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Unveiling the Landscape of COVID-19 Vaccination in Saudi Arabia: A Socio-Demographic, Clinical, and Vaccine Profile Analysis

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Abstract: The worldwide competition to vaccinate against COVID-19 has highlighted the importance of immunization measures in containing the virus. Saudi Arabia, like the rest of the globe, must assess socio-demographic subtleties, chronic illnesses, vaccination effects, and public health policy implications as it navigates this complicated environment. This cross-sectional study examined Saudi COVID-19 vaccine in many ways. It examined the socio-demographic makeup of vaccine recipients, the prevalence of chronic conditions in this population, vaccine administration patterns, post-vaccination side effects, and vaccine-infection rates. A questionnaire-based online survey of 401 participants ensured gender, nationality, age, weight, and educational diversity. We analyzed vaccine manufacturer choice for each dosage, side effects after the first and second doses, and chronic diseases in the sample. Pfizer/BioNTech vaccines are preferred for all three doses, reflecting worldwide vaccination acceptance patterns. Side effects were not significantly different between vaccination kinds. Interestingly, immunization reduced infection rates, demonstrating the efficacy of COVID-19 vaccines. The data fills important information gaps and illuminates Saudi COVID-19 vaccination kinetics. These data support the global preference for mRNA vaccines, demonstrating the faith in this breakthrough technology. They also sponsor COVID-19 vaccine safety and effectiveness studies. The dramatic drop in infection rates among vaccinated people shows how vaccinations suppress the pandemic. These findings inform Saudi Arabia's immunization efforts. As booster doses become more common, long-term vaccination research is crucial. Vaccine reluctance, especially in certain demographics, must be addressed. Due to vaccines' protective potential, equitable vaccine distribution and large immunization programs are essential for herd immunity and pandemic management. This thorough cross-sectional study helps policymakers and healthcare practitioners build successful and inclusive COVID-19 immunization regimens in Saudi Arabia.

Keywords: COVID-19 vaccination; Saudi Arabia; Cross-sectional study; Socio-demographic characteristics; Chronic conditions; Vaccine administration; Infection rates

1. Introduction

The emergence of SARS-CoV-2, a previously unidentified variant within the human coronavirus lineage, was identified as the etiological agent responsible for a probable disease outbreak in China

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in 2019. This particular strain was shown to be connected with significant health implications, potentially posing a risk to individuals' well-being and even their lives [1]. In March 2020, the declaration of a pandemic for the new sickness epidemic was made by the World Health Organisation (WHO) [2]. Governments worldwide have been compelled to combat the advancement of the pandemic due to the lack of a vaccine or any viable therapeutic options. In response to the global epidemic, a range of preventive measures have been implemented, encompassing strategies such as lockdowns, social distance, the utilisation of face masks, and the imposition of travel restrictions. The development of a vaccine, conversely, represents the most effective approach of mitigating the spread of the pandemic [3].

On December 11, 2020, the emergency use of the Pfizer-BioNTech COVID-19 vaccine was granted approval by the US Food and Drug Administration (FDA). In order for the immunisation to achieve its desired efficacy, it is necessary to provide two doses with a minimum gap of 21 days between each treatment. According to studies, it has been suggested that the attainment of the maximal efficacy, estimated to be around 95%, can occur one week following the administration of two doses. According to the cited source, the administration of the immunisation is appropriate for those who are 16 years of age or older [4]. The Moderna COVID-19 vaccine, with a reported efficacy rate of 94.1 percent, has received emergency authorization for administration in anyone aged 16 years and older. The administration of the Moderna vaccine also necessitates the administration of two doses, with a recommended interval of 28 days between each treatment [5].

In anticipation of commencing the immunisation campaign, the ministry made a deliberate choice to identify the primary target populations for vaccination based on suggestions put out during a comprehensive assessment initiative. Healthcare professionals, specifically emergency personnel operating in crucial regions, individuals aged 60 and above, individuals with a body mass index (BMI) exceeding 40 indicating obesity, immunocompromised individuals who have undergone organ transplantation and are currently taking immunosuppressive medications, and individuals with two or more chronic conditions such as diabetes and cardiovascular disease.The user did not provide any text to rewrite.

Both the Pfizer-BioNTech and Moderna COVID-19 vaccines employ messenger RNA (mRNA) technology. The SARS-CoV-2 virus possesses a distinctive surface characteristic referred to as the S protein, which exhibits a spike-like structure. In turn, the COVID-19 mRNA vaccines contain directives for the synthesis of a harmless segment of the S protein. After the administration of a vaccine, cellular mechanisms initiate the synthesis of supplementary protein fragments which are subsequently presented on the surfaces of the coronavirus. Due to the potential lack of compatibility of the peptide inside the system, the immune system will initiate an immunological response and generate antibodies [6].

The process of eliciting immunity subsequent to vaccination might occasionally result in undesired adverse reactions. Adverse effects that may occur subsequent to the administration of the Pfizer-BioNTech COVID-19 vaccine include pain, erythema, or swelling at the injection site, exhaustion, headaches, shivering, muscle and joint pains, as well as fever. These symptoms might manifest following either the initial or subsequent doses of the vaccine. These indicators may suggest that the human body is undergoing the process of developing the essential antibodies for self-protection [7].

The efficacy of immunisation strategies relies on the assessment of public perceptions of the benefits and hazards associated with vaccines, as well as their level of trust in the immunisation process. According to scholarly research, the decision to decline or delay vaccination can be attributed to a limited understanding of the comparative advantage ratio associated with immunisation [8,9]. This phenomenon, identified by the World Health Organisation Strategic Advisory Group of Experts on Immunisation in 2015, is commonly referred to as vaccine hesitancy [10]. The identification of this hesitancy as a primary global health problem was made by the World Health Organisation (WHO) in the year 2019 [11].

At now, it is imperative to implement monitoring measures in the context of vaccine distribution among the general population [12]. Additionally, it is crucial to conduct a prospective observational

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research that investigates and establishes a connection between the dissemination of the initial vaccine dosage and the occurrence of COVID-19 hospital admissions [13]. The SIREN research [14] and similar surveys aim to establish a direct connection between health records and analyse the efficacy and safety of different stages of vaccination distribution. However, conducting such investigations necessitates a significant amount of time to reach completion.

The COVID-19 vaccine, developed by Pfizer-BioNTech, is a prospective solution to the ongoing global epidemic. Nevertheless, due to the novelty of mRNA technology in the field of vaccine development, its potential consequences remain uncertain. Consequently, it is imperative to conduct studies in order to monitor the adverse effects of the vaccination. Moreover, enhancing the rate of vaccination adoption necessitates a more comprehensive understanding of the risks associated with the Pfizer-BioNTech COVID-19 vaccine, as well as transparent communication of those risks to the general public. The objective of this study was to evaluate the occurrence of reinfection, manifestation of symptoms, impact on quality of life, and potential vulnerabilities subsequent to the administration of the initial, subsequent, or combined doses of the Pfizer-BioNTech COVID-19 vaccine among a cohort of Saudi Arabian individuals aged 16 years and older.

This cross-sectional online survey in Hail region, Saudi Arabia was conducted to evaluate the general population's Covid-19 related experiences following immunization. The study's main goal was to see if vaccination helps to lower the rate of positivity in the general population during the second wave, and possibly during the third wave of infection. The secondary goals was to determine whether: vaccination protected people of all ages from infection, and/or caused fewer serious illnesses in those who have been vaccinated, and/or a single vaccine dose as effective at preventing infection as two vaccine doses, and/or two dosage regimens help to avert more serious illnesses as compared to persons who only had a single dose of vaccination, and/or vaccination is effective in those with comorbid condition, and/or total number of persons who received the BNT162b2 or ChAdOx1 nCoV-19 or Moderna vaccines and recorded symptoms using the COVID Illness Survey questions in real time between November 2021 and September 2022.

2. Materials and Methods

Research design: The study was a cross-sectional prospective study.

Research location and duration:

Residences, work places, Malls, and public health sectors of Hail region for a duration of three months.

Sample size calculation:

The minimal effective sample size of 377 was computed using a population size of 20,000 aged 16 to 74 years, a confidence level of 95%, a margin of error of 5%, and a response distribution of 50%. The sample size for this study was calculated using the Raosoft sample size calculator [http://www.raosoft.com/samplesize.html].

$n = Z^2 P (1-P)/d^2$

Where, n = required sample size, P = disease prevalence Z = confidence level, and d = margin of error. Additionally, using a cluster sampling methodology, a sampling error of 6% was computed, hence the total sample size was 401.

Study tool:

Tools used in this current research was a questionnaire developed by referring to standard published literature. The questionnaire was validated with initial responses from the volunteers through Cronbach's alpha value analysis and Bartlett's test of sphericity. The questionnaire was validated with an initial 40 responses from the consumer through Cronbach's alpha value analysis with a value of 0.87 and Bartlett's test of sphericity ($p<0.001$).

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Study participants, procedure, and data analysis: The research involved members of the general public, both males and females, aged 16 years and above, who were willing to freely participate. The individuals in the Hail region were sampled using a cluster random sampling strategy at various venues such as malls, public health sectors, and banks. The responses were acquired electronically using fifteen and more items through Google Forms (Appendix A and B). Participants' identities and their engagement will be kept fully consensual. Online a freebie, cross-platform centralized messaging, the URL for the Google Form, and another electronic platform were disseminated digitally in numerous places of work, malls, and residential areas connected groups. Additional data were obtained from the public health sector. The reason for which the information will be acquired will be stated explicitly in the associated communication, and participation in the survey will be taken as implied permission. All answers obtained within the timeframe will be electronically transformed into a Google sheet for data processing.

Data collection:

The data collected was processed online through https://www.socscistatistics.com/tests/. The correctness of the outcome of the computations and applications on this webpage was checked against the output of several well-known statistics applications, such as SPSS and Minitab. 1 The Chi-square test of independence was used, and the level of significance will be set at.05. The COVID Symptom Study questionnaire developed by referring to standard published literature will be utilized. SARS-CoV-2 reinfection will be evaluated using self-presented symptoms through the list of questions. Persons above the age of 16 would get a list of questions with no limitations.

The list of questions will gather information including self-reported venue, age, and key health conditions (BMI, cigarette smoking, ethnic background, and existence of comorbid conditions such as cancer, diabetes, eczema, cardiovascular disease, respiratory illness, kidney disease, and seasonal allergies), along with job status (for example, being a healthcare professionals).

Participants having reported immunization will be assessed and whether they have any detrimental effects over the next eight days, including both systemic (whole body) and local impacts. Headaches, tiredness, shivers and chills, dysentery, feverish, arthralgia, myalgia, and nausea were among the systemic adverse effects requested; local adverse effects included local pain, edema, soreness, erythema, itching, warming, and enlarged armpit glands (Appendix B). By keeping the item unchecked, users might potentially claim no symptoms.

Following the second dosage of the COVID-19 vaccination, several of them appeared to get significant systemic symptoms, such as a high temperature, which prohibited them from returning to work the next day. This poll intends to assess the real prevalence of these adverse effects when compared across vaccine kinds, ethnicities, and age, in order to aid persons who will be receiving the immunization soon in anticipating what will happen following the immunization. The post-vaccination quality of life questionnaire mentioned in Annexure C will be surveyed and evaluated.

3. Results and Discussion

3.1. Demographic characteristics:

Table 1 shows that there were 252 men (62.84%) and 149 women (37.16%) who took part in this study. A bigger percentage of men than women shows that there is a significant difference ($P < 0.001$) between the number of male and female volunteers. Out of the 401 people who are taking part, 385 (96.01%) are Saudi citizens and only 16 (3.91%) are not Saudi. The spread of nationalities is heavily skewed towards Saudis, and this difference is statistically important ($P < 0.001$). People who answered were put into several age groups. The majority are between the ages of 21 and 30, making up 45.89% of the sample. The other age groups are not all the same size, and there are big differences in how the ages are spread out ($P < 0.001$). The fourteen to twenty-one and twenty-one to thirty-three age groups are the most common. There are levels for each weight category. Most of the subjects are between 51 and 75 kg (45.39%), but the percentages of people in other weight groups are not the same. There were big changes in how the weights were distributed ($P < 0.001$). There is a range of

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educational levels among the members, with 66.58% having finished a university degree. The next group is high school graduates (21.20%). The different levels of schooling are very different (P < 0.001), which suggests that most of the people have graduated from college or university. Respondents have a range of work situations. 27.43% of the group are people who work for the government, and 36.66% are students.

Table 1. Demographic Characteristics of the Study Participants.

Demographic Data					
Socio-demographic Characteristics	**N**	**(N, %)**	**%**	**95% CI**	**Sig.**
Gender					
Male	252	(252, 62.84%)	62.84%	0.58 - 0.67	P< 0.001
Female	149	(149, 37.16%)	37.16%	0.32 -0.42	
Nationality					
Saudi	385	(385, 96.01%)	96.01%	0.94 - 0.97	P< 0.001
Non-Saudi	16	(16, 3.99%)	3.99%	0.03 - 0.07	
Age Group (Years)					
14–20	61	(61, 15.21%)	15.21%	0.12 - 0.19	P< 0.001
21–30	184	(184, 45.89%)	45.89%	0.41 - 0.50	
31–40	74	(74, 18.45%)	18.45%	0.15 - 0.23	
41–50	54	(54, 13.47%)	13.47%	0.10 - 0.17	
51–60	25	(25, 6.23%)	6.23%	0.04 - 0.09	
61–100	3	(3, 0.75%)	0.75%	0.002 - 0.02	
Weight (Kg)					
34–50	42	(42, 10.47%)	10.47%	0.08 - 0.14	P< 0.001
51–75	182	(182, 45.39%)	45.39%	0.41 - 0.50	
76–100	151	(151, 37.66%)	37.66%	0.33 - 0.42	
101–125	18	(18, 4.49%)	4.49%	0.03 - 0.07	
126–150	6	(6, 1.5%)	1.50%	0.007 - 0.03	
151–175	2	(2, 0.5%)	0.50%	0.0001 - 0.01	
Education level					
Diploma	5	(5, 1.25%)	1.25%	0.005 - 0.028	P< 0.001
High School	85	(85, 21.2%)	21.20%	0.17 - 0.25	
Intermediate	8	(8, 2%)	2.00%	0.01 - 0.03	
University graduate	267	(267, 66.58%)	66.58%	0.62 - 0.71	
PG (Masters and/or PhD)	32	(32, 7.98%)	7.98%	0.57 - 0.11	
I can read (Literate)	4	(4, 1%)	1.00%	0.003 - 0.025	
Employment Status					
Government	110	(110, 27.43%)	27.43%	0.23 - 0.32	P< 0.001
Private	74	(74, 18.45%)	18.45%	0.15 - 0.23	
Retired	12	(12, 2.99%)	2.99%	0.017 - 0.051	
Student	147	(147, 36.66%)	36.66%	0.32 - 0.41	
Housewife	22	(22, 5.49%)	5.49%	0.04 - 0.08	
Unemployed	35	(35, 8.73%)	8.73%	0.06 - 0.11	
Others	1	(1, 0.25%)	0.25%	0.000 - 0.01	
Avg. monthly Income (SAR)					
<5000	214	(214, 53.37%)	53.37%	0.48 - 0.58	P< 0.001
5000 to <10000	50	(50, 12.47%)	12.47%	0.09 - 0.16	
10000 to <15000	80	(80, 19.95%)	19.95%	0.16 - 0.24	
15000 to <20000	42	(42, 10.47%)	10.47%	0.08 0.14	
20000 & Above	15	(15, 3.74%)	3.74%	0.02 - 0.06	

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There are big changes in job status (P < 0.001), with students and people who work for the government being the most noticeable. Different amounts of income are shared out. Over half of the people who answered (53.37%) say they make less than 5,000 SAR a month. Significant differences exist in the spread of income (P < 0.001), which suggests that most of the individuals have a lower income level. The study population's sociodemographic and other traits are summed up in these results. This can help you figure out what kind of people are in the group and how their demographics might affect your study of the research results.

3.1. Prevenance of diseases across different socio-demographic groups

The information in Table 2 shows that the number of people with heart diseases changes by sociodemographic group. Interesting enough, heart problems are more common in women (3.36%) than in men (0.4%). These changes in the number of people with heart disease are statistically important (P < 0.001). The rates of diabetes mellitus also vary between social and ethnic groups. For example, 10.74% more women than men have diabetes, while only 6.75% of men do. There is a strong statistical link between these changes (P < 0.001). The results show that the rates of hypertension are different in different groups. Hypertension is more common in women (8.05%) than in men (2.38%). There is a strong statistical link between these changes (P < 0.001). Kidney diseases are not very common overall, but there are some differences seen in different groups. The information gives us a better idea of how many people in each group have kidney disease. The numbers of overweight and obese people varies by gender, country of origin, age, weight, and level of schooling. One example is that the statistics shows that some subgroups, like women, may have a lower rate of overweight and obesity than others. The figures show how common liver diseases were among the people who answered the survey. It shows how the rates of liver cancer vary between groups of people from different social and economic backgrounds. The figures show how many of the respondents have HIV and how that number changes across different social and demographic groups. Most of the people who answered do not have any chronic diseases.

Table 2. Chronic Disease Prevalence and Sociodemographic Factors Among Participants.

Socio-demographic Characteristics	Heart diseases	Diabetes mellitus	Hypertension	Kidney diseases	Overweight-obesity	Liver diseases	HIV	No Chronic Disease	Others
Gender									
Male	1 (0.4%)	17 (6.75%)	6 (2.38%)	1 (0.4%)	7 (2.78%)	1 (0.4%)	1 (0.4%)	217 (86.11%)	4 (1.59%)
Female	5 (3.36%)	16 (10.74%)	12 (8.05%)	1 (0.67%)	2 (1.34%)	0 (0%)	0 (0%)	118 (79.19%)	6 (4.03%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Nationality									
Saudi	6 (1.56%)	33 (8.57%)	21 (5.45%)	2 (0.52%)	8 (2.08%)	1 (0.26%)	1 (0.26%)	320 (83.12%)	10 (2.6%)
Non-Saudi	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (6.25%)	0 (0%)	0 (0%)	15 (93.75%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Age Group (Years)									
14–20	0 (0%)	2 (3.28%)	1 (1.64%)	0 (0%)	1 (1.64%)	0 (0%)	0 (0%)	56 (91.8%)	1 (1.64%)
21–30	1 (0.54%)	5 (2.72%)	0 (0%)	1 (0.54%)	5 (2.72%)	1 (0.54%)	0 (0%)	166 (90.22%)	6 (3.26%)
31–40	3 (4.05%)	4 (5.41%)	2 (2.7%)	0 (0%)	1 (1.35%)	0 (0%)	0 (0%)	65 (87.84%)	2 (2.7%)
41–50	1 (1.85%)	7 (12.96%)	6 (11.11%)	0 (0%)	1 (1.85%)	0 (0%)	1 (1.85%)	39 (72.22%)	1 (1.85%)
51–60	1 (4%)	12 (48%)	9 (36%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)	9 (36%)	0 (0%)

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61–100	0 (0%)	3 (100%)	3 (100%)	1 (33.33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Weight (Kg)									
34–50	0 (0%)	1 (2.38%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	39 (92.86%)	2 (4.76%)
51–75	5 (2.75%)	11 (6.04%)	10 (5.49%)	1 (0.55%)	0 (0%)	1 (0.55%)	1 (0.55%)	156 (85.71%)	5 (2.75%)
76–100	0 (0%)	19 (12.58%)	11 (7.28%)	1 (0.66%)	2 (1.32%)	0 (0%)	0 (0%)	124 (82.12%)	3 (1.99%)
101–125	1 (5.56%)	2 (11.11%)	0 (0%)	0 (0%)	4 (22.22%)	0 (0%)	0 (0%)	11 (61.11%)	0 (0%)
126–150	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (50%)	0 (0%)	0 (0%)	3 (50%)	0 (0%)
151–175	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Education level									
Diploma	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	0 (0%)
High School	1 (1.18%)	7 (8.24%)	8 (9.41%)	1 (1.18%)	0 (0%)	0 (0%)	0 (0%)	69 (81.18%)	2 (2.35%)
Intermediate	0 (0%)	0 (0%)	1 (12.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (87.5%)	0 (0%)
University graduate	5 (1.87%)	20 (7.49%)	8 (3%)	0 (0%)	8 (3%)	1 (0.37%)	1 (0.37%)	225 (84.27%)	8 (3%)
PG (Masters and/or PhD)	0 (0%)	3 (9.38%)	1 (3.13%)	0 (0%)	1 (3.13%)	0 (0%)	0 (0%)	28 (87.5%)	0 (0%)
I can read (Literate)	0 (0%)	3 (75%)	3 (75%)	1 (25%)	0 (0%)	0 (0%)	0 (0%)	1 (25%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Employment Status									
Government	3 (2.73%)	12 (10.91%)	6 (5.45%)	0 (0%)	2 (1.82%)	0 (0%)	1 (0.91%)	88 (80%)	1 (0.91%)
Private	1 (1.35%)	4 (5.41%)	0 (0%)	1 (1.35%)	0 (0%)	0 (0%)	0 (0%)	68 (91.89%)	1 (1.35%)
Retired	0 (0%)	8 (66.67%)	8 (66.67%)	0 (0%)	1 (8.33%)	0 (0%)	0 (0%)	3 (25%)	0 (0%)
Student	1 (0.68%)	5 (3.4%)	1 (0.68%)	0 (0%)	5 (3.4%)	1 (0.68%)	0 (0%)	131 (89.12%)	4 (2.72%)
Housewife	1 (4.55%)	2 (9.09%)	5 (22.73%)	1 (4.55%)	0 (0%)	0 (0%)	0 (0%)	15 (68.18%)	1 (4.55%)
Unemployed	0 (0%)	2 (5.71%)	1 (2.86%)	0 (0%)	1 (2.86%)	0 (0%)	0 (0%)	29 (82.86%)	3 (8.57%)
Others	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
Avg. monthly Income (SAR)									
<5000	2 (0.93%)	9 (4.21%)	7 (3.27%)	1 (0.47%)	5 (2.34%)	1 (0.47%)	0 (0%)	185 (86.45%)	10 (4.67%)
5000 to <10000	0 (0%)	7 (14%)	5 (10%)	1 (2%)	1 (2%)	0 (0%)	0 (0%)	39 (78%)	0 (0%)
10000 to <15000	2 (2.5%)	8 (10%)	5 (6.25%)	0 (0%)	2 (2.5%)	0 (0%)	1 (1.25%)	66 (82.5%)	0 (0%)
15000 to <20000	2 (4.76%)	6 (14.29%)	2 (4.76%)	0 (0%)	1 (2.38%)	0 (0%)	0 (0%)	33 (78.57%)	0 (0%)
20000 & Above	0 (0%)	3 (20%)	2 (13.33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	12 (80%)	0 (0%)
P-Value	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**

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3.1. Vaccine Manufacturer and Dose Administration:

Table 3 shows how the interviewees were given their first, second, and third doses of the different COVID-19 vaccines. 83.46% of people got the Pfizer/BioNTech vaccine as their first dose. With a p-value of less than 0.001, this shows a difference that is statistically significant when compared to the other vaccines. Oxford/AstraZeneca was the second most popular first dose given, with 15.5% of responders getting it. One percent of those who answered got the Moderna vaccine as their first dose. No one got the Janssen (Johnson & Johnson) vaccine or any other vaccine as their first dose. The results give more information about how the second dose of COVID-19 vaccines was given. With 78.1% of responders getting it, Pfizer/BioNTech was the most popular choice for the second dose. This difference from other vaccines was very important (p-value < 0.001). Oxford/AstraZeneca was the second most common second dose, making up 13.19% of all answers. Moderna made up 7.92% of the second doses, and Janssen (Johnson & Johnson) was picked by 0.79% of these people. In this study, the second shot did not include any other vaccines. 39.28% of those who answered got the Pfizer/BioNTech third dose, which was the most common. There is a big difference between this vaccine and others; the p-value is less than 0.001. Moderna was responsible for 13.44% of the third doses, and Oxford/AstraZeneca was responsible for 1.55%. Notably, 43.67% of those who answered got a different vaccine as their third dose. As their third dose, none of the people in this study got Janssen (Johnson & Johnson). This information provides information about how the study subjects were spread out in terms of vaccine makers and doses. It shows how important the Pfizer/BioNTech vaccines were in the first, second, and third doses, as well as how they were statistically different from other vaccines.

Table 3. Distribution of Vaccination by Vaccine Manufacturer for Different Doses.

S.No	Vaccine Manufacturer	1st Dose (N, %)	95 % CI	Sig.
1	Pfizer/BioNTech	323 (83.46%)	(0.7976 - 0.8716)	
2	Oxford/AstraZeneca	60 (15.5%)	(0.119 - 0.1911)	
3	Janssen (Johnson & Johnson)	0 (0%)	(0 - 0)	P<0.001
4	Moderna	4 (1.03%)	(0.0003 - 0.0204)	
5	Other Vaccines	0 (0%)	(0 - 0)	
S.No	**Vaccine Manufacturer**	**2nd Dose (N, %)**	**95 % CI**	**Sig.**
1	Pfizer/BioNTech	296 (78.1%)	(0.7398 - 0.8222)	
2	Oxford/AstraZeneca	50 (13.19%)	(0.0982 - 0.1656)	
3	Janssen (Johnson & Johnson)	3 (0.79%)	(0.0009 - 0.0167)	P<0.001
4	Moderna	30 (7.92%)	(0.0523 - 0.1061)	
5	Other Vaccines	0 (0%)	(0 - 0)	
S.No	**Vaccine Manufacturer**	**3rd Dose (N, %)**	**95 % CI**	**Sig.**
1	Pfizer/BioNTech	152 (39.28%)	(0.3436 - 0.4419)	
2	Oxford/AstraZeneca	6 (1.55%)	(0.0031 - 0.0279)	
3	Janssen (Johnson & Johnson)	0 (0%)	(0 - 0)	P<0.001
4	Moderna	52 (13.44%)	(0.1 - 0.1687)	
5	Other Vaccines	169 (43.67%)	(0.3868 - 0.4866)	

3.1.1. Association Between Vaccines and Side Effects After 1st Dose:

Table 4 shows more information about the link between vaccines and side effects after the first and second doses, as well as how long the side effects lasted: This information shows the connection between the side effects people had after getting their first dose of COVID-19 vaccines and the different vaccine makers. 36.53% of people who got the Pfizer/BioNTech vaccine said they had side effects. 43.03% of those people needed some kind of medicine to help with their problems, and only 1.86% went to the doctor or were hospitalised. This data has a p-value of 0.192, which means that there is no statistically significant difference between vaccine makers when it comes to side effects. 5.57 percent of people who got the Oxford/AstraZeneca vaccine or another vaccine said it caused side

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effects. A higher number, 10.53%, needed medicine, and 0.93% went to the doctor or the hospital because of side effects. 53.87% of people who got Pfizer or BioNTech drugs said they had side effects that went away in one to two days, and 23.53% said they lasted three to six days. 2.79 percent or fewer said the side effects lasted a week or more. The p-value for this data is 0.297, which means that there is no statistically significant difference between vaccine makers in how long side effects last. People who got the Oxford/AstraZeneca vaccine and others said that 9.6% had side effects that lasted one to two days, 6.5% had side effects that lasted three to six days, and 0.93% had side effects that lasted a week or more.

Table 4. Associations Between Vaccine Manufacturers and Post-Vaccination Side Effects.

Vaccines association with Side Effects after 1st dose						
S.No	**Vaccine Manufacturer**	**No. Side Effects (N, %)**	**No medication needed (N, %)**	**Some medication needed (N, %)**	**Visited doctor or Hospitalized (N, %)**	**P-Value**
1	Pfizer/BioNTech	118 (36.53%)	60 (18.58%)	139 (43.03%)	6 (1.86%)	0.192
2	Oxford/AstraZeneca/Others	18 (5.57%)	9 (2.79%)	34 (10.53%)	3 (0.93%)	
Vaccines association with duration of Side Effects after 1st dose						
S.No	**Vaccine Manufacturer**	**1-2 days (N, %)**	**3-6 days (N, %)**	**Week or more (N, %)**	**No Side effects (N, %)**	**P-Value**
1	Pfizer/BioNTech	174 (53.87%)	76 (23.53%)	9 (2.79%)	64 (19.81%)	0.297
2	Oxford/AstraZeneca/Others	31 (9.6%)	21 (6.5%)	3 (0.93%)	9 (2.79%)	
Vaccines association with Side Effects after 2nd dose						
S.No	**Vaccine Manufacturer**	**No. Side Effects (N, %)**	**No medication needed (N, %)**	**Some medication needed (N, %)**	**Visited doctor or Hospitalized (N, %)**	**P-Value**
1	Pfizer/BioNTech	114 (35.29%)	63 (19.5%)	104 (32.2%)	5 (1.55%)	0.131
2	Oxford/AstraZeneca/Jnassen	19 (5.88%)	10 (3.1%)	22 (6.81%)	1 (0.31%)	
3	Moderna/Others	7 (2.17%)	3 (0.93%)	19 (5.88%)	0 (0%)	
Vaccines association with duration of Side Effects after 2nd dose						
S.No	**Vaccine Manufacturer**	**1-2 days (N, %)**	**3-6 days (N, %)**	**Week or more (N, %)**	**No Side effects (N, %)**	**P-Value**
1	Pfizer/BioNTech	161 (49.85%)	51 (15.79%)	8 (2.48%)	68 (21.05%)	0.153
2	Oxford/AstraZeneca/Jnassen	20 (6.19%)	17 (5.26%)	2 (0.62%)	13 (4.02%)	
3	Moderna/Others	18 (5.57%)	6 (1.86%)	0 (0%)	5 (1.55%)	

35.29% of people who got Pfizer or BioNTech reported side effects. 32.2% of these people needed to take some kind of medicine, but only 1.55% went to the doctor or the hospital because of side effects. The p-value for this data is 0.131, which means that there isn't a statistically significant difference between vaccine makers when it comes to side effects. 5.88% of people who got the Oxford/AstraZeneca and Janssen vaccines said they had side effects. 6.81% of these people needed medicine, and 0.31% went to the doctor or were hospitalised. 2.17 percent of people who got the Moderna vaccine or another vaccine mentioned side effects, and 5.8 percent needed to take medicine. No one in this group went to the doctor or the hospital. 49.85% of people who got Pfizer or BioNTech reported side effects that lasted one to two days, 15.79% reported side effects that lasted three to six days, and 2.48% reported side effects that lasted a week or more. The p-value for this data is 0.153, which means that there is no statistically significant difference between vaccine makers in how long side effects last.

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61% of people who got the Oxford/AstraZeneca and Janssen vaccines said they had side effects that lasted one to two days, 52% said they had side effects that lasted three to six days, and 6% said they had side effects that lasted a week or more. 5.57 percent of people who got the Moderna vaccine or any other vaccine had side effects that lasted one to two days, 1.86 percent had side effects that lasted three to six days, and no one had side effects that lasted a week or more. These results give a full picture of the connection between vaccine makers, side effects, and how long they last.

3.1.2. Association between vaccines and infection rates

Table 5 provides a comprehensive analysis of the correlation between vaccinations and infection rates both before to and after to the administration of the first, second, and third doses. This study examines the association between various vaccine manufacturers and the incidence of COVID-19 infections both prior to and following immunisation. Within the cohort of individuals who were administered the Pfizer/BioNTech vaccine, a notable proportion of 43.18% disclosed a history of previous illnesses. Following the administration of the initial dose, there was a reduction in the infection rate to 16.67%. Subsequently, following the administration of the second dose, the infection rate further dropped to 31.82%. Following the administration of the third dosage, the prevalence of infection exhibited a rather modest value of 8.33%. The obtained p-value of 0.928 suggests that there is no statistically significant evidence to support the presence of variations in infection rates.

Among those who received the Oxford/AstraZeneca vaccination and other similar immunisations, a total of 7.58% reported having experienced prior illnesses. Following administration of the initial dose, there was a notable reduction in the infection rate to 3.79%. Subsequently, with receipt of the second dose, the infection rate further decreased to 6.06%. Following the administration of the third dosage, the observed infection rate was recorded as 2.27%. Among those who were administered the Pfizer/BioNTech vaccine, a notable proportion of 37.12% indicated a history of previous illnesses. Following the administration of the initial dose, there was a notable decrease in the infection rate to 12.88%. Subsequently, when receiving the second dose, the infection rate further decreased to 26.52%. Following the administration of the third dosage, the prevalence of infection continued to exhibit a low incidence of 9.09%. Based on the obtained p-value of 0.34, the results indicate a lack of statistical significance in the observed differences in infection rates.

Table 5. Associations Between Vaccine Manufacturers and COVID-19 Infections Post-Vaccination.

Vaccinces1st Dose vs. association with infection post Vaccination						
S.No	**Vaccine Manufacturer**	**Before Taking Vaccine**	**After the 1st Dose**	**After the 2nd Dose**	**After the 3rd Dose**	**P-Value**
1	Pfizer/BioNTech	57 (43.18%)	22 (16.67%)	42 (31.82%)	11 (8.33%)	0.928
2	Oxford/AstraZeneca/Others	10 (7.58%)	5 (3.79%)	8 (6.06%)	3 (2.27%)	
Vaccinces2nd Dose vs. associationwith infection post Vaccination						
S.No	**Vaccine Manufacturer**	**Before Taking Vaccine**	**After the 1st Dose**	**After the 2nd Dose**	**After the 3rd Dose**	**P-Value**
1	Pfizer/BioNTech	49 (37.12%)	17 (12.88%)	35 (26.52%)	12 (9.09%)	0.34
2	Oxford/AstraZeneca/Others	17 (12.88%)	9 (6.82%)	14 (10.61%)	1 (0.76%)	
Vaccinces3rd Dose vs. associationwith infection post Vaccination						
S.No	**Vaccine Manufacturer**	**Before Taking Vaccine**	**After the 1st Dose**	**After the 2nd Dose**	**After the 3rd Dose**	**P-Value**
1	Pfizer/BioNTech	24 (18.18%)	11 (8.33%)	8 (6.06%)	10 (7.58%)	0.000*
2	Oxford/AstraZeneca/Others	42 (31.82%)	15 (11.36%)	41 (31.06%)	3 (2.27%)	

*P<0.05, Pearson Chi-square test.

Among the recipients of the Oxford/AstraZeneca vaccine and other vaccines, a proportion of 12.88% reported having had previous illnesses. Following the administration of the initial dose, there was a notable reduction in the infection rate to 6.82%. Subsequently, with the administration of the

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second dose, the infection rate further declined to 10.61%. Following the administration of the third dosage, the observed infection rate was a mere 0.76%.

Among those who received the Pfizer/BioNTech vaccine, a total of 18.18% reported having experienced past illnesses. Following the administration of the initial dosage, there was a notable reduction in the infection rate to 8.33%, which further declined to 6.06% subsequent to the administration of the second dose. Following the administration of the third dosage, there was a marginal rise seen in the infection rate, reaching a value of 7.58%. The statistical analysis reveals a remarkably low p-value of 0.000*, which signifies a substantial disparity in infection rates. A total of 31.82% of individuals who received the Oxford/AstraZeneca vaccination and other vaccines reported having experienced past illnesses. Following administration of the initial dose, there was a notable reduction in the infection rate to 11.36%. Subsequently, while receiving the second dose, the infection rate experienced a further fall to 31.06%. Following the administration of the third dose, the observed infection rate was recorded at a mere 2.27%. The provided data offers a complete analysis of the correlation between various vaccine manufacturers and dosage regimens and COVID-19 infection rates.

3.6. Comparative Analysis of Impact of COVID-19 Vaccination on Infection Rates

Table 6 presents an analysis of the relationship between the vaccination status of the respondents and their prior occurrences of COVID-19 infections. Within the cohort of persons who have not been administered any COVID-19 vaccination, a proportion of 14.29% have not encountered a COVID-19 infection at any point in time. Nevertheless, a significant proportion of individuals, namely 85.71%, had previously been infected with the virus. The obtained p-value of 0.029* suggests that there exists a statistically significant disparity in infection rates between individuals who have never had vaccination and those who have. In contrast, within the population that has been administered COVID-19 vaccinations, 43.67% have remained uninfected, whereas 56.33% have encountered an illness. The observed statistical significance persists, as shown by a p-value below the threshold of 0.05.

Table 6. A Comparative Analysis of Impact of COVID-19 Vaccination on Infection Rates.

Vaccination status vs. NEVER got Infection with Covid-19				
	Vaccination status	**Have you ever been infected with Covid-19?**		
Have you been vaccinated with any Covid-19 Vaccine?		**No (N, %)**	**Yes (N, %)**	**P-Value**
	No	2 (14.29%)	12 (85.71%)	0.029*
	Yes	169 (43.67%)	218 (56.33%)	
Vaccination status vs. Infection with Covid-19 BEFORE taking vaccine				
	Vaccination status	**Have you been infected before taking any Covid-19 Vaccine?**		
Have you been vaccinated with any Covid-19 Vaccine?		**No (N, %)**	**Yes (N, %)**	**P-Value**
	No	12 (85.71%)	2 (14.29%)	0.604
	Yes	310 (80.1%)	77 (19.9%)	
Vaccination status vs. Infection with Covid-19 AFTER taking vaccine				
	Vaccination status	**Have you been infected after taking any Covid-19 Vaccine?**		
Have you been vaccinated with any Covid-19 Vaccine?		**No (N, %)**	**Yes (N, %)**	**P-Value**
	No	14 (100%)	0 (0%)	0.020*
	Yes	278 (71.83%)	109 (28.17%)	

*P<0.05, Pearson Chi-square test.

Of the unvaccinated people, 85.71% had not contracted COVID-19 before receiving any COVID-19 vaccine, whereas 14.29% had a previous history of infection. The obtained p-value of 0.604

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indicates that there is insufficient evidence to support the presence of a statistically significant difference in infection rates prior to vaccination, as determined by vaccination status. Among those who received COVID-19 vaccinations, a majority of 80.1% had not had prior illness prior to immunisation, while a minority of 19.9% had a documented history of infection. The obtained p-value of 0.604 once again suggests that there is no statistically significant difference.

All individuals who did not receive any COVID-19 immunisation demonstrated a 100% absence of infection subsequent to vaccination, with no instances of post-vaccination infection reported. The obtained p-value of 0.020* indicates a statistically significant distinction, suggesting that there were no reported instances of post-vaccination infections within this particular group. Of the individuals who were administered COVID-19 vaccinations, 71.83% remained uninfected after to immunisation, whereas 28.17% reported experiencing illness following vaccination. The observed discrepancy is considered to be statistically significant, as indicated by the p-value of 0.020*. In essence, the aforementioned evidence highlights a notable disparity in the frequencies of COVID-19 infection among those who have received immunisation and those who have not, both prior to and after to vaccination. Furthermore, it elucidates a statistically significant disparity in infection rates after immunisation between the groups that received the vaccine and those that did not.

4. Discussion:

This study offers significant contributions to the understanding of COVID-19 immunisation, encompassing socio-demographic factors, the prevalence of chronic illnesses, vaccine delivery, side effects, and infection rates. The aforementioned data enhance our comprehension of the effectiveness and safety of several COVID-19 vaccinations within a heterogeneous population. Through a comparative analysis of these findings with the extant body of research, a more thorough understanding of COVID-19 immunisation techniques may be achieved. The gender distribution found in this study reveals a notable disparity, with a substantially larger percentage of male participants (62.84%) compared to females (37.16%). This finding is consistent with other research that has reported a greater incidence of COVID-19 among men [15]. The observed discrepancy can be ascribed to differences in behaviours and occupational exposures [16]. The wide variety of socio-demographic factors, such as age groups, educational attainment, work statuses, and income ranges, demonstrates the extensive diversity among the Saudi population. The results of our study indicate that there are disparities in the occurrence of chronic illnesses among various socio-demographic populations. It is worth mentioning that certain subgroups had a higher prevalence of heart disorders, diabetes, hypertension, and renal ailments. This conclusion aligns with other studies that have shown a correlation between patients with pre-existing chronic illnesses and a heightened susceptibility to catastrophic consequences of COVID-19 [17,18]. The identification of these diseases within our research cohort emphasises the necessity for the implementation of focused vaccination programmes and preventative interventions for populations at elevated risk [19].

The data presented indicates that the Pfizer/BioNTech vaccine was the predominant selection for the initial, subsequent, and tertiary administrations of COVID-19 vaccinations, exhibiting a statistically noteworthy distinction in comparison to alternative vaccine options. The inclination towards mRNA vaccines is consistent with prevailing worldwide patterns, given that mRNA vaccines were among the initial vaccinations to get authorization and achieve widespread acceptance [20]. The choice of the Pfizer/BioNTech vaccine exemplifies the confidence put in its effectiveness and safety. In contrast, the relatively lower utilisation rates of the Moderna and Janssen vaccines can be attributed to variables such as limited availability and distribution tactics, as well as variances in vaccine preferences influenced by considerations such as cold storage needs and immunisation schedules. The analysis of our data pertaining to the occurrence of side effects following administration of the initial and subsequent vaccination doses did not provide any statistically significant disparities in prevalence among various vaccine manufacturers. The aforementioned findings provide further support for the current body of research that highlights the overall safety and tolerability of COVID-19 vaccines [21]. The vaccinations in question have been subjected to thorough examination in clinical studies, and empirical evidence consistently supports their safety

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profiles. Understanding the occurrence and severity of side effects can serve as a valuable tool for individuals in comprehending the anticipated experiences following vaccination. This knowledge plays a crucial role in fostering acceptance of vaccination.

The analysis of the relationship between vaccine manufacturers and infection rates both prior to and during vaccination revealed that although infection rates exhibited a decline after vaccination, the observed disparities across various vaccine types did not reach statistical significance. This discovery is consistent with previous substantial research that has demonstrated the protective efficacy of COVID-19 vaccinations [22]. The increased incidence of infections among those who have not had vaccinations underscores the need of immunisation as a preventive measure against COVID-19. The results of our study reaffirm the importance of vaccinations in mitigating the transmission of the virus and diminishing the probability of severe illness manifestations. The choice for the Pfizer/BioNTech vaccine in our study aligns with global trends and findings from several studies that have demonstrated the initial efficacy and extensive use of mRNA vaccines in numerous countries [20,23]. The prevalence of this vaccination underscores the confidence bestowed upon mRNA vaccine technology. The results of our study align with previous research that has shown the overall safety and effectiveness of COVID-19 vaccinations [21,22]. The drop in infection rates that has been seen following vaccination serves as a strong indication of the efficacy of vaccinations, a finding that aligns with the conclusions drawn from several research [22].

5. Conclusions

In summary, our research offers a thorough examination of the socio-demographic attributes, prevalence of chronic ailments, administration of vaccines, occurrence of side effects, and rates of infection within the framework of COVID-19 vaccination. The results emphasise the significance of fair distribution of vaccines, including socio-demographic inequalities, and confirm the overall efficacy and safety of COVID-19 immunisation. Our study provides a significant contribution to the worldwide endeavours in addressing the epidemic and informing public health strategies. The findings of this study provide support for more research on the enduring impacts of vaccination, particularly in light of the increasing use of booster doses. Furthermore, these results underscore the need of ongoing vaccination initiatives aimed at attaining broad immunity. The imperative to tackle vaccination hesitancy and inequities across diverse demographic cohorts continues to be a crucial area of concern for forthcoming public health initiatives.

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