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Impact of COVID-19 Vaccination on Infection Rates and Severity in Healthcare Workers at Benghazi Medical Centre

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A B S T R A C T

During the SARS-CoV-2 pandemic, health care workers (HCWs) were more susceptible to infection, and as such, they were given priority immunization. This study aims to evaluate the effectiveness of COVID-19 vaccination against symptomatic SARS-CoV-2 infection among HCWs in Libya.164 healthcare professionals at Benghazi Medical Center participated in this cross-sectional research to assess the efficacy of the COVID-19 vaccination. A standardized questionnaire evaluating demographics, vaccination status, post-vaccination experiences, breakthrough infections, history of SARS-CoV-2 and COVID-19 exposure, adherence to safety protocols, and medical history was filled out by participants who had received at least one dose of the vaccine. Using chi-square and t-tests, the data, which were analysed using SPSS v28, showed correlations between vaccination status and health outcomes ($p<0.05$). The study, which has received ethical approval, sheds light on the efficacy of vaccines in this medical group. The study involved 164 participants, with a majority being doctors (92.7%), and women (67.7%). Most participants (64%) were aged 25–35 years. Among the participants, 32.93% (n= 54) received only one dose, 57.93% (n=95) were fully vaccinated with two doses and 9.15% (n=15) received one booster dose. For the first and second doses, Sputnik was predominantly utilized. A significant association was found between gender ($P = 0.011$), and age ($P < 0.001$) with vaccination status. Before vaccination, 36% had already been infected with COVID-19, with most infections having been treated at home. Post-vaccination data indicated a decrease in infection rates of COVID-19 and severity of symptoms among vaccinated participants. VE against symptomatic infection was 30% (95% CI:16.4 - 43.6) for HCWs vaccinated with two doses and 44.5% (95% CI: 24-65) for HCWs vaccinated with one booster dose. Infection prevention and control practices were good as 71.3% practiced hand hygiene consistently, but with less compliance with social distancing and the use of gowns. In conclusion, the effectiveness of the COVID-19 vaccine in preventing the infection incidence and the severity among the healthcare workers is supported by this study. To achieve a maximum protection and maintenance of uninterrupted healthcare system function during the ongoing pandemic, it calls for complete vaccination and booster doses in addition to intensified IPC measures and customized public health measures. Future research needs to address the long-term vaccine efficacy, and the interventions to enhance IPC adherence in hospitals.

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INTRODUCTION

The COVID-19 pandemic, caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), first appeared in December 2019 and ever since has been accompanied by lots of devastation all over the world [1-4]. It was identified for the first time in Wuhan, China, and has spread fast worldwide; hence, the WHO declared it a Public Health Emergency of International Concern in January 2020 [3-7]. On March 11, 2020, the WHO announced COVID-19 as a pandemic [3,5]. The highly contagious nature of the disease, asymptomatic spread during the incubation period, and lack of specific treatments initially made the control of the outbreak significantly difficult [4].

Worldwide, the pandemic brought catastrophic social, economic, and public health disruption [3]. Governments instituted emergency policies, such as lockdowns, social distancing, mask mandates, and vaccination campaigns, to reduce SARS-CoV-2 transmission [1,3,4,6]. Vaccination became a key component of pandemic prevention [3,4,6,7], and by January 2024, over 13.5 billion doses had been administered globally [3].

Healthcare workers (HCWs) were involved in controlling and reducing the pandemic's effects [1,5,8]. Being at the frontline put them at increased risk of acquiring SARS-CoV-2 infection compared to the general population, with an average prevalence of between 7% and 19% in HCWs [3,5,9-11,13,14]. Nurses and midwives were severely impacted because of their patient-facing occupations (13). Inadequate availability of personal protective equipment (PPE) also heightened their susceptibility, particularly in resource-scarce environments [9].

The infection of HCWs had a cascading effect on healthcare systems through workforce shortages caused by isolation, hospitalization, and even deaths among the frontline workers [3]. This put further pressure on already overstretched health systems, especially in low- and middle-income countries [3,11,13]. The protection of HCWs was important for the sustainability of health services during the pandemic, since their role extended beyond patient care to preventing onward transmission of the virus within healthcare settings [11].

HCWs were prioritized early for vaccination by the WHO

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and national public health authorities due to their higher risk of infection as well as being critical in maintaining healthcare service delivery [1-3,13]. Starting from early 2021, many countries initiated vaccinating HCWs as a strategy to safeguard the healthcare workforce and reduce transmission risk within hospitals, which was in line with the recommendations issued by the U.S. Advisory Committee on Immunization Practices [10,13]. These vaccines significantly lowered severe illness, hospitalization, and mortality among HCWs, thereby decreasing workforce disruptions and the transmission risks [1,2,8,13]. However, declining immunity and the emergence of new SARS-CoV-2 variants led to breakthrough infections and underscored the importance of repeated booster campaigns and ongoing vaccine development [1,2,14].

HCWs represent an essential population for studying vaccine efficacy and reinfection rates due to their regular access to screening and diagnostics services [2,8]. Building on this, the current study seeks to evaluate the effectiveness of COVID-19 vaccination in preventing SARS-CoV-2 infection and disease among HCWs in Libya.

Methods

Study design

This research is a cross-sectional study, which permits the evaluation of the effectiveness of COVID-19 immunization among health care workers at Benghazi Medical Centre (BMC).

The inclusion criteria are health care workers at BMC who have received at least one type of COVID-19 vaccine and agreed to participate in the research. Exclusion criteria included health care workers who have not had any COVID-19 vaccination and those who refused to give informed consent to participate. The sample size was 164 participants, which was determined according to Morgan's table.

Data collection

Information was collected using a structured questionnaire that included questions designed to measure the following: Sociodemographic data: age, gender, specialty, marital status, residency, blood group, and smoking habit. Vaccination status: type and number of vaccinations received and the date. Perceived effectiveness and side effects experienced post-vaccination. Any breakthrough infections or health complications following vaccination. History of positive results for SARS-COV2 before and after vaccinations, how it was confirmed, severity of the signs and the symptoms and the management plan. Contact with inpatients, or close contact with a confirmed COVID-19 patient or a person with COVID-19 symptoms. Adherence to the recommended safety measures, such as hand hygiene and alcohol-based hand rub or soap, wearing a mask and coverall gown when indicated, and staying 2 meters from other people in indoor spaces as recommended. History of medical problems, hospital admissions, and regular medication consumption.

Ethical considerations

Approval from the Benghazi Medical Centre was obtained prior to commencing the study. Informed consent was taken from all participants before data collection, ensuring they understood their rights and the purpose of the research.

Statistical analysis

Data analysis was performed using statistical software SPSS version 28. Descriptive statistics (mean, median, mode) summarized demographic data and vaccination status. Inferential statistics (chi-square tests, t-tests) evaluated associations between vaccination status and health outcomes or perceived effectiveness. A significance level of $p < 0.05$ is used to determine statistical significance.

Results

Demographic and Health-Related Characteristics of Participants

The study included 164 participants, of whom the majority were female, comprising 67.7% (n=111) of the study sample. The mean age was 36.24 ± 8.114 years. Most participants were within the 25–35 age group (64%, n=105) compared to other age groups. 52.1% (n=73) of participants were single, 46.4% (n=65) were married, and only 1.4% (n=2) were divorced.

Of the participants, 78.7% (n=129) had completed undergraduate studies, while 21.3% (n=35) had finished postgraduate work, including master's or doctoral degrees. Doctors made up the bulk of participants (92.7%, n=152), with pharmacists (6.1%, n=10) and health administrators (1.2%, n=2) being the least frequent occupations in the sample.

The most common blood group, according to the distribution, was O+ (37.3%, n=60) followed by A+ (30.4%, n=49). The less common blood groups, including A-, AB-, B-, and O-, were less reported; O- (2.5%, n=4) and AB- (0.6%, n=1) revealed the least figures. According to lifestyle behaviours, 92.7% (n=152) did not smoke, indicating that smoking was not a common habit in the population. Table 1 presents the demographic and health-related characteristics of participants.

Participants' workplaces were varied, with wards being the most common (31.1%, n=51), followed by intensive care units (ICU; 15.9%, n=26) and emergency/ward/ICU combinations (9.1%, n=15). Other combinations of workplaces were distributed in lower percentages (Table 2).

Out of the total participants, 18.9 % (n=31) declared to have at least one chronic disease, with 3 of them having been hospitalized due to their condition, and 4 were receiving immunosuppressive therapy in the form of steroids and monoclonal antibodies. The most prevalent chronic illness noted was hypertension, affecting a total of 8.5% (n=14) participants (Table 3).

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Table 1. Demographic and Health-Related Characteristics of the participants (n=164)

Variables	Class	Frequency	Percentage
Age in years	25-35	105	64.0%
	36-46	35	21.3%
	47-57	20	12.2%
	>57	4	2.4%
Gender	Female	111	67.7%
	Male	53	32.3%
Marital status	Single	73	52.1%
	Married	65	46.4%
	Divorced	2	1.4%
Educational level	Undergraduate	129	78.7%
	Postgraduate	35	21.3%
Occupation	Doctor	152	92.7%
	Health Administration	2	1.2%
	Pharmacist	10	6.1%
Blood Group	A-	5	3.1%
	A+	49	30.4%
	AB-	1	0.6%
	AB+	9	5.6%
	B-	4	2.5%
	B+	29	18.0%
	O-	4	2.5%
	O+	60	37.3%
Smoking Status		12	7.3%
Chronic disease		31	18.9 %
Hospitalization for chronic illness		3	1.8%
Received regular immunosuppressive medications		4	2.4%
Contact with a COVID-19 patient at the hospital		145	88.4%
Contact with a COVID-19 patient outside the hospital		108	65.9%

Table 2. Participants' workplaces (n=164)

Place of work	N	%
CCU	10	6.1%
Emergency	4	2.4%
Emergency/CCU	1	0.6%
Emergency/ICU/CCU/Ward	7	4.3%
Emergency/Ward	13	7.9%
Emergency/ward/CCU	1	0.6%
Emergency/Ward/ICU	15	9.1%
Emergency/Ward/ICU/CCU/OPD	2	1.2%
Emergency/Ward/ICU/Radiology	2	1.2%
ICU	26	15.9%
ICU/CCU	1	0.6%
OPD	1	0.6%
Pharmacy	6	3.7%
Ward	51	31.1%
Ward/ICU/OPD	1	0.6%
Ward/CCU	1	0.6%
Ward/ICU	9	5.5%
Ward/ICU/CCU/OPD	2	1.2%
Ward/ICU/CCU	8	4.9%
Ward/ pharmacy	2	1.2%
Ward/OPD	1	0.6%

Table 3. Prevalence of Chronic Diseases in a Study Population (n=164)

Chronic disease	Total
NO chronic disease	133
Adrenal insufficiency	1
Anemia	1
Asthma	2
Atopy	1
Diabetes Mellitus	3
Epilepsy	1
Gastritis	2
Gout	1
Hashimoto's thyroiditis	1
Hypertension + Asthma	1
Hypertension + heart disease	1
Hypertension	11
Hypertension + Diabetes mellitus	1

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Hypothyroidism	1
Rheumatoid arthritis	1
SLE	1
Urticaria	1
Total	164

A significant association was found between gender (P = 0.011), and age (P < 0.001) with vaccination status. Whereas, no statistically significant differences were observed regarding smoking status, blood groups, the presence of chronic disease, hospitalization history, regular immunosuppressive medication, or contact with COVID -19 patients about different vaccination status (partially vaccinated, fully vaccinated with two doses, and those who received a booster dose), table 5.

The majority of participants reported direct contact with COVID-19 patients, either in a hospital (88.4%, n=145) or outside the hospital (65.9%, n=108).

The majority of the participants, 57.93% (n=95), were fully vaccinated (two doses) during 2021, whereas 32.93% (n=54) received only one dose, and a smaller but considerable percentage, 9.15% (15), received three doses.

For the first (58.5%, n=96) and second (53.2%, n=59) doses, Sputnik was utilized most. For the third dose (53.3%, n=8), Pfizer was the most common one, and 26.7% (n=4) was for AstraZeneca. The others, which were used less, were Sinopharm and Sinovac for all doses (Table 3).

Table 4. Vaccine distribution of the participants (n=164)

Type of vaccine		AstraZeneca	Pfizer	Sinopharm	Sinovac	Sputnik	Total
First dose of vaccine	N	24	13	23	8	96	164
	%	14.7%	8.0%	14.1%	4.9%	58.5%	100%
Second dose of vaccine	N	20	9	15	8	59	111
	%	18.0%	8.1%	13.5%	7.2%	53.2%	100%
Third dose of vaccine	N	4	8	1	0	2	15
	%	26.7%	53.3%	6.7%	0	13.3%	100%

Table 5. Demographic and Health-Related Characteristics of the participants, according to their vaccination status (n=164)

Variables	**Characteristics**	**Vaccine Status of participants**			**Chi-Square**	**P**
		Partially vaccinated (One dose)	**Vaccinated (Two doses)**	**Vaccinated (booster dose)**		
Gender	Female	43	62	6	9.033	0.011
	Male	11	33	9		
Age	25-35	40	56	8	27.876	0.00
	36-46	11	24	1		
	47-57	3	14	3		
	> 57	0	1	3		
Blood group	A-	1	4	0	8.733	0.848
	A+	19	27	6		
	AB-	0	1	0		
	AB+	2	5	2		
	B-	1	3	0		
	B+	11	16	2		
	O-	0	4	0		
	O+	20	35	5		
Smoking	0	52	87	13	2.011	0.366
	1	2	8	2		
Chronic Disease	0	46	75	12	0.887	0.642
	1	8	20	3		
Hospitalization for chronic illness	0	52	95	14	4.781	0.092
	1	2	0	1		
Received regular immunosuppressive medications	0	54	92	14	2.683	0.261
	1	0	3	1		
Contact with a COVID-19 patient at the hospital	0	10	7	2	4.228	0.121
	1	44	88	13		
Contact with a COVID-19 patient outside the hospital	0	20	31	5	0.302	0.86
	1	34	64	10		

Table 6. The pre- and post-vaccination COVID-19 infection of participants (n=164)

Variable	Score	Pre-vaccination COVID-19 infection		Post-vaccination COVID-19 infection						Chi-Square	P
				Partially vaccinated (One dose)		Vaccinated (Two doses)		Vaccinated (booster dose)			
		n	%	n	%	n	%	n	%		
COVID-19 infection	0	105	64%	44	81.5	71	74.70	12	80.00	7.937	0.047
	1	59	36%	10	18.5	24	25.30	3	20.00		
Severity of Symptoms	0	1	1.7	0	0	1	4.17	0	0	11.785	0.695
	1	3	5.1	0	0	1	4.17	0	0		
	2	16	27.1	4	40.0	4	16.67	0	0		
	3	7	11.9	2	20.0	5	20.83	2	66.67		
	4	14	23.7	1	10.0	7	29.17	1	33.33		
	5	18	30.5	3	30.0	6	25.00	0	0		
Duration of illness	0	1	1.7	0	0	1	4.17	0	0	7.33	0.948
	1	27	45.8	6	60.0	15	62.50	3	100		
	2	17	28.8	2	20.0	5	20.83	0	0		
	3	11	18.6	2	20.0	3	12.50	0	0		
	4	1	1.7	0	0	0	0	0	0		
	5	2	3.4	0	0	0	0	0	0		
Place of treatment	1	48	81.4	10	100.0	24	100	3	100	13.427	0.569
	2	6	10.1	0	0	0	0	0	0		
	3	1	1.7	0	0	0	0	0	0		
	4	3	5.1	0	0	0	0	0	0		
	5	1	1.7	0	0	0	0	0	0		
Treatment taken	0	0	0	1	10.0	1	4.17	0	0	14.138	0.515
	1	25	42.4	3	30.0	11	45.83	1	33.33		
	2	24	40.7	4	40.0	9	37.50	0	0		
	3	8	13.6	2	20.0	2	8.33	2	66.67		
	4	1	1.7	0	0	0	0	0	0		
	5	1	1.7	0	0	0	0	0	0		

Pre- and post- vaccination Covid- 19 infection

Out of the total participants, 36% (n = 59) had a history of pre-vaccination COVID-19 infection. Among these participants, 81.4% (n=48) needed home care without oxygen and 10.1% (n=6) required home care with oxygen. Hospitalization was required for 8.5% (n = 5) of the participants, and 1.7% (n = 1) were admitted to the Intensive Care Unit (ICU). However, none of the participants were placed on a ventilator.

The symptoms associated with pre-vaccination COVID-19 infection were different, ranged from absent to severe; 30.5% (n=18) of infected participants had severe pneumonia, 44.1% (n=26) of COVID-19 cases reported mild to moderate illnesses, 23.7% (n= 14) experienced moderate to severe symptoms and 1.7% of infected participants (n=1) were completely asymptomatic. The duration of illness varied among participants; 45.8% (n=27) reported symptoms lasting one week, 28.8% (n=17) experienced symptoms for two weeks, and 18.6% (n=11) reported three weeks.

In terms of treatment, 40.7% (n = 24) of participants received antibiotics as part of their therapeutic regimen, whereas 42.4% (n = 25) received supportive care only. Moreover, steroids and anticoagulants were needed by 15% (n = 9), and antiviral therapy was provided to 1.7% (n=1).

Among those who received vaccinations, the rate of COVID-19 infections showed a statistically significant decline (p = 0.047). 18.5% (n=10) of the partially vaccinated group (those receiving one dose), 25.3% (n=24) of those who received two doses, and 20% (n=3) of participants who received a booster dose experienced COVID-19 infection. Additionally, the severity of symptoms showed marked differences based on vaccination status. Post-vaccination, symptoms exhibited a distinguished reduction in severity, particularly among those receiving booster doses. Remarkably, 66.67**%** (n=2) of participants in the booster group reported moderate symptoms, with no reports of severe symptoms. The duration of illness varied across the vaccination groups; 60% (n=6) of partially vaccinated participants, 62.5% (n=15) of fully vaccinated participants experienced symptoms lasting one week. This percentage increased to 100% (n=3) in the booster group.

The treatment patterns of post-vaccination COVID-19 infection show a noticeable shift compared to the treatment of pre-vaccination infection. All the vaccinated participants, whether partially vaccinated, fully vaccinated, or those who received a booster dose, were treated at home without the need for supplemental oxygen. Furthermore, there were no cases of post-vaccination infection that required anticoagulant or antiviral treatment. 30% (n=3) of partially vaccinated individuals, 45.83% (n=11) of fully vaccinated, and 33.33% (n=1) of those receiving a booster dose were treated by supportive treatment only. Table 6 presents the pre- and post-vaccination COVID-19 infection of participants.

Score of symptoms: 0= asymptomatic, 1= mild, 2= mild to moderate, 3= moderate, 4= moderate to severe, 5= severe symptoms. Score of duration of illness: 0= 2-3 days, 1= 1 week, 2= 2 weeks, 3= 3 weeks, 4= 1 month, 5 = more than 1 month. Score of places of treatment: 1= Home without oxygen, 2= Home with oxygen, 3= Medical ward without oxygen, 4= Medical ward with oxygen. 5= ICU. Score of received treatment: 1= supportive treatment, 2= supportive treatment and antibiotics, 3= supportive treatment + antibiotics steroid, 4= supportive treatment + antibiotics steroid + anticoagulant, 5= supportive treatment + antibiotics steroid + antiviral.

The COVID-19 infections were confirmed by PCR in 84.7% (n=50) of unvaccinated participants, 87.5% (n=21) of fully

vaccinated participants, and 66.67% (n=2) of those receiving a booster dose by PCR. Whereas, 100% of partially vaccinated participants had confirmed COVID-19 infections based on contact history with a COVID-19 patient, Table 7.

COVID Vaccine effectiveness

Vaccine effectiveness against symptomatic COVID infection was 30 % (95% CI: 16.4 - 43.6) for vaccinated participants with two doses and 44.5% (95% CI: 24-65) for vaccinated participants with one booster dose. Whereas, the vaccine effectiveness of the first dose (partial vaccination) against COVID-19 infection was 48.7% (95% CI: 35.3-61.9).

Compliance with Infection Prevention and Control Measures Among Participants:

Regarding various infection prevention and control measures, high compliance was observed. 71.3% (n=117) of participants always practiced hand hygiene, 73.2% (n=120) always used alcohol or soap, 62.2% (n=102) always used masks, and 59.1% (97) reported always adhering to IPC practices. While 16.5% (n=27) always maintained 2 2-meter distance, and 65.2% (n=107) never used coverall gowns, table 8.

Table 7. Confirmatory test of pre- and post-vaccination COVID-19 infection (n=164)

Confirming test	Pre-vaccination against COVID-19 infection		Post-vaccination COVID-19 infection					
			Partially vaccinated (One dose)		Fully Vaccinated (Two doses)		Vaccinated (booster dose)	
	n	%	n	%	n	%	n	%
CXR+ ESR+ CRP	2	3.4	0	0	0	0	0	0
PCR	50	84.7	0	0	21	87.5	2	66.67
Contact with confirmed patient	6	10.1	10	100	3	12.5	0	0
Positive family members	1	1.7	0	0	0	0	0	0
Symptoms	0	0	0	0	0	0	1	33.33

Table 8. Adherence to Infection Prevention and Control (IPC) Measures among participants (n=164).

Variables		Never	Rarely	Sometimes	Always	Mean	Std. Deviation
Hand hygiene	n	1	4	42	117	3.677	0.553
	%	0.6	2.4	25.6	71.3		
Alcohol or soap use	n	1	4	39	120	3.695	0.547
	%	0.6	2.4	23.8	73.2		
2 meters space	n	20	51	66	27	2.610	0.903
	%	12.2	31.1	40.2	16.5		
Mask use	n	4	11	47	102	3.506	0.731
	%	2.4	6.7	28.7	62.2		
IPC	n	7	6	54	97	3.470	0.763
	%	4.3	3.7	32.9	59.1		
Coverall gown	n	107	14	25	18	1.720	1.083
	%	65.2	8.5	15.2	11		

Discussion

The efficacy of COVID-19 vaccines has been a subject of the highest research priority since the onset of the pandemic. Fresh evidence indicates that vaccination is correlated with a highly significant reduction in risk of symptomatic infection and severe disease, highlighting the importance of both initial vaccination and booster doses. In this, diverse levels of vaccine efficacy have been found in studies, which are of highest significance in defining how to best maximize public health efforts.

The demographic profile of the participants in this study provides valuable insights into the health and lifestyle characteristics of a predominantly female cohort, with a mean age of 36.24 years. The majority of participants were within the 25-35 age range, which aligns with findings from similar studies examining health behaviors in young adults (15). The majority of women (67.7%) in the research sample is consistent with trends in healthcare research, where women are more likely to be involved in health research (16). As health risk and behavior can be very different between the genders, this gender split needs to be taken into account when extrapolating the results.

It has been noted that older individuals and females were more likely to have been vaccinated, possibly because they perceived a higher risk or had better access to healthcare (17). Such demographic data are key in developing public health interventions to maximize vaccination rates among underrepresented groups.

The results of the research reveal a statistically significant reduction in cases of COVID-19 infection in the group that took the immunization, where the p-value equals 0.047. This is supported by past research that reveals just how effective COVID-19 vaccines reduce infection rates (18,19). Rates of infection among our cohort were 18.5% among participants with partial vaccination (n = 10), 25.3% among participants with full vaccination (n = 24), and 20% among participants with a booster dose (n = 3). These numbers show that the rate is greatly lower within the partially vaccinated than in the completely vaccinated group, despite the fact that all groups experience breakthrough infections to a greater or lesser degree. This

is due to a heightened immunological response upon the subject receiving two doses, which has been shown to increase antibodies significantly and enhance defense against potentially fatal disease [20].

Interestingly, the illness rate in the booster dose group was similar to that of the partially vaccinated group, even though they received an additional dose. This could indicate that while booster shots are necessary to enhance immunity, their short-term impact on preventing infections may not be as significant as would be anticipated. However, one should consider that the sample size for the booster group was extremely small (n=3), and thus, results should be carefully interpreted.

According to our results, the intensity of symptoms was also apparently determined by vaccination status. Those who had more vaccinations had fewer symptoms, the study found. Just 1.7% of the people who had received all the vaccinations, for instance, reported that they had suffered severe symptoms (rating 5); this was far lower than the 30.5% of people who had not received any of the recommended immunizations. This finding supports work by other studies that confirmed vaccinated people had reduced infections and less severe symptoms from their infections [21,22].

The findings show that those who have been given all the vaccinations suggested have reduced duration of illnesses relative to those who have not received any. For instance, when compared to fully vaccinated individuals (62.5%), a proportionally lower number of partially vaccinated people (45.8%) indicated an illness of one week or more. This is consistent with findings from a meta-analysis by Ioannidis et al. [23], which showed that vaccination is associated with shorter duration and severity of COVID-19 symptoms.

By vaccination status, variations in where and how care was provided were also notable. In comparison to unvaccinated patients, who had a greater opportunity to be given intensive care unit (ICU) admission or oxygen therapy throughout the length of hospital stay, vaccinated individuals were being given mainly home-based care without oxygen or medical ward care without oxygen. This aligns with other research that proves vaccination lowers the requirement for intense medical treatment of COVID-19 patients [24]. The capacity to treat post-vaccination illnesses at home implies that vaccination considerably lessens the severity of disease in those who are vaccinated.

The effectiveness of immunizations in avoiding severe illness outcomes is also seen from the fact that 33.33% of booster recipients, 45.83% of fully vaccinated, and 30% of partially vaccinated individuals were given supportive treatment. Supportive treatment typically includes rest, water, and relief from symptoms in mild cases [25]. This agrees with findings that indicate that those who are vaccinated experience fewer severe symptoms than unvaccinated individuals [26].

Another notable observation is that there are few post-vaccination infection patients requiring anticoagulant or antiviral therapy. Before the routine use of universal vaccination, complications of COVID-19 were predominantly managed using antiviral medication such as remdesivir and anticoagulants [27]. These are not needed by vaccinated patients because they have fewer virus loads and fewer occurrences of sequelae such as critical pneumonia or thrombosis [28]. A mere 1.7% (n=1) of the patients received antiviral therapy, indicating most post-vaccination infections didn't reach the point where antiviral treatment would be needed. This outcome is consistent with recent research findings that vaccines do reduce viral load in breakthrough infections and curb the formation of severe disorders [20].

Based on the number of doses given, the results show different degrees of vaccination efficacy against symptomatic COVID-19 disease. The 30% (95% CI: 16.4 - 43.6) vaccine efficacy provided by the group who received two doses indicates that although a regimen such as this will provide some form of protection, it will potentially be too little to cut off symptomatic infection, based on the recent event of newly appearing variants that possess better transmission ability and likely escape from immunity [24]. This result is consistent with previous studies that show immunity generated by the vaccines may wane over time and that additional doses can increase protection (29).

Following a booster dose, the vaccine effectiveness boosted to 44.5% (95% CI: 24–65), highlighting the significance of multiple doses of immunizations in having good protection against COVID-19. Boosters seek to increase antibody levels, which decline over time after immunization, and reactivate the immune response (20). Surprisingly, the effectiveness of a single dose at 48.7% (95% CI: 35.3 - 61.9) implies that even a low rate of partial immunization is a good degree of protection against symptoms of illness. This is in line with previous research that showed that, unlike the non-vaccinated population, one dose can significantly lower the chances of infection and transmission [18]. Care must be taken to note that partial vaccination is protective, but it is not the same as full immunity.

Although 18.9% (n=31) of the participants reported having one or more chronic diseases, with a highest prevalence of hypertension (8.5%, n=14), the results of the study reveal that no statistically significant correlation was established between the effectiveness of the COVID-19 vaccine and whether the participants have chronic diseases or not. Furthermore, vaccine efficacy was also not markedly lower, even for the four participants on immunosuppressive drugs (corticosteroids and monoclonal antibodies). Given the well-established knowledge of immunosuppressive medications' capacity to reduce immunological responses, this discovery is especially applicable [30]. Unlike some past research suggesting possible negative effects of hypertension on immunological responses to vaccination, this study found no considerable relationship between hypertension and reduced vaccine effectiveness [31]. Other research, however, suggests that hypertension alone will not affect immunity elicited by the SARS-CoV-2 vaccine [32]. One of the mechanisms that raises the question about vaccine efficacy is the use of immunosuppressive agents such as monoclonal antibodies and corticosteroids. Individuals who use corticosteroids following vaccination would be expected to have impaired antibody responses as these drugs are known to influence multiple immune system components [30]. Monoclonal antibodies further disrupt immunological activation cascades, which play a role in inducing vigorous vaccination responses.

We did not find a strong correlation between the effectiveness of immunizations and immunosuppressive treatment, even though four of our patients were undergoing it. Our finding aligns with current studies that indicate while immunocompromised patients may experience diminished antibody titers with vaccination, they still benefit from immunization in the form of decreased hospitalization [32].

In line with the precedence of hand hygiene in healthcare-associated disease prevention, in this study, high self-reported compliance with key hand hygiene practices was identified, such as 71.3% reporting always following hand hygiene and 73.2% reporting daily hand soap or alcohol-

based rub use consistent with WHO regulations and guidelines [33]. In addition, 62.2% used masks, reflecting high adherence to this practice for respiratory droplet transmission prevention [34]. However, despite its efficacy in the prevention of virus transmission, adherence to the two-meter physical distancing was poor (16.5%) and to the overall IPC principles was moderate (59.1%), raising concern regarding possible information gaps or enforcement problems [35]. Additionally, a high percentage (65.2%) reported never wearing coverall gowns.

While the study revealed a statistically significant reduction in COVID-19 infection among vaccinated HCWs, the concurrent adherence to IPC practices likely contributed to these findings. The individual contribution of vaccination versus IPC practices cannot be easily determined. But it is also possible to speculate that the observed vaccine effectiveness occurred within the context of a high percentage of the study population, which was also actively engaging in hand hygiene and face mask wearing. Lower compliance with physical distancing and coverall gown use could reflect the possibility of areas that might still be carrying transmission risk, even for vaccinated persons. It is crucial to learn the reasons behind these lower compliance rates to guide the development of targeted interventions to further decrease the transmission of SARS-CoV-2 in healthcare settings.

Conclusion

In conclusion, although these findings are promising, more investigation is needed to truly understand long-term implications in the context of post-vaccine infections. The duration that vaccine-induced immunity lasts, as well as how it interfaces with new variants, should be a research target for the future. Whether or not outcomes from treatment in vaccinated subjects were influenced by some demographics or comorbidities may prove to be beneficial.

Limitation

While the study provides valuable insights, limitations include a small sample size and potential reporting biases. Larger, diverse cohorts are essential for generalizing findings. In addition, it is a cross-sectional study, so it cannot establish causality. The study population was primarily healthcare professionals, so the findings may not be generalizable to the broader population. The study did not specify the COVID-19 variants prevalent during the study period, which could impact the interpretation of vaccine efficacy. Due to the small number of participants with chronic diseases and immunosuppression, detailed subgroup analyses were limited.

Conflict of interest. Nil

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