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The impact of different brands of covid-19 vaccination on public health outcomes: analyzing the effectiveness and side effects of these vaccines among ksmu students and their perspectives towards covid vaccinations

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Abstract

Background: The COVID-19 pandemic highlighted the critical role of vaccines in reducing infection rates and improving public health outcomes. This study focuses on the impact of different COVID-19 vaccine brands among students at Kursk State Medical University (KSMU). The research investigates vaccine effectiveness in preventing infection, the occurrence of side effects, and medical students' perspectives regarding vaccination. Understanding these elements is essential to ensure effective vaccination campaigns among future healthcare professionals.

Methods and Materials: A descriptive cross-sectional study was conducted using a structured online questionnaire. The sample comprised 65 foreign medical students from KSMU across various academic levels. The survey included questions on vaccine types, demographics, side effects, infection history, and personal perceptions. Statistical analyses were performed to assess the trends in vaccine effectiveness, side effects, and student attitudes.

Results: Of the 65 respondents, 95.4% were vaccinated with at least one dose, with Pfizer-BioNTech, Sputnik Light, and Sinovac being the most common vaccines. Among vaccinated students, 62.9% reported side effects, including fever, fatigue, and muscle pain. Reinfection occurred in 32.8% of vaccinated participants, predominantly after the third dose. Despite this, 65.1% of students believed vaccines effectively prevent COVID-19, and 98.4% encouraged others to get vaccinated.

Conclusion: The study concludes that COVID-19 vaccines, particularly booster doses, significantly reduce reinfection rates and severity of illness. Mixed and same-brand vaccine regimens demonstrated comparable effectiveness. However, persistent reinfection rates highlight the need for continued public health efforts, including booster campaigns and transparent communication to address hesitancy and misconceptions.

Keywords: COVID-19 vaccines, Vaccine effectiveness, Side effects, Medical students' perspectives, Public health outcomes

Introduction

The global COVID-19 pandemic underscored the critical role of vaccines in safeguarding public health. This study investigates the impact of different COVID-19 vaccine brands on public health outcomes, specifically focusing on Kursk State Medical University (KSMU) students. The research examines two key aspects: the effectiveness of these vaccines in reducing infection rates and severity of illness and the occurrence of side effects reported by students. Additionally, the study explores the attitudes and perspectives of KSMU students toward COVID-19 vaccinations, shedding light on their acceptance, hesitancy, or concerns.

Through surveys and health data analysis, this research aims to identify trends in vaccine performance and the factors influencing student perceptions. By comparing the responses and experiences associated with various vaccine brands, the study seeks to contribute to a broader understanding of vaccine efficacy and public sentiment in a highly informed demographic. The findings are expected to provide valuable insights into the relationship between vaccine brand selection, side effects, and vaccine uptake among future healthcare professionals, offering recommendations for improving vaccine campaigns and addressing concerns among similar populations.

COVID-19 is an infectious respiratory disease caused by the coronavirus 2 that causes severe acute respiratory syndrome (SARS-cov-2). The first reports came from Wuhan, China, in December 2019, and it quickly became a global epidemic. The respiratory droplets that transmit COVID-19 are also released when an infected person coughs, sneezes, or talks. Additionally, if a person touches their face after coming into contact with a surface that has been exposed to HPV, the virus might spread. The symptoms of COVID-19 can range from mild to severe and include fever, coughing, fatigue, body aches, and difficulty breathing. In extreme cases, COVID-19 can

result in acute respiratory distress syndrome (ARDS), pneumonia, and organ failure. The virus poses a higher danger to older adults, people with underlying medical conditions, and people with weakened immune systems. There is currently no specific treatment for COVID-19, although there are vaccines that can help prevent infection and reduce the illness's severity. Extra precautions, such as donning masks, avoiding direct contact with people, and practicing good hand hygiene, can also delay the virus's spread.

Global health and well-being have been significantly impacted by the COVID-19 pandemic, which has prompted the quick creation and widespread use of vaccines to stop the virus's spread. Numerous factors can affect vaccines' effectiveness and side effects, even though they have been demonstrated to lower the prevalence and severity of COVID-19. Along with vaccine-related elements like type, dosage, and storage conditions, individual variables like age, gender, and underlying medical disorders are also covered. Furthermore, political, economic, social, and cultural variables may influence vaccination adoption and uptake. It is essential to comprehend these elements in order to maximize vaccine effectiveness, reduce adverse effects, and guarantee that all populations have fair access to vaccinations.

Problem Statement

The global rollout of COVID-19 vaccines has been a critical strategy in combating the pandemic, yet several challenges persist regarding their effectiveness, side effects, and public perception. Different vaccine brands demonstrate varying degrees of efficacy influenced by factors such as dosage, administration intervals, and individual characteristics like age, health status, and immune response. Furthermore, the emergence of new virus variants raises concerns about the long-term effectiveness of these vaccines. Simultaneously, reports of short- and long-

term side effects, allergic reactions, and rare adverse events contribute to vaccine hesitancy and fuel public debates about their safety.

As future healthcare providers, medical students hold unique perspectives on these issues due to their education, clinical exposure, and personal experiences with the pandemic. However, their understanding, attitudes, and willingness to accept vaccinations may be shaped by factors like their level of training, patient interactions, and cultural or national contexts. This is particularly evident in diverse groups like the international students at Kursk State Medical University (KSMU). Despite their role as trusted sources of health information, there is limited research focusing on medical students' views, especially in a multicultural academic setting.

This study addresses these gaps by exploring the factors affecting COVID-19 vaccine efficacy, side effects prevalence, and KSMU medical students' perceptions of vaccination. Understanding these issues is essential for enhancing public health strategies, improving vaccine campaigns, and ensuring informed decision-making among future medical professionals.

Chapter 1. Literature review

1.1 Background on covid-19

COVID-19 is an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-cov-2), a member of the Coronaviridae family. These viruses are enveloped, positive-sense, single-stranded RNA viruses. SARS-cov-2 is closely related to other human coronaviruses like SARS-cov and MERS-cov, which have caused significant outbreaks in the past. Its structure is characterized by spike (S) proteins that bind to human cells' angiotensin-converting enzyme 2 (ACE2) receptor, allowing the virus to enter and replicate. This process triggers an immune response that can result in symptoms ranging from mild to severe, especially in individuals with pre-existing conditions.

Mechanism of Transmission:

SARS-cov-2 spreads primarily through respiratory droplets when an infected individual coughs, sneezes, or talks. Airborne transmission can also occur in enclosed, poorly ventilated spaces, and although less common, the virus can spread via contaminated surfaces (fomite transmission). Asymptomatic carriers significantly influence the virus's rapid and widespread transmission.

Epidemiology:

First identified in Wuhan, China, in December 2019, COVID-19 quickly escalated into a global pandemic. It has affected nearly every country, causing millions of infections and deaths. Variants such as Alpha, Delta, and Omicron have driven successive waves of infections due to their increased transmissibility and immune evasion. Vulnerable populations, including older adults and those with underlying conditions like diabetes, heart disease, and respiratory disorders, are at higher risk of severe outcomes and mortality.

Pathogenesis:

After entering the body, SARS-cov-2 primarily targets the respiratory system, especially the lungs, by binding to ACE2 receptors. These receptors are abundant in the lungs, heart, and gastrointestinal tract. The infection can result in a spectrum of outcomes, from mild upper respiratory symptoms to severe pneumonia, acute respiratory distress syndrome (ARDS), and multi-organ failure. Severe cases may involve a hyperinflammatory response known as a "cytokine storm," which exacerbates complications.

Clinical Presentation:

COVID-19 symptoms vary widely, ranging from asymptomatic cases to severe illness. Common symptoms include fever, cough, fatigue, shortness of breath, and loss of taste or smell. Severe cases can progress to pneumonia, ARDS, and multi-organ failure, often requiring intensive care

and mechanical ventilation. Risk factors for severe illness include advanced age, obesity, and chronic health conditions. Long COVID, characterized by prolonged symptoms like fatigue and brain fog, can persist for weeks or months after recovery.

Diagnosis:

COVID-19 is primarily diagnosed using RT-PCR tests, which detect viral RNA in respiratory samples such as nasopharyngeal swabs. Rapid antigen tests provide quicker results but are less sensitive. Serological tests can detect antibodies to determine past infection but are ineffective for early diagnosis. In severe cases, chest imaging (X-rays or CT scans) may be used to evaluate lung involvement.

Treatment:

Treatment approaches range from supportive care for mild cases—such as rest, hydration, and fever management—to advanced therapies for severe cases, including oxygen therapy and mechanical ventilation. Dexamethasone, a corticosteroid, has been shown to reduce mortality in severe cases requiring oxygen. Antiviral drugs like remdesivir and monoclonal antibodies have also been used, and convalescent plasma and immunomodulatory therapies are under investigation for their potential benefits in severe disease.

Prevention:

The cornerstone of COVID-19 prevention has been vaccination. Vaccines such as Pfizer-biontech, Moderna, astrazeneca, and Johnson & Johnson have proven effective in preventing symptomatic infection and severe illness. Booster doses are recommended to maintain immunity, especially against emerging variants. Public health measures, including mask-wearing, social distancing, and frequent handwashing, have also played a crucial role. Additional strategies include quarantine, contact tracing, and travel restrictions to curb the virus's spread.

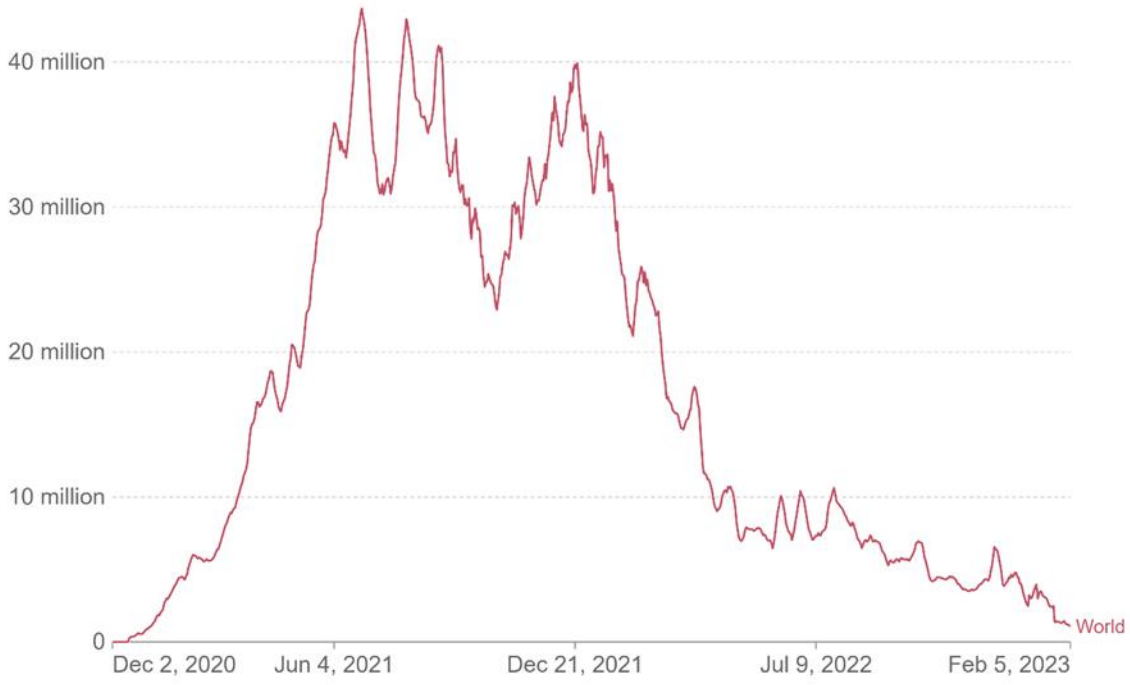


Figure 1: Global COVID-19 vaccination rates from 2020 to 2023 (Source: Our World in Data).

1.2 Evolution of coronavirus variants: a timeline

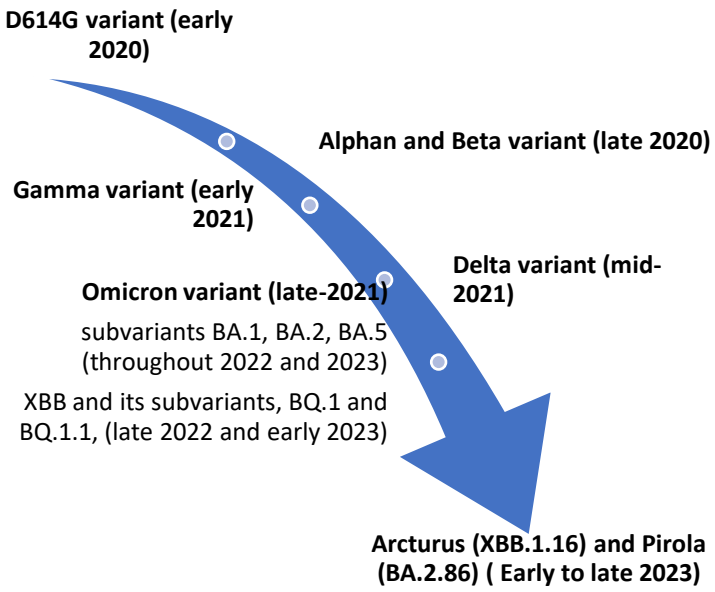


Figure 2. The Timeline for The Evolution of Coronavirus Variants

Since COVID-19 first emerged in December 2019, the virus has undergone numerous mutations, giving rise to various variants with distinct characteristics. These mutations have significantly influenced the virus's ability to spread, cause illness, and evade immune responses, driving concerns worldwide. The original Wuhan strain initiated the outbreak, but by early 2020, the D614G mutation appeared in Europe. This mutation, which increased infectivity without significantly altering disease severity, quickly became the globally dominant strain.

In 2020, three major variants of concern emerged. The Alpha variant (B.1.1.7), first identified in the UK in September, exhibited a 50% higher transmission rate than earlier strains, resulting in its rapid spread. Around the same time, the beta variant (B.1.351) was detected in South Africa, gaining attention for its ability to evade immunity partially due to the E484K mutation. Meanwhile, the Gamma variant (P.1), discovered in Brazil in November, shared similar immune escape features and contributed to severe outbreaks across South America.

By late 2020, the Delta variant (B.1.617.2) emerged in India and swiftly became the dominant strain worldwide by mid-2021. Delta was linked to increased transmissibility, more severe illness, and higher viral loads, although vaccines provided substantial protection against severe disease and death. In November 2021, the Omicron variant (B.1.1.529) was first identified in South Africa. Known for its significant number of spike protein mutations, Omicron demonstrated enhanced transmissibility and the ability to evade immunity from vaccines and previous infections. Although it spreads quickly, Omicron generally causes milder illness, especially in vaccinated individuals. Subvariants such as BA.1, BA.2, and BA.5 emerged in early 2022, with BA.5 becoming dominant due to its increased immune escape capabilities.

The virus's evolution continued into 2023 with the emergence of the XBB lineage, including the XBB.1.5 variant, which spread rapidly due to its strong ACE2 receptor binding. However, it did not cause more severe illness. Other subvariants like BQ.1 and BQ.1.1, derived from BA.5, became prevalent for their resistance to monoclonal antibody treatments and heightened immune evasion. Variants such as CH.1.1 and BF.7 also contributed to reinfections, with BF.7 causing significant outbreaks in China. Later, in 2023, the Arcturus variant (XBB.1.16) was detected in India, demonstrating increased transmissibility and immune escape, though disease severity remained moderate among vaccinated populations.

By late 2023, the Pirola variant (BA.2.86) emerged, marked by a large number of spike protein mutations reminiscent of early Omicron strains, raising concerns about further immune evasion. While it did not cause more severe disease, Pirola underscored the ongoing evolution of the virus and the challenge of maintaining global immunity. As of early 2024, new variants continue to arise, necessitating ongoing vaccine updates, booster campaigns, and vigilant

monitoring systems to manage the pandemic's progression. These adaptations remain essential in the fight against SARS-cov-2 as it evolves.

1.3 Characteristics of different brands of covid-19 vaccines and their advantages and disadvantages

The global race to develop and distribute COVID-19 vaccines has resulted in various options, each with distinct advantages and disadvantages. Pfizer-biontech, the first vaccine to receive emergency use authorization in December 2020, is a two-dose mrna vaccine with a reported 95% efficacy in clinical trials. It is approved for individuals aged 5 and older, offers strong protection against COVID-19 and new variants, and can be stored at -70°C for up to six months. However, it requires two doses spaced 21 days apart, has been linked to rare cases of myocarditis in young adults, and may cause short-term side effects like fatigue, headaches, and injection site pain.

The Moderna vaccine, also an mrna vaccine, is administered in two doses 28 days apart and has a reported efficacy of 94.1%. It is approved for individuals 18 and older and provides robust protection against the virus and its variants. Moderna is more straightforward to store at -20°C for up to six months, but it shares similar drawbacks to Pfizer-biontech, including the need for two doses and common side effects like fatigue and soreness.

Johnson & Johnson's viral vector vaccine offers the convenience of a single dose and an efficacy of 66.3% in clinical trials. It is approved for individuals aged 18 and above and does not require freezing, making it easier to store and distribute. However, it is less effective than mrna vaccines and has been associated with rare blood clot incidents, particularly in women under 50. It also causes short-term side effects like injection site discomfort, fatigue, and headache.

The astrazeneca vaccine, developed using a weakened chimpanzee adenovirus, is more affordable and easier to store than many other vaccines, requiring only standard refrigeration (2-8°C) for up to six months. It has been widely distributed, particularly in low- and middle-income countries. However, concerns about its effectiveness against specific COVID-19 variants and reports of rare blood clotting issues have led some countries to pause its use. Common side effects include fever, fatigue, and pain at the injection site.

Sputnik V, a two-dose vaccine from Russia, uses a viral vector approach and boasts an efficacy rate of over 90%, making it one of the most effective COVID-19 vaccines. It is relatively affordable and easy to store at standard refrigerator temperatures for up to two months. However, its approval process faced criticism for lack of transparency, and its availability is limited outside Russia and a few other nations. Like other vaccines, typical side effects include fever, fatigue, and soreness.

Sinovac, an inactivated vaccine developed in China, uses killed viral particles to trigger an immune response. It is affordable, easy to store (2-8°C for up to two years), and has demonstrated safety and effectiveness. However, it is less effective than other vaccines and has limited global availability outside China and a few other countries. Common side effects include fever, tiredness, and soreness at the injection site. Despite their differences, all these vaccines represent significant achievements in the fight against COVID-19, offering various options for protection worldwide.

Chapter 2. Materials and method

This capstone project has the following goals:

To research the factors that can influence the effectiveness and potential adverse effects of various COVID-19 vaccination brands, as well as medical students' views on the topic of COVID-19 vaccinations.

Objectives:

• A review of the literature about the COVID-19 pandemic, COVID vaccination, preventative and treatment management for various population risk categories, the risk of mortality for both vaccinated and unvaccinated individuals, and the effects of COVID-19 on the global public health system.

• To determine the variables, such as vaccine type, dosage, and frequency of administration, as well as the patient's age, health, and immune response, that may affect the effectiveness of different COVID-19 vaccinations.

• To look at the possible drawbacks of the COVID-19 vaccine, including allergic responses, short- and long-term side effects, and adverse events connected to the vaccination.

• To investigate medical students' attitudes and opinions regarding COVID-19 immunizations and their understanding of, worries about, and impressions of the accessibility, efficacy, and safety of vaccines.

• To examine the variables, including educational background, training, patient exposure, and individual experiences with the pandemic, that impact medical students' desire for COVID-19 immunization.

• Provide recommendations for strengthening COVID-19 vaccination-related public health initiatives and policies based on the research findings.

• A review conducted by KSMU medical students opposing the COVID-19 vaccine

KSMU students' ability to avoid COVID-19 is examined using a cross-study analysis. Recommendations about the Covid-19 vaccine are made for medical students.

• The opinions of medical students about the effectiveness of vaccinations

Method

This study employed a descriptive methodology through a structured survey (questionnaire) to explore the effectiveness and possible side effects of different COVID-19 vaccine brands. The study aimed to assess medical students' knowledge, attitudes, and experiences with vaccination and its implications. The questionnaire, consisting of 37 questions, was distributed among a sample of foreign medical students from Kursk State Medical University (KSMU), spanning pre-med through sixth-year levels of study. A total of 65 students participated in the survey, comprising 24 men and 41 women from Brazil, Africa, Sri Lanka, Thailand, Maldives, Malaysia, and India. The study adhered to confidentiality requirements, ensuring that responses remained anonymous and were solely used for academic purposes. The survey was accessible online for 34 days, after which responses were finalized for analysis.

Content of the Questionnaire:

The questionnaire was divided into sections focusing on key areas relevant to the study objectives:

1. Types of Vaccines: Questions were designed to assess the perceived efficacy and potential side effects of different COVID-19 vaccine brands based on their mechanisms of action (e.g., mrna, viral vector, inactivated virus).

2. Demographics: Participants were asked to provide information on age, gender, underlying medical conditions, and prior exposure to COVID-19, as these factors could influence vaccine effectiveness and adverse reactions.
3. Vaccine Distribution and Administration: The survey explored factors such as storage, transportation, dosing schedules, and the impact of these variables on vaccine performance and side effects.
4. Virus Variants: Questions addressed students' awareness of how SARS-cov-2 variants might affect vaccine efficacy and long-term protection.
5. Medical Student Viewpoints: This section focused on participants' general vaccination knowledge, attitudes towards vaccination, and opinions on the COVID-19 pandemic and vaccine-related controversies.
6. Public Awareness and Risk Factors: Questions aimed to gauge students' perspectives on raising public awareness about vaccination and their insights into risk factors exacerbating vaccine-related side effects.

Inclusion Criteria:

- Foreign medical students enrolled at KSMU in the pre-med, first, second, third, fourth, fifth, or sixth year of study.
- Students from Brazil, Africa, Sri Lanka, Thailand, Maldives, Malaysia, and India.
- Students currently residing in Kursk, Russia.
- Voluntary participation in the online survey with informed consent.

Exclusion Criteria:

- Students not enrolled at KSMU or those outside the specified academic years.
- Students from countries other than those listed above.

- Individuals were unwilling to participate or provide informed consent.
- Responses were deemed incomplete or inconsistent during data analysis.

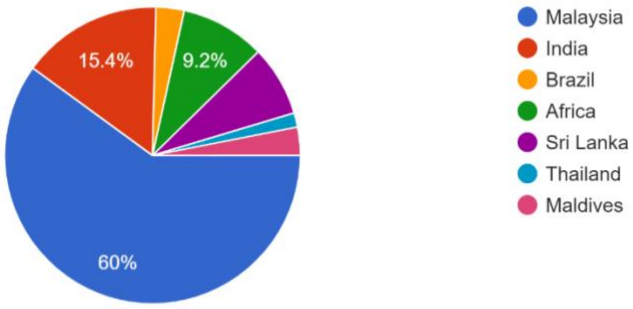
By adhering to these inclusion and exclusion criteria, the study ensured a focused and relevant dataset for analyzing the perspectives and experiences of foreign medical students regarding COVID-19 vaccination.

Chapter 3. Statistical analysis and their discussion

Results

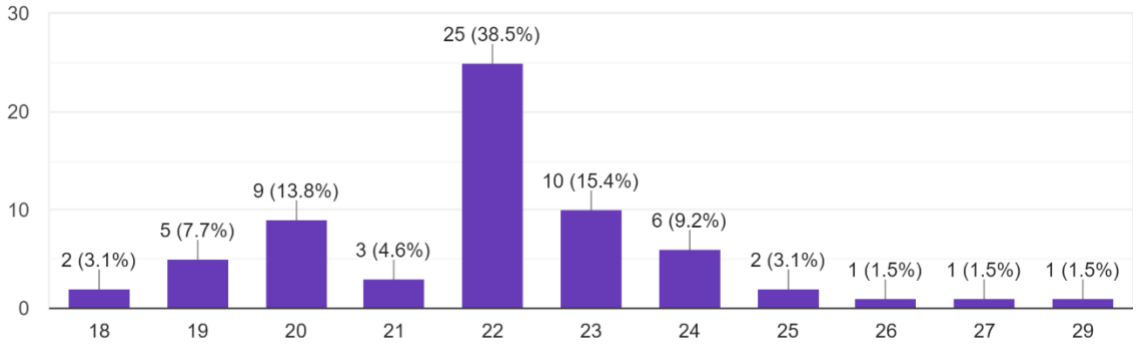
The survey's findings were interpreted and discussed after the data were displayed in tables and charts.

Figure 1: nations from which the students are



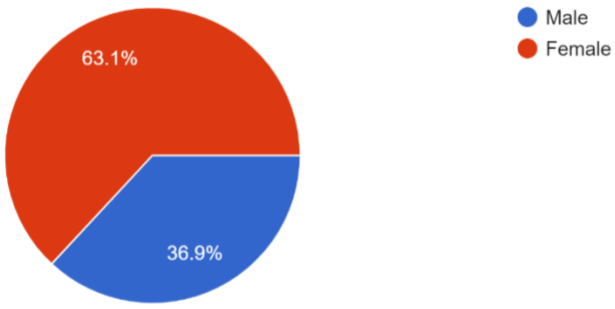
The total number of students that took part in this study was 65, and every single one of them was able to correctly answer every question, giving a score of 100%. The majority of students (60% of 39) are from Malaysia, followed by 15.4% of 10 from India, 9.2% of 6 from Africa, 7.7% of 5 from Sri Lanka, 3.1% of 2 from Brazil and Maldives respectively, and 1.5% of 1 from Thailand.

Figure 2: age of students



Since 47 students responded to this question, the overall percentage is 100%. The age range is between 18 and 29. 38.5% of the participants, or 25 pupils, are under 22. Following that, 20 years, 13.8% at 9 people, and 23 years old, 15.4% at 10 people. Minority age groups include those who are 24 years old (9.2% of the total 6 people), 19 years old (7.7% of the total 5 people), 21 years old (4.6% of the total 3 people), 18 and 25 years old (3.1% of the total 2 people), and 26 to 29 years old (1.5% of the total 1 person).

Figure 3: gender diversity among students



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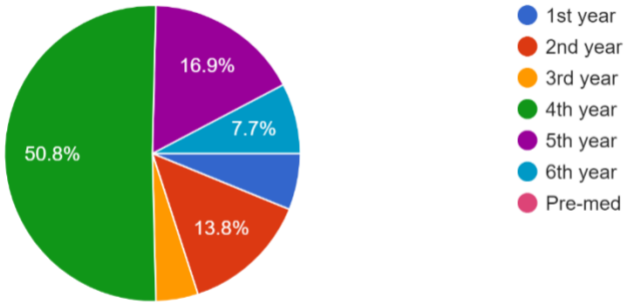
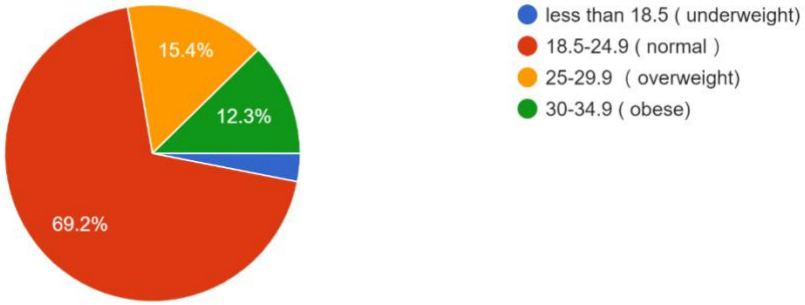
65 students responded to my questionnaires while this research was being done. Female students comprise 63.1% of the student body, while male students comprise 36.9%. The student has responded to 37 sets of questions in this research.

Figure 4: year in medical school



Of the 65 medical students who responded to my inquiry, 75.4% are in the clinical year, the fourth through sixth year; 24.6% are in the pre-clinical year, from pre-med to third year.

Figure 5: bmi status among the students



According to the results regarding their BMI status, the majority of them fall in the normal range (18.5-24.9) for 69.2% of the 45 individuals, followed by 15.4% with a total of 10 individuals falling into the overweight range (25-29.9), 12.3% with a total of eight individuals falling into the obese range (30-34.9), and 3.1% with a total of two individuals falling into the underweight range (less than 18.5). All 65 individuals responded to this question**.**

Table 6: habits

HABITS	**NO. OF STUDENTS**	**PERCENTAGE OF STUDENTS**
ALCOHOLISM	5	19.2%
SMOKING	5	19.2%
TAKING DRUGS	0	0%
OVEREATING(SWEET TOOTH AND JUNK FOOD)	5	19.2%

OVERSLEEPING	1	3.8%
HEALTHY HABITS(SPORTS, READING, STUDYING, WATCHING MOVIES, DRINKING FRUIT JUICE)	5	19.2%
NONE	9	34.2%

In response to the question I posed, 19.2% of the medical students mentioned alcoholism and smoking in a total of 5 people, 19.2% mentioned overeating in a total of 5 people, and 3.8% mentioned oversleeping. None of them reported using drugs, while 19.2% reported leading healthy lifestyles that included exercise, reading, studying, and watching movies. Finally, 34.2% of them did not mention any habits. 35 students did not respond to the question, which suggests that they would have preferred not to.

Table 7: allergic status

TYPE OF ALLERGIC	**NO. OF STUDENTS**	**PERCENTAGE OF STUDENTS**
FOOD ALLERGIC (SEAFOOD AND SALMOND)	12	18%
DRUG ALLERGIC (AMOXICILLIN, ASPIRIN, CHLOROQUINE, G6PD AND OTHERS)	8	12%
POLLEN ALLERGIC	9	13.8%
DUST ALLERGIC	19	29.2%
LATEX ALLERGIC	1	1.5%
NO ALLERGIC	35	53.8%

The majority of the 65 students who responded to the question about their allergic status—53.8% out of 35—said they had no allergies. Next, 18% of them mentioned having food allergies, then 12% mentioned having drug allergies, 13.8% mentioned having pollen allergies, and 29.2% mentioned having dust allergies. There is only one person who is 1.5% allergic to latex. It should be noted that 19 persons have multiple allergies.

Figure 8: chronic disease status

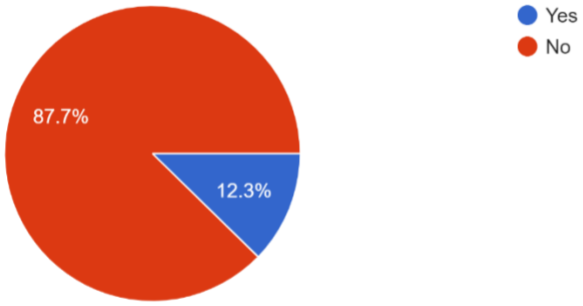
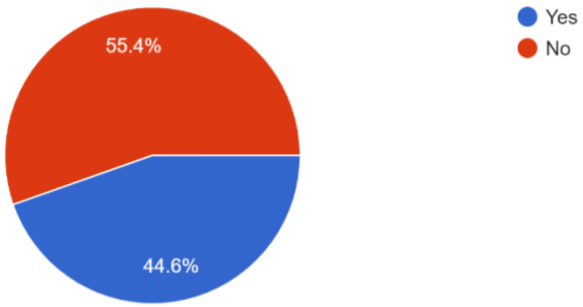


Table 8: chronic disease status

SYSTEMS INVOLVED	NO. OF STUDENTS	PERCENTAGE OF STUDENTS
RESPIRATORY SYSTEM	4	36.4%
ENDOCRINE SYSTEM	2	18.2%
REPRODUCTIVE SYSTEM	2	18.2%
DERMATOLOGICAL	2	18.2%
NEUROLOGICAL	2	18.2%

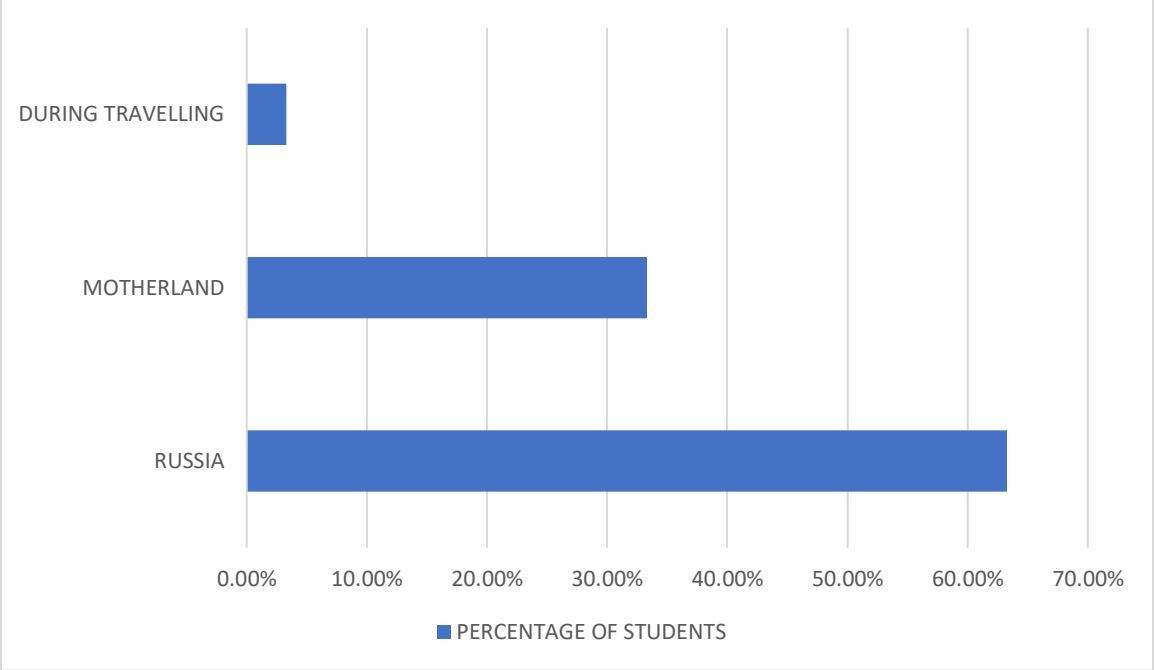
This question received 65 responses, all of which were positive. The students may select as many responses as they like. Of the 65 students, 57.8% (or 57) have no chronic illnesses, while 8% (or 8) do. Out of these eight students, two (18.2%) have endocrine ailments, reproductive diseases, dermatological difficulties, and neurological issues, respectively, while four (36.4%) have respiratory diseases.

Figure 9: past covid-19 status



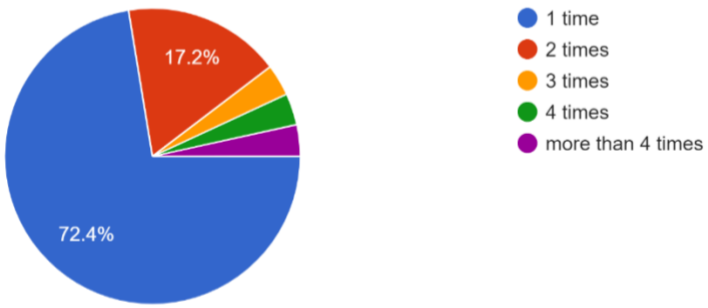
This question received responses from all 65 respondents. 36 persons, or 55.4%, have never had Covid-19 infection. While 29 persons, or 44.6%, have Covid-19 infection.

Figure 10: location where they exposed to covid-19



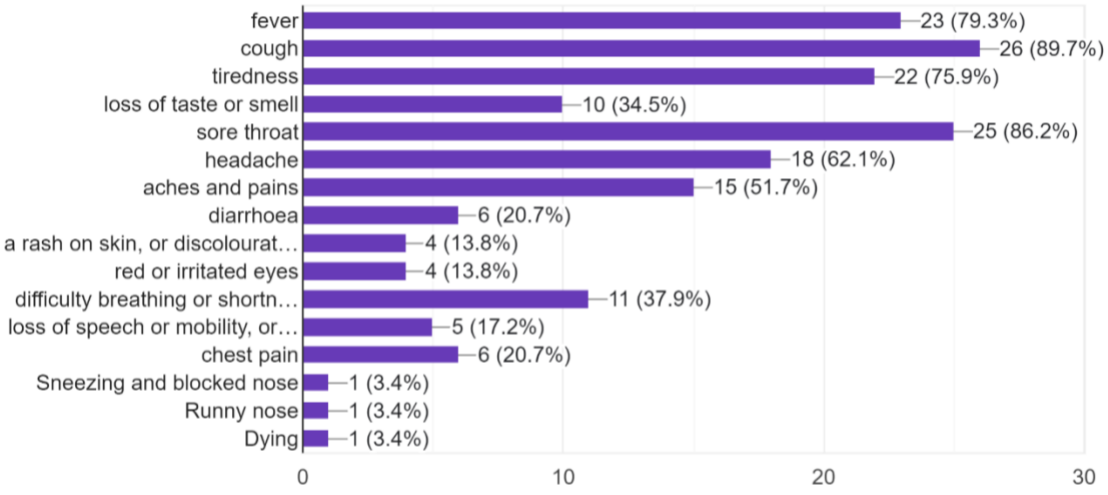
Of these 29 students who contracted COVID-19, 19 of them—63.3%—were infected in Russia, and 10 of them—33.3%—were infected in their own country. One person (3.3%) contracted the disease when returning to Malaysia.

Figure 11: number of times was infected with covid-19



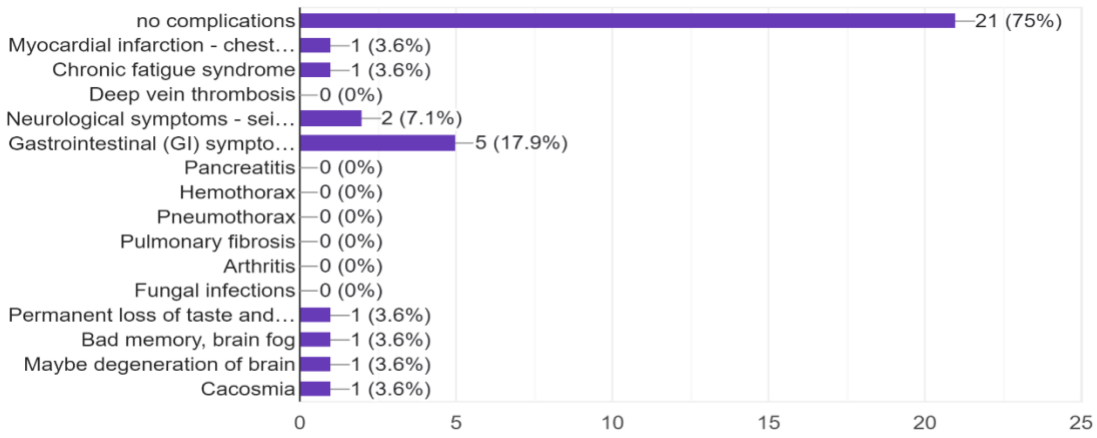
Out of these 29 students that had Covid-19 before, 21 (72.4%) have only ever had one infection, and 5 (17.2%) have had two infections. Three times, four times, or even more than four infections were seen in one person (3.4%), respectively.

Figure 12: symptoms during covid-19 infection



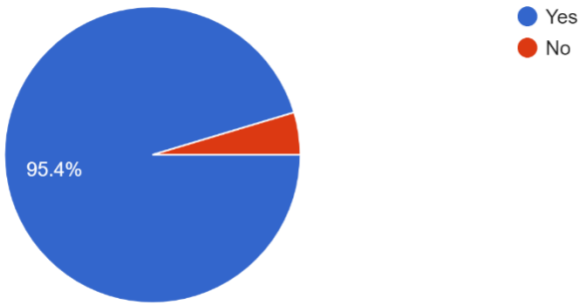
This question received answers from all 29 respondents who have previously had COVID-19, and students may select as many answers as they like. 23 pupils, or 89.7%, had a cough and sore throat affected 25 students, or 86.2%. Next, 79.3% of the 23 participants developed a fever, and then 75.9% of the 22 participants felt fatigue. While 62.1% of the total 18 participants experienced headaches, 51.7% 15 had aches and pains, and 37.9% of the total 11 participants cited dyspnea. Of them, 10.5% (10 people) reported losing their sense of taste and smell, while 5.2% (17) reported losing their speech and movement. Diarrhea and chest pain were reported by 6 persons (20.7%), respectively. Last but not least, one person (3.4%) reported having sneezing, blocked nose, runny nose, and feeling of dying, respectively.

Figure 13: complications after infected by covid-19



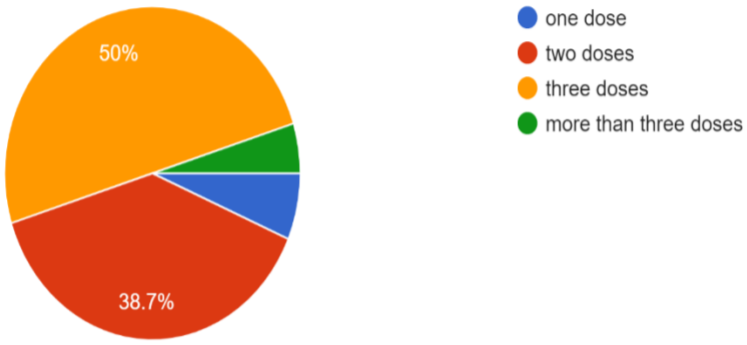
Only 28 of the 29 students with COVID-19 replied to the question for various reasons, although students are free to choose as many responses as they want. Five of them—17.9%—have gastrointestinal issues, and 21 of them—75%—stated that there were no complications. Neurological problems were reported by two individuals (7.1%). Last but not least, one person (3.6%) had signs of myocardial infarction, chronic fatigue syndrome, irreversible loss of taste and smell, poor memory, brain fog, brain degeneration, and cacosmia, respectively.

Figure 14: vaccine status



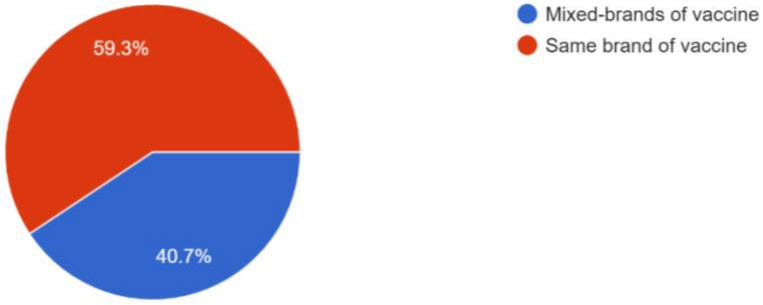
There were 65 answers to this query. 95.4% (or 62) of the 65 students had gotten the covid vaccine, compared to 4.6% (or 3) who had not.

Figure 15: number of doses of vaccines



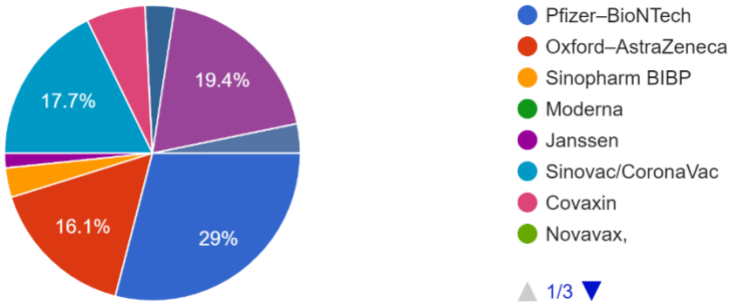
Out of these 62 students, 50% (or 31) had received three doses, 38.7% (or 24)had received two doses, 6.5%(or 4) had received just one dose, and 4.8%(or 3) had received three or more doses.

Figure 16: types of vaccines



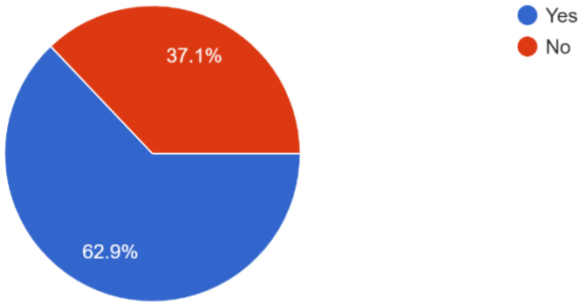
Only 59 of the 62 students who had previously gotten the COVID-19 vaccine provided an answer since 4 of them had only received one dose of vaccine, 59.3% had received the same brand of vaccine along with the booster shot, and 40.7% had received vaccines from different brands.

Figure 17: brand of first dose of covid-19 vaccine



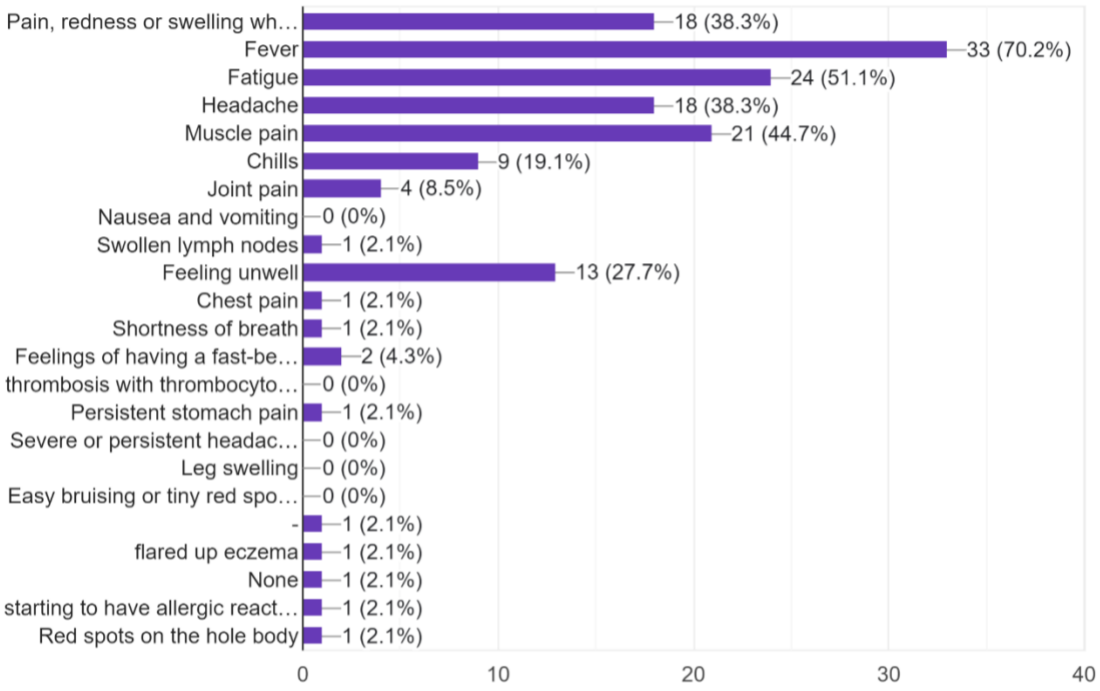
Three respondents did not receive the COVID vaccination. Hence, 62 people responded appropriately. 18 of them (29%) were given Pfizer-biontech, 12 (20.9%) were given Sputnik Light, 11 (17.7%) were given Sinovac, 10 (16.1%) were given Oxford-astrazeneca, and 4 (6.5%) were given Covaxin. Sputnik V, Covishield, Sinopharm, and Janssen were all given to minorities (3.2%, or 2 persons, and 1.6%, or 1 person), respectively.

Figure 18: side effects after the first dose of the vaccine



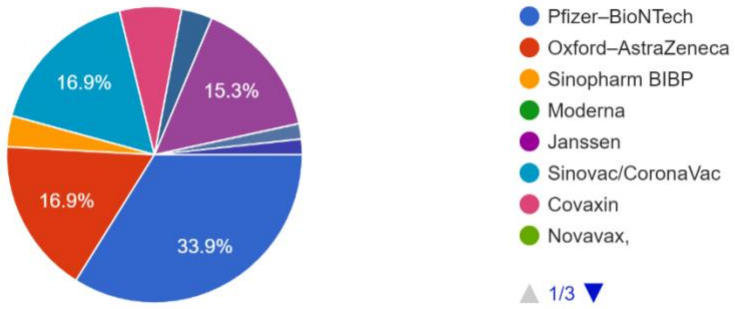
Due to the fact that 3 respondents had not gotten the COVID-19 vaccine, 62 respondents provided the answer to this question. Of the 65 pupils, 62.9% (or 39) suffered side effects, as opposed to 37.1% (or 23) who had not.

Figure 19: side effects after the first dose of the vaccine



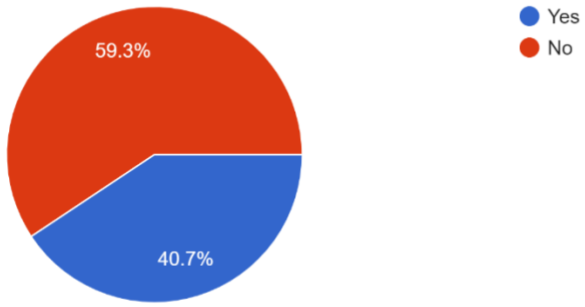
This question received answers from all 41 respondents who received the first dose of the vaccine with side effects; however, two students gave wrong answers to questions, and students may select as many answers as they like. 33 pupils, or 70.2%, had a fever, and fatigue affected 24 students or 51.5%. Next, 44.7% of the 21 participants developed muscle pain, and 38.3% of the 18 participants felt pain, redness, and headache, respectively. While 27.7% of the 13 participants felt unwell, 19.1% of the 9 had chills, and 8.5% of the total 4 participants cited joint pain. 4.3% (2 people) reported palpitation, while 2.1% (1) reported swollen lymph nodes, chest pain, dyspnea, persistent stomach pain, red spots on the whole body, and allergic reactions, respectively.

Figure 20: brand of second dose of vaccine



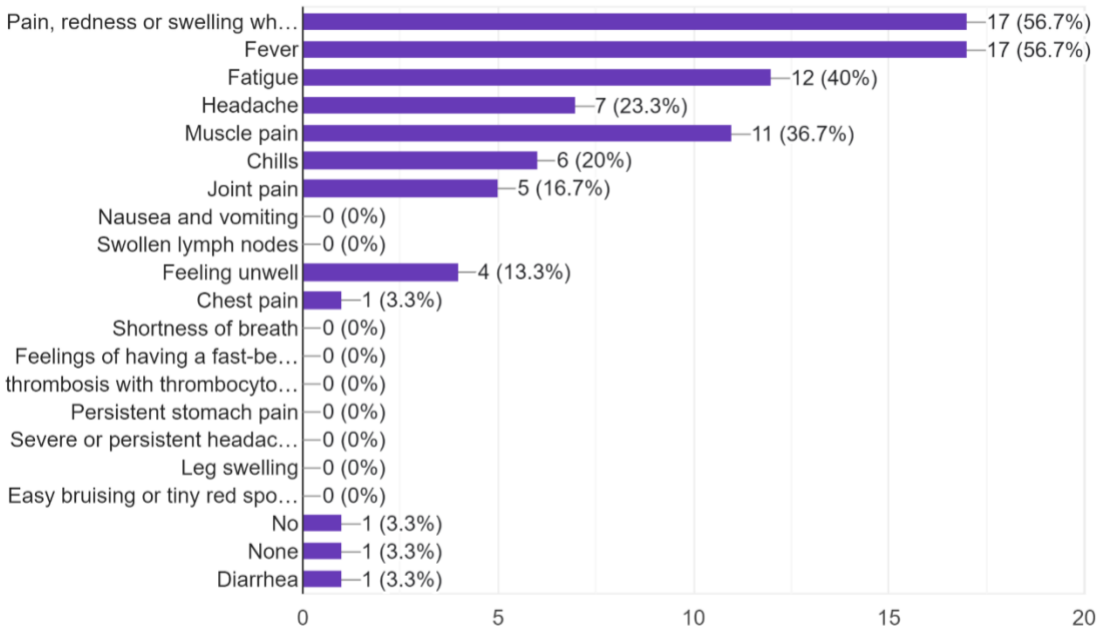
Because three respondents did not receive the COVID immunization and three more did not receive the second dose of the vaccine, 59 respondents gave the correct response. Twenty of them (33.9%) received Pfizer-biontech, ten (16.0%) Sinovac and Oxford-astrazeneca, respectively, nine (15.3%) Sputnik Light, four (6.8%) Covaxin, and two (3.4%) each of Sputnik V and Sinopharm. Coronavac and Covishield were given to a combined total of 2 persons (3.4%).

Figure 21: side effects after the second dose of vaccine



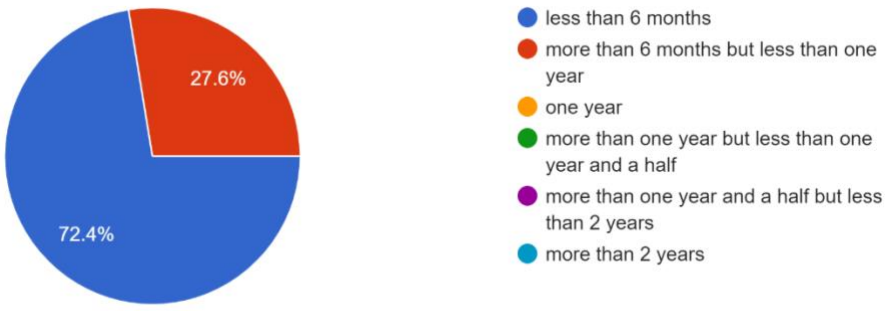
Due to the fact that 3 respondents had not gotten the COVID-19 vaccine and three more did not receive the second dose of the vaccine, 59 respondents provided the answer to this question. Of the 59 pupils, 40.7% (or 24) suffered side effects, as opposed to 59.3% (or 35) who had not.

Figure 19: side effects after the second dose of the vaccine



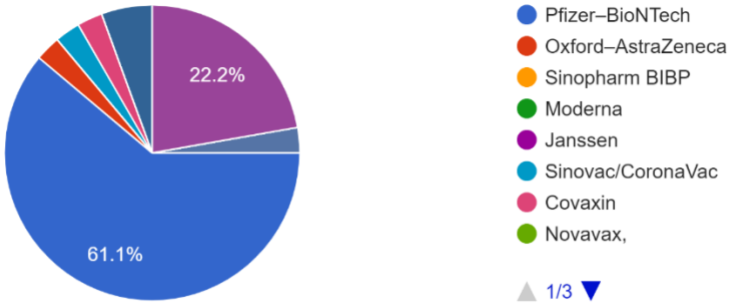
This question received answers from all 24 respondents who received a second dose of vaccine with side effects; however, two students gave wrong answers to the questions, and students may select as many answers as they like. 17 pupils, or 56.7%, had fever, pain, redness, and swelling, respectively. Fatigue affected 12 students, or 40%. Next, 36.7% of the 11 participants developed muscle pain, and 23.3% of the 7 participants felt headache. While 20% of the total 6 participants felt chills, 16.7% of the whole 5 had joint pain, and 13.3% of the total 4 participants felt unwell. Lastly, 3.3% (1 person) reported diarrhea.

Figure 20: gap between two doses of vaccine



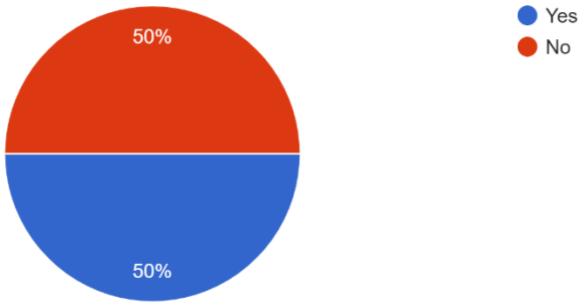
Due to the fact that 3 respondents had not gotten the COVID-19 vaccine, three more did not receive the second dose of the vaccine, and one respondent chose not to answer due to some reasons, 58 respondents answered this question. Of the 58 pupils, 72.4% (or 42) received a second dose of vaccine less than 6 months after the first dose, as opposed to 27.6% (or 16) who had more than 6 months but less than a year.

Figure 21: brand of third dose of vaccine



Only 36 responded correctly since 25 respondents did not receive the third dosage of the vaccine, three did not receive the COVID vaccination, and three more did not receive the second dose. There are an extra 2 responders who answered the questions due to misunderstanding questions; therefore, their data has been excluded.22 of them (61.1%) received Pfizer-biontech, 8 (22.2%) Sputnik Light, 2 (5.6%) Sputnik V, and a total of 4 (11.2%) received Covaxin, Sinovac, Oxford-astrazeneca, and Covishield.

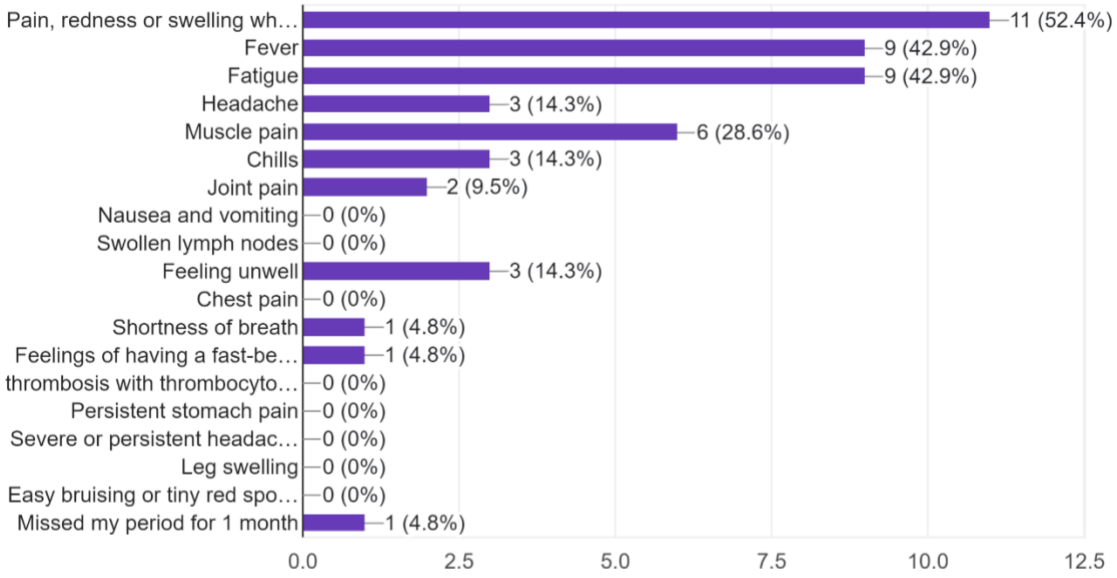
Figure 22: side effects after third dose of vaccine



Due to the fact that 3 respondents had not gotten the COVID-19 vaccine, three more did not receive the second dose of the vaccine, and 25 respondents did not receive a third dose of the

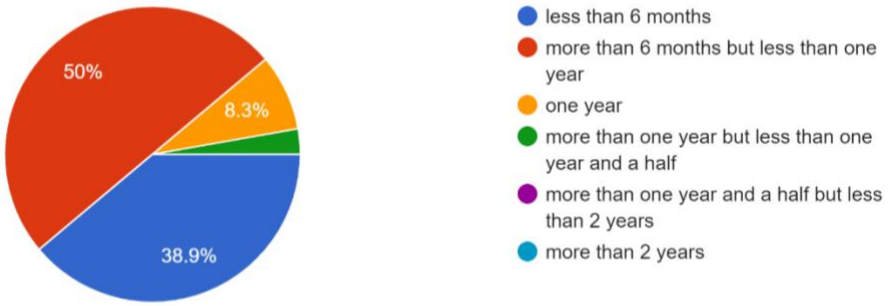
vaccine, 38 respondents provided the answer to this question. However, there are an extra 7 responders who answered these questions wrongly. Therefore, their data was excluded. Of the 34 pupils, 50% (or 19) suffered side effects, as opposed to 50% (or 19) who had not.

Figure 23: side effects after third dose of vaccine



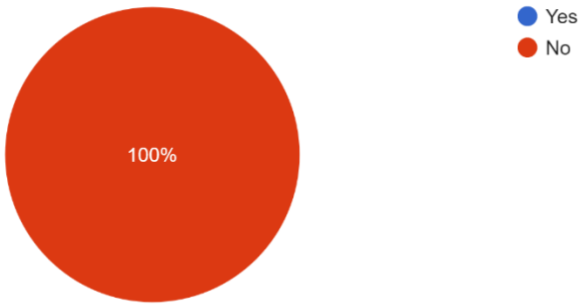
This question received answers from all 19 respondents who received a third dose of vaccine with side effects. Students may select as many answers as they like. 11 pupils, or 52.4%, had pain, redness, swelling, fatigue, and fever affected 9 students, or 42.9% respectively. Next, 28.6% of the 6 participants developed muscle pain, and then 14.3% of the 3 participants felt headache, chills, and unwell, respectively. In contrast, 9.5% of the total 2 participants reported about joint pain. Lastly, 4.8% (1 person) reported dyspnea, palpitation, and missing period.

Figure 24: gap between the second dose and third dose of the vaccine



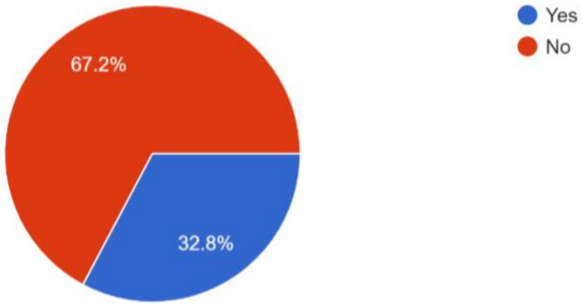
Due to the fact that 3 respondents had not gotten the COVID vaccine, three more did not receive the second dose of the vaccine,e and 25 respondents did not receive the third dose of the vaccine, 36 respondents provided the answer to this question; however there are extra 5 responders answer these questions wrongly. Therefore, their data was excluded. Of the 36 pupils, 50% (or 18) received third dose of vaccine more than 6 months but less than a year. As opposed to 38.9% (or 14) receiving a third dose of vaccine in less than 6 months, 8.3%(or 3) received it in one year. Lastly, 2.8% (or 1) received more than one year but less than one year and a half.

Figure 25: hospitalization due to side effects of vaccination



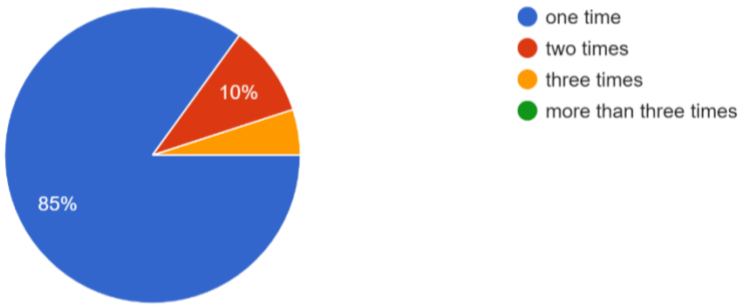
Out of a total of 62 respondents who had vaccinations, only 57 responded to the question; 5 respondents chose not to respond due to personal issues. All of them have never had a vaccination-related hospitalization.

Figure 26: covid-19 status after covid vaccinations



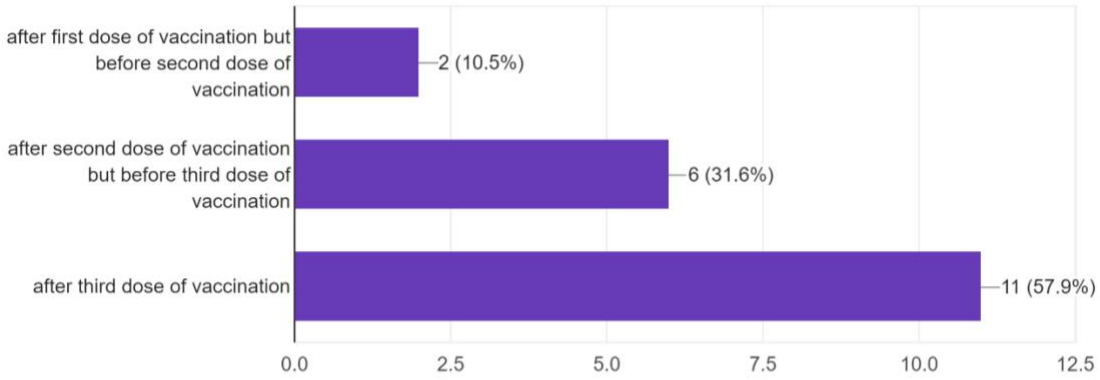
Of 62 respondents who had vaccinations, only 61 responded to the question; 1 chose not to respond due to personal issues. 67.2% (or 41) never being infected with Covid-19 after vaccination, while 32.8%(or 20) were still being infected with Covid-19 after vaccination.

Figure 27: number of times of reinfection after vaccination



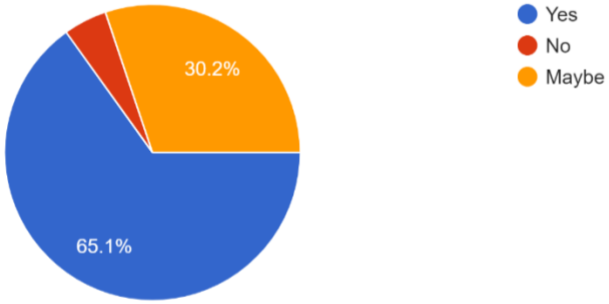
This question received answers from all 20 respondents who were reinfected after vaccination. 17 pupils, or 85%, were only reinfected once, 2 pupils, or 10%, have been reinfected twice, and 1 pupil, or 5%, was reinfected three times after vaccination.

Figure 28: in which dose of vaccines students reinfected with covid-19



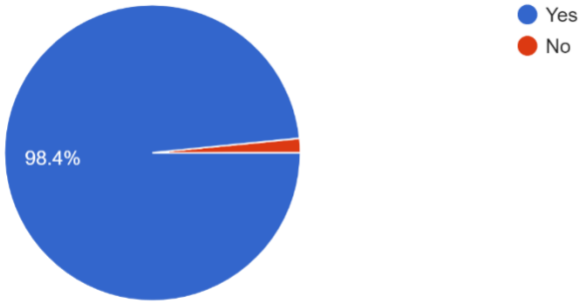
This question received answers from 19 respondents who were reinfected after vaccination, but there is 1 respondent who did not answer this question due to personal issues. 11 pupils, or 57.9%, were reinfected after the third dose of vaccination, 6 pupils, or 31.6%, reinfected after the second dose of vaccination but before the third dose of vaccination, and 2 pupils, or 10.5%, reinfected after the first dose of vaccination but before the second dose of vaccines.

Figure 29: opinions of medical students toward the efficiency of vaccines in prevention of covid-19



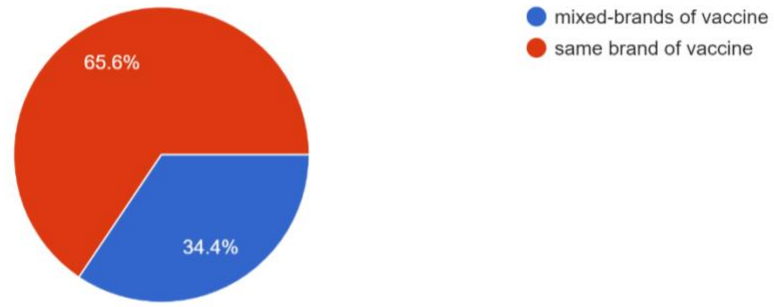
Only 63 out of 65 respondents answered the question; two respondents declined to do so for personal reasons. Among them, 65.1% (or 41) concur that the vaccine is beneficial in preventing COVID-19, whereas 4.8% (or 3) disagree. However,19 people, or 30.2%, are unsure about the claim.

Figure 30: medical students' views on whether they should advise a person who has not been vaccinated to get vaccinated



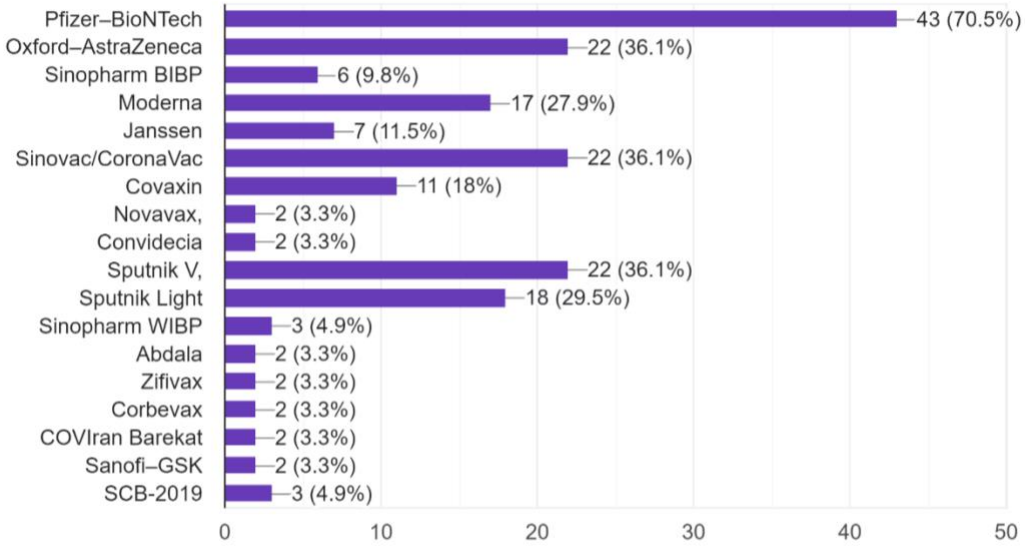
Only 64 out of 65 respondents answered the question; one respondent declined to do so for personal reasons. Among them, 98.4% (or 63) encourage a person who has not been vaccinated to get vaccinated, whereas 1.6% (or 1) discourage.

Figure 31: forms of vaccine that will be encouraged



Only 61 out of a total of 63 respondents gave an answer to the question; two respondents declined to do so because of personal reasons. Among them, 65.6% (or 40) same vaccine brands, whereas 34.4% (or 21) encourage mixed vaccine brands.

Figure 32:brands of vaccine that will be encouraged



Only 61 respondents out of 63 respondents answered the question, and two chose not to answer due to personal issues. 43 of them (70.5%) encourage Pfizer-biontech, 22 (36.1%%) encourage Sputnik V, Sinovac, and Oxford-astrazeneca respectively, 18 (29.5%) encourage Sputnik Light, and a total of 17 (27.9%) encourage Moderna, 11 (18%) encourage Covaxin and

3 (4.9%) encourage Sinopharm WIBP and SCB-2019 respectively. Lastly, 2(3.3%) encourage Novavax, Convidecia, Abdala, Zifivax, Corbevax, coviran Barekat and Sanofi-GSK respectively.

Conclusion

In conclusion, this study underscores the effectiveness of COVID-19 booster vaccinations in reducing the disease burden. Booster doses significantly lowered reinfection rates, with 67.2% of vaccinated students reporting no reinfection after booster shots. Notably, reinfections that did occur were milder and primarily followed the third dose, highlighting the enhanced immunity provided by boosters. These findings support global health guidelines emphasizing the importance of booster doses for sustained protection. However, the study revealed a disconnect between medical students' perceptions of vaccine efficacy and reinfection rates. While 65.1% of students believed in the vaccine's effectiveness, 32.8% still experienced reinfections, indicating the need for clearer public health communication.

The study also highlighted variations in booster uptake and impact across different countries. For instance, students in Russia had higher adoption of mixed-brand vaccine regimens due to broader availability. In contrast, countries like Malaysia and Russia, with better vaccine access, showed higher overall uptake. Mixed-brand regimens were found to provide immune responses comparable to same-brand regimens, demonstrating that flexibility in vaccine choices does not compromise booster efficacy.

Unexpected trends included differences in side effects and reinfection rates after boosters. While half of the students reported mild side effects, others experienced no symptoms, and a minority had severe reactions, suggesting variability in immune responses. Although boosters reduced reinfections overall, some students still experienced breakthrough infections after two doses, underscoring the necessity of booster shots for optimal protection.

Demographic factors such as age, gender, and country of origin influenced vaccine perceptions and effectiveness. Younger students and those in regions with better vaccine access were more likely to receive boosters and report milder side effects. However, no significant gender differences were observed in side effect severity. Reinfections were less frequent among those with more doses, reinforcing the role of boosters in reducing reinfection risks.

The study found no significant difference between mixed-brand and same-brand booster regimens in boosting immunity. Both approaches effectively reduced reinfection rates,

supporting flexible vaccine strategies, especially in response to supply constraints. This finding aligns with existing literature advocating for adaptable vaccination protocols.

Despite aligning with global health recommendations, the study's limitations—such as a small, homogenous sample of medical students and reliance on self-reported data—may limit the generalizability of its findings. Future research should include more diverse populations and investigate the long-term durability of immunity provided by booster doses to better understand their lasting impact.

While students generally perceived vaccines positively, reinfections underscores the need for public health messaging to align perceptions with the reality of breakthrough infections. Regional disparities in vaccine access also revealed inequities in booster availability, highlighting the need for policy interventions to ensure equitable distribution.

Based on these findings, recommendations for policymakers and healthcare authorities include promoting ongoing booster vaccinations, maintaining flexibility in vaccine regimens to address supply issues, and tackling vaccine hesitancy through public education campaigns. Transparent communication about vaccine safety and side effects is critical for high booster uptake. Public health strategies should also prepare for new COVID-19 variants, emphasizing adaptability and continued booster vaccinations to maintain immunity.

Finally, the study identified key concerns among students, such as fears of severe side effects and skepticism about the need for additional doses. Addressing these issues through targeted public health campaigns and transparent communication will be vital in maintaining confidence in booster vaccinations. Authorities must prioritize these efforts to ensure continued protection against evolving COVID-19 threats while addressing regional challenges in vaccine distribution.

References

1. World Health Organization. (2022). Clinical management of COVID-19 (1st ed., pp. 1–148). Https://apps.who.int/iris/bitstream/handle/10665/349321/WHO-2019-ncov-Clinical-2022.1-eng.pdf
2. Coronavirus (COVID-19) vaccinations. (2023). Our World in Data. Retrieved from https://ourworldindata.org/covid-vaccinations
3. Centers for Disease Control and Prevention. (2019). SARS-cov-2 variants. Retrieved from https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-info.html
4. Centers for Disease Control and Prevention. (2023, February 10). COVID-19 incidence and mortality among unvaccinated and vaccinated persons aged ≥12 years by receipt of bivalent booster doses and time since vaccination — 24 U.S. jurisdictions, October 3, 2021–December 24, 2022. Morbidity and Mortality Weekly Report.
5. European Medicines Agency. (2021). Sputnik V COVID-19 vaccine approved for use in the European Union. Retrieved from https://www.ema.europa.eu/en/news/sputnik-v-covid-19-vaccine-approved-use-european-union
6. World Health Organization. (2021, June 1). China's Sinovac COVID-19 vaccine receives WHO validation. Retrieved from https://www.who.int/news/item/01-06-2021-china-s-sinovac-covid-19-vaccine-receives-who-validation
7. World Health Organization. (2021). Astrazeneca COVID-19 vaccine: What you need to know. Retrieved from https://www.who.int/news-room/feature-stories/detail/astrazeneca-covid-19-vaccine-what-you-need-to-know

8. Centers for Disease Control and Prevention. (2021). Sputnik V COVID-19 vaccine. Retrieved from https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/sputnik.html
9. Research and Policy. (2020). Global COVID-19 surge strains health systems. Retrieved from https://www.cidrap.umn.edu/news-perspective/2020/11/global-covid-19-surge-strains-health-systems
10. World Health Organization. (2021). Health workforce. Retrieved from https://www.who.int/health-topics/health-workforce#tab=tab_1
11. Centers for Disease Control and Prevention. (2021, November 4). Smoking and COVID-19. Retrieved from https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease/need-to-know/index.html
12. World Health Organization. (2021, October 28). Alcohol and COVID-19: What you need to know. Retrieved from https://www.who.int/emergencies/disease-outbreak-news/item/2020-DON-29October2020-alcohol-and-COVID-19
13. Centers for Disease Control and Prevention. (2021, November 4). Drinking water. Retrieved from https://www.cdc.gov/healthywater/drinking/nutrition/index.html
14. BBC News. (2021, January 11). COVID: How has the pandemic affected global birth rates? Retrieved from https://www.bbc.com/news/world-55573686
15. The World Bank. (2021). Migration and remittances: Recent developments and outlook. The World Bank Group.