventive Medicine, while the lowest incidence was at the Faculty of Dentistry. However, no statistically significant differences were revealed (Fig. 1).



**Fig. 1.** The incidence of a new coronavirus infection among university students for the period from September 1 to December 15, 2020 and 2021 with faculties

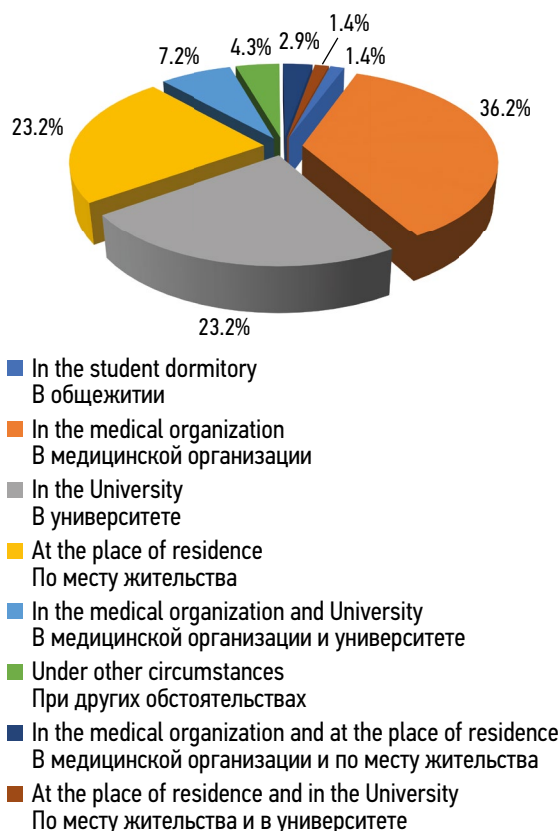
**Рис. 1.** Заболеваемость новой коронавирусной инфекцией среди студентов университета за период с 1 сентября по 15 декабря 2020 и 2021 гг. с указанием факультетов

A re-infection was detected in 35 (18.3%) patients with the history of COVID-19, 18 of them were vaccinated earlier than 6 months after the primary disease (8 people), after 6–12 months (14 people), and after 12 months and more (11 people). In a study by H. Altawalrah, it is revealed that antibody titers differ greatly in different patients, regardless of the clinical course of the disease, and about 5% of patients have undetectable antibody titers, despite the confirmed presence of infection [1]. A systematic review described cases of re-infection with COVID-19 with an interval between primary and recurrent infections from 42 days to 6 months [2]. A major study revealed that 13% of patients lost detectable IgG titers 10 months after the virus contamination [3].

The risk of re-infection is reduced by primary illness with COVID-19. The incidence among students with the history of the disease was 3.6 per 100 people, and 5.2 per 100 people without the history of the disease (RR 0.76; 95% CI 0.57–1.0;  $p = 0.038$ ).

The probable place of infection was identified in 69 patients (36.1%), 8 of them were in contact simultaneously with several sources of infection, mainly at the place of work; a medical organization (Fig. 2).

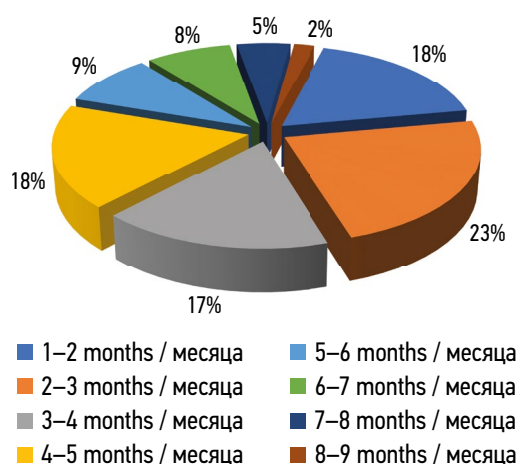
By December 15, 2021, 62.8% of students had been vaccinated against COVID-19. To stop the spread of the virus, the reproductive number ( $R$ ) must be less than 1. According to systematic reviews of different authors, the average  $R_0$  is from 3.4 to 4.1 [4, 5]. In order to achieve  $R$  less than 1, 75% of the population must be vaccinated.



**Fig. 2.** Distribution of cases of new coronavirus infection with an established source of infection by the likely place of infection  
**Рис. 2.** Распределение случаев новой коронавирусной инфекции с установленным источником инфекции по вероятному месту заражения

The effective reproduction number is calculated by the equation  $R = R_0 - R_0 \cdot I$ , where  $I$  is the share of immunized members of the population.

The incidence of COVID-19 among the vaccinated was 2.72 per 100 students (95% CI 2.19–3.37), and 4.94 per 100 students among the unvaccinated (95% CI 4.02–6.06).



**Fig. 3.** Distribution of cases of breakthrough infections by timing of occurrence after vaccination  
**Рис. 3.** Распределение случаев прорывных инфекций по срокам возникновения после вакцинации

Vaccination reduces the risk of disease by 45% (RR 0.56; 95% CI 0.42–0.76;  $p < 0.01$ ). In the absence of vaccination, the incidence would have remained at the level of 2020 (5.47 per 100 students); 1.82 times lower among the vaccinated students, and if they had not been vaccinated, 65 additional cases of the disease would have been registered. Given that the number of cases of the disease in St. Petersburg in 2021 was 1.75 times higher than in 2020, and the risk of infection was higher, the incidence of COVID-19 among students could possibly reach 9.57 per 100 students.

Around the world, cases of COVID-19 following the repeated dose of any COVID-19 vaccine have been registered. The study showed that after vaccination, the sick people before the infection contamination had lower titer of neutralizing antibodies than in those who were not sick [6]. Phase III trials of Gam-COVID-Vac (Sputnik V) showed that vaccination prevented symptomatic SARS-CoV-2 infection by 91.6% after the repeated dose, inducing a significant humoral and cellular immune response in patients [7]. First-generation vaccines have been proven to be less effective against the virus variants with some non-synonymous substitutions in Spike, such as E484K [8]. Genetic variants of SARS-CoV-2 affect the vaccine-induced immune response in different ways. According to an *in vitro* study, neutralization of the virus by the serum of vaccinated people is reduced by three to fifteen times for the beta variant and by 1.4–3 times for the delta variant compared with earlier variants of SARS-CoV-2. These data are largely consistent with the results of epidemiological studies. With other conditions being equal, several studies reveal that the probability of breakthrough infection with the delta variant infection is higher than with the alpha variant infection [9].

The most infection cases (74%) after vaccination occurred within 5 months after the repeated dose of the vaccine (Fig. 3).

The risk factor for the disease after vaccination was known to be close contact with the source of infection, detected in 50% of cases of those vaccinated, and among the unvaccinated individuals, it was registered in 28.9% of cases (RR 1.73; 95% CI 1.16–2.57;  $p = 0.006$ ). Contacts with a patient in a medical organization and contacts with several sources of infection were more common, namely 31.1% and 5.6%, respectively (RR 5.59; 95% CI 2.24–13.99;  $p < 0.01$ ). Studies have shown that exposure to a higher viral inoculum can reduce the vaccine efficacy and increase the probability of breakthrough infection [10, 11].

Re-infection after vaccination is possible; therefore, understanding its impact on the epidemic process in order to develop further anti-epidemic measures is necessary. The rate of infection transmission from unvaccinated individuals is three times higher than from those fully vaccinated. These data underline the importance of vaccination

to ease the strict restrictive general measures in the control of the pandemic [12].

## CONCLUSION

Vaccination against COVID-19 is proven to be the most effective preventive measure. Creation of herd immunity, which is formed when the share of vaccinated patients in the population reaches 70–80%, is of paramount importance. A risk factor for disease after vaccination is close contact with

the source of infection. Other important preventive measures include the use of medical face masks in public places and social distancing.

## ADDITIONAL INFORMATION

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**Authors' contributions.** All authors made significant contributions to the study and preparation of the article, read, and approved the final version before its publication.

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