

# Current status of COVID-19 infection and vaccination coverage, and factors associated with infection acquisition and vaccine uptake

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## ABSTRACT:

- **Objective:** The COVID-19 vaccine coverage has a crucial role in controlling the coronavirus disease 2019 (COVID-19) pandemic. In this regard, this study aimed to explore the prior COVID-19 infections and COVID-19 vaccine coverages and their associated factors among students and staff of the University of Duhok (UoD).
- **Subjects and methods:** In this cross-sectional study, 16,874 students and 2,538 staff of the UoD from different colleges (medical, science and engineering, and humanities colleges) and centers were included through an online platform.
- **Results:** The study found that 32.40% of students and 48.39% of staff were infected by COVID-19. The total COVID-19 vaccine coverages of students and staff were 53.16% and 89.16%, respectively. The infected students and staff were more likely to be older, male, and from medical colleges and higher stages. The students from medical colleges were more likely to receive COVID-19 vaccine (31.47%) compared to humanities (24.67%) and science and engineering (24.79%,  $p < 0.0001$ ). Those students and staff who received full vaccination (two doses) were older compared to non-receivers. The infected students were more likely to receive the full vaccination (47.79% vs. 42.50%,  $p < 0.0001$ ). The rate of receiving COVID-19 vaccination increased with increasing scientific titles. The staff was more likely to be infected by COVID-19 compared to the students, 51.62% vs. 32.60%;  $p < 0.0001$ ). However, the staff was more likely to receive the full vaccination, 76.52% vs. 37.15% ( $p < 0.0001$ ).
- **Conclusions:** The COVID-19 vaccines coverage was low among students of the UoD. More attempts are required to increase vaccine coverage among students.
- **Keywords:** COVID-19, Infection, Vaccine.

## INTRODUCTION

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), the causative agent of coronavirus disease 2019 (COVID-19), has resulted in significant morbidity and mortality worldwide. In Iraq, from

January 3, 2020, to June 16, 2022, there had been 2,330,735 confirmed COVID-19 cases and 25,225 deaths<sup>1</sup>.

The virus is predominantly transmitted *via* virus-containing droplets through coughing, sneezing, or people interacting together in close prox-



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imity<sup>2</sup>. Community transmission is avoided by isolation, quarantine, social distancing, and face masks<sup>3</sup>. However, such measures result in social life restrictions. Therefore, achieving herd immunity would be the best preventive measure to control the pandemic. Herd immunity can be achieved either by natural infection (prior COVID-19 infection) or by vaccination<sup>4</sup>. However, reaching herd immunity through prior infection is impractical because of the disease sequelae. Hence, expanded vaccination administration would be the most effective<sup>4</sup>. In December 2020, Pfizer and Moderna vaccines were the first approved effective vaccines against COVID-19<sup>5</sup>. Four COVID-19 vaccines have been approved for use in Iraq, as follows: Sinopharm (Sinopharm BBIBP vaccine), Sputnik V, Oxford AstraZeneca (ChAdOx1 nCov-19), and Pfizer (mRNA-based Pfizer-BioNtech)<sup>6</sup>.

In Duhok, the first vaccine dose was administered on March 26, 2021, which was Sinopharm. Thereafter, the AstraZeneca vaccine was introduced in early April 2021, followed by Pfizer in the middle of April 2021<sup>7</sup>. Since June 2022, the number of vaccination doses administered per 100 people has been 45. Therefore, the vaccination rate has been below the standard level to stop spreading SARS-CoV-2<sup>4</sup>.

Important hotspots of SARS-CoV-2 transmission have been found to be super-spreaders of the virus, e.g., healthcare settings, schools, universities, mass and family gatherings etc<sup>3</sup>. In such settings, it is crucial to know prior infections and to vaccinate people accordingly<sup>8</sup>. Universities have long been recognized as sources of infectious disease outbreaks due to their operating system, e.g., dorms, clinical training, sports activities, and social interactions<sup>9</sup>. Consequently, the objectives of this study at the University of Duhok (UoD) were as follows: to explore the prior COVID-19 infections and vaccination coverage among students, teaching staff and employees, to assess the association between COVID-19 vaccine uptake and prior COVID-19 infection, to examine the association of vaccine administration with general characteristics of students, teaching staff and employees, and to advise decision-makers whether classes should be online.

## SUBJECTS AND METHODS

### Study Design and Sampling

In this cross-sectional study, the students, teaching staff and employees (hereafter referred to as “staff”) of the University of Duhok (UoD) were invited through an online platform. The students of the Medical, Science and Engineering, and Humanities colleges and their staff from different colleges,

centers, and the UoD Presidency were invited in a convenience way. In this regard, we made a Google Form and sent the registration unit of the colleges at the University. After that, the registration unit sent the form to the representatives of the students at each stage. The students were invited to fill out the form within a month. A separate Google Form was created and sent to the staff through the Vice Deans of the colleges and heads of the centers and the administration of the UoD Presidency.

The study aimed to include all students and staff in the study. Of the total 22,942 students, 16,874 (response rate: 73.55%) participated in the study. Of the total 4,354 academic members and employees (1,827 and 2,527, respectively), 2,538 (response rate: 58.29%) returned the filled questionnaires. The data collection was done from January 20, 2022, to February 14, 2022.

### Population and Eligibility Criteria

The population of this study was composed by the students studying at the following colleges: Administration and Economics (n=1,261), Agricultural Engineering Sciences (n=581), Basic Education (n=2,070), Basic Education – Amedy (n=622), Dentistry (n=529), Education – Akre (n=1,573), Engineering (n=1,144), Health Sciences (n=330), Humanities (n=2,819), Languages (n=1,423), Law (n=763), Medicine (n=619), Nursing (n=486), Pharmacy (n=338), Physical Education and Sport Sciences (n=232), Political Sciences (n=418), Science (n=1,248), Spatial Planning (n=231), and Veterinary Medicine (n=187). The students had different socio-demographic and educational characteristics, including different religions, educational backgrounds, and geographical locations.

The second part of the population of this study was composed by the staff working in the above-mentioned colleges, centers, and UoD Presidency as follows: Centers (n=55), Administration and Economics (n=155), Agricultural Engineering Sciences (n=220), Basic Education (n=312), Basic Education – Amedy (n=54), Dentistry (n=108), Education – Akre (n=110), Engineering (n=214), Health Sciences (n=32), Humanities (n=130), Languages (n=157), Law (n=69), Medicine (n=120), Nursing (n=104), Pharmacy (n=67), Physical Education and Sport Sciences (n=64), Political Sciences (n=66), Science (n=233), Spatial Planning (n=43), Veterinary Medicine (n=113), and UoD Presidency (n=112). The colleges were categorized as medical, science and engineering, and humanities along with centers and UoD Presidency in staff. The center’s staff components were not affiliated with the colleges. These centers work under direct supervision of the Presidency of the UoD (such as trauma center).

## Measurements

The data of the study were collected through an online platform. The following information was collected from the students: age, gender, college, stage, infection by COVID-19, and doses and types of received COVID-19 vaccines. The following information was obtained from the staff: age, gender, colleges or centers, infection by COVID-19, titles of staff, and doses and types of received COVID-19 vaccines. The vaccination was categorized as not receiving the vaccine, receiving the first dose, or receiving both doses (full vaccination).

## Ethical Considerations

The participation of the students and staff in this survey was mandatory because it was the part of University strategy for improving the COVID-19 vaccines among its students and staff. However, we protected the confidentiality of the personal information of the participants throughout the steps of this study. We obtained the administrative permission from the presidency of the University of Duhok for publishing these data, taking into consideration the protection of confidentiality of the personal information.

## Statistical Analysis

The information of the students and staff was presented in numbers and percentages. The prevalence of receiving and infection by COVID-19 vaccines were determined in number and percentage. The difference in the prevalence of infection and receiving the COVID-19 vaccines were examined in a Pearson's Chi-squared test. A significant level of difference was identified in a  $p$ -value lower than 0.05. The statistical calculations were performed by JMP Pro 14.3.0 (JMP Statistical Discovery LLC, Cary, NC, USA).

## RESULTS

### Prior COVID-19 Infection Rates

The study found that 32.60% of students and 51.61% of staff had been infected by COVID-19 at the University of Duhok. The study showed that infected students were older compared to non-infected students ( $p < 0.0001$ ). The male students and those from medical colleges and higher stages were more likely to be infected by COVID-19. A similar pattern was found among staff as well (Table 1).

### Prevalence Rates of COVID-19 Vaccines and Prior Infection

The total coverages of COVID-19 vaccines were 53.16% and 89.16% among students and staff, respectively. The types of COVID-19 vaccines received by students were

AstraZeneca (4.87%), Pfizer (42.65%), and Sinopharm (4.57%). A small percentage of students received the booster dose (1.25%). The COVID-19 vaccines received by staff were AstraZeneca (16.46%), Pfizer (65.35%), and Sinopharm (7.39). A small percentage of staff received the booster (6.32%). The study showed that Pfizer was a popular COVID-19 vaccine among students (42.65%) and staff (65.35%). In addition, the study showed that the students who had been infected by COVID-19 were more likely to receive Pfizer (44.54%), followed by AstraZeneca (5.12%;  $p = 0.0089$ ). A similar pattern was found among staff. Interestingly the study showed that the staff who had been infected by COVID-19, was less likely to receive the booster dose (5.17% vs. 7.55%;  $p = 0.0128$ ; Table 2).

### Partial and Full Dose COVID-19 Vaccines Among Students

The study showed that the students from medical colleges were more likely to receive partial COVID-19 vaccines (31.47%) compared to humanities (24.67%) and science and engineering (24.79%,  $p < 0.0001$ ). The partial vaccination was significantly increased with increasing the stages of the students ( $p = 0.0004$ ). Those students who received full vaccination (two doses) were older compared to non-receivers. A similar pattern was found for the full vaccination. The infected students were more likely to receive the full vaccination (47.79% vs. 42.50%,  $p < 0.0001$ ; Table 3).

### Partial and Full Dose COVID-19 Vaccines Among Staff

The study showed that staff who received the partial vaccination were mostly from centers and science and engineering colleges and were males. The staff who received the full vaccination were older compared to those who did not receive the COVID-19 vaccine ( $p < 0.0001$ ). The rate of receiving COVID-19 vaccination increased with increasing scientific titles (Table 4).

### Infection Rate and COVID-19 Vaccine Coverages Between Students and Staff

The study showed that the staff was more likely to be infected by COVID-19, 51.62% vs. 32.60%; ( $p < 0.0001$ ). However, the staff was more likely to receive the full vaccination, 76.52% vs. 37.15% ( $p < 0.0001$ ). The students were more likely to not receive the COVID-19 vaccine (46.84% vs. 10.84%,  $p < 0.0001$ ); (Table 5 and Figure 1).

## DISCUSSION

To the best of our knowledge, this is the largest study describing the previous COVID-19 infections and vaccination status among students and staff in a University

**Table 1.** Prevalence of COVID-19 information and vaccination by general characteristics among students and employees of the University of Duhok.

General information (n=16,874)	Students no. (%)			p (two-sided)
	Overall	Infection by COVID-19		
		Yes (5,501, 32.60%)	No (11,373, 67.40%)	
<i>Age (17-42 yrs)</i>	20.71 (1.78)	20.82 (1.68)	20.64 (1.79)	<0.0001 <sup>a</sup>
<b>Gender</b>				
Female	10,454 (61.95)	3,346 (32.01)	7,108 (67.99)	0.0358 <sup>b</sup>
Male	6,420 (38.05)	2,155 (33.57)	4,265 (66.43)	
<b>Colleges</b>				
Humanities	10,949 (64.89)	3,273 (29.89)	7,676 (70.11)	<0.0001 <sup>b</sup>
Medical Science	2,489 (14.75)	945 (37.97)	1,544 (62.03)	
Science and Engineering	3,436 (20.36)	1,283 (37.34)	2,153 (62.66)	
<b>Stage</b>				
First stage	5,226 (30.97)	1,463 (27.99)	3,763 (72.01)	<0.0001 <sup>b</sup>
Second stage	4,486 (26.59)	1,394 (31.07)	3,092 (68.93)	
Third stage	3,735 (22.14)	1,305 (34.94)	2,430 (65.06)	
Fourth stage	2,996 (17.76)	1,134 (37.85)	1,862 (62.15)	
Fifth stage	346 (2.05)	156 (45.09)	190 (54.91)	
Sixth stage	85 (0.50)	49 (57.65)	36 (42.35)	
<b>Staff (n=2,538)</b>				
	Students no. (%)			p (two-sided)
	Overall	Infection by COVID-19		
		Yes (1,310, 51.61%)	No (1,228, 48.39%)	
<i>Age (18-87 yrs)</i>	38.32 (8.65)	38.44 (7.52)	37.79 (9.30)	0.0577 <sup>a</sup>
<b>Gender</b>				
Female	1,078 (42.47)	587 (54.45)	491 (45.55)	0.0140 <sup>b</sup>
Male	1,460 (57.53)	723 (49.52)	737 (50.48)	
<b>Title</b>				
Employee	1,059 (41.73)	494 (46.65)	565 (53.35)	<0.0001 <sup>b</sup>
Teacher (without scientific title)	160 (6.30)	71 (44.38)	89 (55.63)	
Assistant Lecturer	508 (20.02)	300 (59.06)	208 (40.94)	
Lecturer	481 (18.95)	273 (56.76)	208 (43.24)	
Assistant Professor	272 (10.72)	138 (50.74)	134 (49.26)	
Professor	58 (2.29)	34 (58.62)	24 (41.38)	
<b>Colleges/Centers</b>				
Humanities	1,117 (44.01)	556 (49.78)	561 (50.22)	0.0006 <sup>b</sup>
Medical Science	544 (21.43)	320 (58.82)	224 (41.18)	
Science and Engineering	710 (27.98)	352 (49.58)	358 (50.42)	
UoD Presidency	112 (4.41)	62 (55.36)	50 (44.64)	
Centers	55 (2.17)	20 (36.36)	35 (63.64)	

<sup>a</sup>ANOVA one-way and <sup>b</sup>Pearson’s Chi-squared test were performed for statistical analyses.

in Iraq and Kurdistan Region. In this study, 32.60% of students and 51.61% of staff were infected with SARS-CoV-2 before vaccination. In agreement with our study, previous infections among staff were higher than among students (15.1% vs. 14.6%)<sup>9</sup>. A similar study<sup>10</sup> among Czeck University students showed 29.6% of previous COVID-19 infections. In contrast, a large cross-study from the University of Salamanca found a lower infection rate among professors/researchers (7.3%) than undergraduate students

(8.9%)<sup>11</sup>. Overall, the infection rate among the mentioned studies was lower than in our study because they were conducted much earlier. Furthermore, the relatively high infection rate in this study could be a significant risk factor for spreading the virus in our community. The staff was significantly more likely to be infected with SARS-CoV-2 compared to the students ( $p < 0.0001$ ). The UoD has a large number of specialties including coaches, which consequently increases the rate of previous COVID-19 infections<sup>9</sup>.

**Table 2.** Prevalence rates of COVID-19 vaccines and their associations with previous infection by COVID-19 among students and staff.

General information (n=16,874)	Students no. (%) / Total coverage (8,971, 53.16%)			p (two-sided)
	Infection by COVID-19			
	Overall	Yes (5,501, 32.60%)	No (11,373, 67.40%)	
<b>Type of vaccines</b>				
Not received	8,086 (47.92)	1,356 (45.38)	3,145 (49.10)	<b>0.0089</b>
AstraZeneca	821 (4.87)	153 (5.12)	304 (4.75)	
Pfizer	7,197 (42.65)	1,331 (44.54)	2,675 (41.76)	
Sinopharm	771 (4.57)	148 (4.95)	281 (4.39)	
<b>Booster dose</b>				
I have not received it	16,664 (98.75)	5,440 (98.9)	11,224 (98.69)	0.03994
I received it	210 (1.25)	61 (1.1)	149 (1.31)	
Staff (n=2,538)	Staff no. (%) / Total vaccine coverage (2,263, 89.16%)			p (two-sided)
	Infection by COVID-19			
	Overall	Yes (1,310, 51.61%)	No (1,228, 48.39%)	
<b>Type of vaccines</b>				
Not received	274 (10.80)	146 (11.16)	128 (10.41)	<b>0.02050</b>
AstraZeneca	418 (16.46)	197 (15.00)	221 (18.03)	
Pfizer	1,659 (65.35)	867 (66.15)	792 (64.5)	
Sinopharm	188 (7.39)	101 (7.69)	87 (7.07)	
<b>Booster dose</b>				
I have not received it	2,378 (93.68)	1,242 (94.83)	1,135 (92.45)	<b>0.0128</b>
I received it	160 (6.32)	68 (5.17)	93 (7.55)	

<sup>a</sup>ANOVA one-way and <sup>b</sup>Pearson's Chi-squared test were performed for statistical analyses.

This study showed that infected students were mostly older ( $p < 0.0001$ ), male ( $p < 0.0358$ ), from medical sciences ( $p < 0.0001$ ), and from higher stages ( $p < 0.0001$ ). Similarly, the infected staff was mostly composed by males ( $p = 0.014$ ), with high academic titles ( $p < 0.0001$ ), and from medical sciences ( $p = 0.0006$ ); whereas age was not statistically significant within the infected staff. In parallel to our findings, males were more frequently presented with previous infections<sup>11,12</sup>. It has been clearly stated<sup>13</sup> that the male gender is a risk factor for the acquisition of COVID-19 due to: higher expression of angiotensin-converting enzyme 2 (ACE 2), sex-based immunological differences driven by sex hormone, and male behaviors such as smoking and alcohol drinking.

The older ages usually have higher stages who are more involved in practical sessions and are more likely to have prior COVID-19 infections. Similarly, other research<sup>11,14</sup> showed increased COVID-19 infection among students and teaching staff in health-related faculties. Staff and students from medical sciences are in direct contact with the patients in health care settings, hence they are more likely to acquire the infection. Therefore, strict preventive measures, i.e., vaccination, mask-wearing, and limiting interactions, would reduce the risk of infection transmission<sup>9</sup>. Concerning academic titles, teaching staff with high-

er ranks are more involved in training students and hence more prone to COVID-19 infections<sup>9,11</sup>.

In this study, the vaccination coverage with at least one dose was 53.16% and 89.16% among students and staff, respectively. Overall, the vaccination coverage among the staff was in line with the WHO target of 70% of the general population. In this study, the COVID-19 vaccine coverage was under the target among students<sup>15</sup>. Therefore, it was recommended to increase the vaccination rate among students by addressing its importance against COVID-19. Correspondingly, a study<sup>8</sup> conducted in Greece found a coverage rate of 85.3% in the largest medical association. In comparison to our study, other studies<sup>16,17</sup> have reported lower COVID-19 vaccine acceptance rates in the United Arab Emirates (UAE) (38.8%) and Jordan (34.9) among university students. The full vaccination coverage was significantly higher among staff in comparison to students (76.52% vs. 37.15%;  $p < 0.0001$ ; Table 4). This was due to mandatory vaccination regulations of Kurdistan Regional Government (KRG) regarding staff. A report<sup>9</sup> by Pennsylvania Department of Health Bureau of epidemiology stated that staff was significantly more likely to have administered at least one dose of vaccine compared to students. In general, the vaccination rate among UoD staff and students was satisfactory to achieve herd immunity in our community, hence online classes were not necessary<sup>18</sup>.

**Table 3.** Association of receiving the partial and full dose covid-19 vaccines with general characteristics among students.

General information (n=16,874)	Receiving COVID-19 vaccine/Total coverage (8,971, 53.16%)		<i>p</i>
	No 7,903 (46.84%)	Partial vaccination 2,703 (16.02%)	
<i>Age (yrs)</i>	20.61 (1.78)	20.68 (1.74)	<b>0.5271<sup>a</sup></b>
<b>Gender</b>			
Female	4,948 (74.78)	1,669 (25.22)	<b>0.4240<sup>b</sup></b>
Male	2,955 (74.08)	1,034 (25.92)	
<b>College</b>			
Humanities	5,432 (75.33)	1,779 (24.67)	<b>&lt;0.0001<sup>b</sup></b>
Medical Science	845 (68.53)	388 (31.47)	
Science and Engineering	1,626 (75.21)	536 (24.79)	
<b>Stage</b>			
First stage	2,857 (76.76)	865 (23.24)	<b>0.0004<sup>b</sup></b>
Second stage	2,070 (73.61)	742 (26.39)	
Third stage	1,659 (72.73)	622 (27.27)	
Fourth stage	1,216 (74.37)	419 (25.63)	
Fifth stage	96 (64.86)	52 (35.14)	
Sixth stage	5 (62.50)	3 (37.50)	
<b>Infection by COVID-19</b>			
No	5,481 (74.86)	1,841 (25.14)	0.2273 <sup>b</sup>
Yes	2,422 (73.75)	862 (26.25)	
General information (n=16,874)	Receiving COVID-19 vaccine/Total coverage (8,971, 53.16%)		<i>p</i>
	No 7,903 (46.84%)	Full vaccination 6,268 (37.15%)	
<i>Age (yrs)</i>	20.61 (1.78)	20.81 (1.69)	<b>&lt;0.0001<sup>a</sup></b>
<b>Gender</b>			
Female	4,948 (56.32)	3,837 (43.68)	0.0897 <sup>b</sup>
Male	2,955 (54.86)	2,431 (45.14)	
<b>College</b>			
Humanities	5,432 (59.24)	3,738 (40.76)	<b>&lt;0.0001<sup>b</sup></b>
Medical Science	845 (40.22)	1,256 (59.78)	
Science and Engineering	1,626 (56.07)	1,274 (43.93)	
<b>Stage</b>			
First stage	2,857 (65.51)	1,504 (34.49)	<b>&lt;0.0001<sup>b</sup></b>
Second stage	2,070 (55.29)	1,674 (44.71)	
Third stage	1,659 (53.29)	1,454 (46.71)	
Fourth stage	1,216 (47.19)	1,361 (52.81)	
Fifth stage	96 (32.65)	198 (67.35)	
Sixth stage	5 (6.10)	77 (93.90)	
<b>Infection by COVID-19</b>			
No	5,481 (57.50)	4,051 (42.50)	<b>&lt;0.0001<sup>b</sup></b>
Yes	2,422 (52.21)	2,217 (47.79)	

<sup>a</sup>ANOVA one-way and <sup>b</sup>Pearson's Chi-squared tests were performed for statistical analyses.

In our study, the most commonly administered vaccine among both students and staff was Pfizer, followed by AstraZeneca and Sinopharm. This finding is consistent with our previous research<sup>7</sup> in evaluating the COVID-19 vaccination program in Duhok. On the contrary, another study<sup>19</sup> from our center found a higher rate of AstraZeneca vaccine administration in the Iraqi population. Overall, in the current study, the administration of the Pfizer vaccine was signifi-

cantly higher among the students ( $p=0.0089$ ) and staff ( $p=0.0205$ ). The discrepancy in the results between reported studies and from the same institution could be explained by acknowledging that the previous study<sup>7</sup> was performed earlier, when people were not aware of the rumors circulating about the AstraZeneca vaccine. In fact, there were fears and misconceptions about rare blood clot complications regarding this vaccine in early 2021<sup>20</sup>.

**Table 4.** Association of receiving the partial and full dose COVID-19 vaccines with general characteristics among staff.

Staff (n=2,538)	Staff no. (%) / Total vaccine coverage (2,263, 89.16%) / Receiving COVID-19 vaccine		p
	No 275, 10.84%	Partial vaccination 321, 12.65%	
<b>Age (yrs)</b>	34.72 (10.16)	36.18 (8.75)	0.0836 <sup>a</sup>
<b>Gender</b>			
Female	150 (50.68)	146 (49.32)	<b>0.0274<sup>b</sup></b>
Male	125 (41.67)	175 (58.33)	
<b>Colleges/centers</b>			
Humanities	158 (56.03)	124 (43.97)	<b>&lt;0.0001<sup>b</sup></b>
Medical Science	57 (44.88)	70 (55.12)	
Science and Engineering	46 (30.67)	104 (69.33)	
UoD Presidency	12 (44.44)	15 (55.56)	
Centers	2 (20.00)	8 (80.00)	
<b>Title</b>			
Employee	152 (44.31)	191 (55.69)	0.2993 <sup>b</sup>
Teacher (without scientific title)	29 (60.42)	19 (39.58)	
Assistant Lecturer	44 (42.72)	59 (57.28)	
Lecturer	37 (50.68)	36 (49.32)	
Assistant Professor	9 (40.91)	13 (59.09)	
Professor	4 (57.14)	3 (42.86)	
<b>Infection by COVID-19</b>			
No	131 (48.52)	139 (51.48)	0.2893 <sup>b</sup>
Yes	144 (44.17)	182 (55.83)	
<b>Staff (n=2,538)</b>	<b>Staff no. (%) / Total vaccine coverage (2,263, 89.16%) / Receiving COVID-19 vaccine</b>		<b>p</b>
	<b>No 275, 10.84%</b>	<b>Full vaccination 1,942, 76.52%</b>	
<b>Age (yrs)</b>	34.72 (10.16)	38.85 (7.74)	<b>&lt;0.0001<sup>a</sup></b>
<b>Gender</b>			
Female	150 (16.09)	782 (83.91)	<b>&lt;0.0001<sup>b</sup></b>
Male	125 (9.73)	1,160 (90.27)	
<b>Colleges/centers</b>			
Humanities	158 (15.91)	835 (84.09)	<b>&lt;0.0001<sup>b</sup></b>
Medical science	57 (12.03)	417 (87.97)	
Science and engineering	46 (7.59)	560 (92.41)	
UoD Presidency	12 (12.37)	85 (87.63)	
Centers	2 (4.26)	45 (95.74)	
<b>Title</b>			
Employee	152 (17.51)	716 (82.49)	<b>&lt;0.0001<sup>b</sup></b>
Teacher (without scientific title)	29 (20.57)	112 (79.43)	
Assistant Lecturer	44 (9.80)	405 (90.20)	
Lecturer	37 (8.31)	408 (91.69)	
Assistant Professor	9 (3.47)	250 (96.53)	
Professor	4 (7.27)	51 (92.73)	
<b>Infection by COVID-19</b>			
No	131 (12.03)	958 (87.97)	0.5989 <sup>b</sup>
Yes	144 (12.77)	984 (87.23)	

<sup>a</sup>ANOVA one-way and <sup>b</sup>Pearson's Chi-squared tests were performed for statistical analyses.

In our study, the minority of participants received booster shots. This may be due in part to the fact that their booster doses coincide with the less severe Omicron variant and also reduced the number of COVID-19

cases, hence they did not pay attention to the recall doses<sup>21</sup>. Furthermore, we found that staff was less likely to receive booster doses and a similar pattern was denoted among students, but the association was not

**Table 5.** Comparisons of infection rate and COVID-19 vaccine prevalence between staff and students.

	Study groups		<i>p</i> (two-tailed)
	Students (n=16,874)	Staff (n=2,538)	
<b>Infection by COVID-19</b>			
No	11,373 (67.40)	1,228 (48.38)	<b>&lt;0.0001</b>
Yes	5,501 (32.60)	1,310 (51.62)	
<b>Receiving COVID-19 vaccine</b>			
No	7,903 (46.84)	275 (10.84)	<b>&lt;0.0001</b>
First dose	2,703 (16.02)	321 (12.65)	
Both doses	6,268 (37.15)	1,942 (76.52)	

Pearson chi-squared test was performed for statistical analyses.

significant. This booster rate among populations may be explained by having preexisting immunity, hence they did not consider booster doses. Furthermore, the booster doses were not mandatory as the first two shots in the vaccination program of KRG.

Considering the association of administrating COVID-19 vaccines with few variables among the students, we found that senior students from medical sciences had a significantly higher prevalence rate of partial and full vaccination. Similar studies from UAE<sup>16</sup>, Saudi Arabia<sup>22</sup>, Jordan<sup>17</sup>, and France<sup>23</sup> showed higher COVID-19 vaccine uptake among health-related jobs. This is related to health behavior and the higher medical knowledge of such people. On the other hand, a study<sup>24</sup> from Italy showed that there is no difference between vaccine uptake between students of health science and non-health sciences.

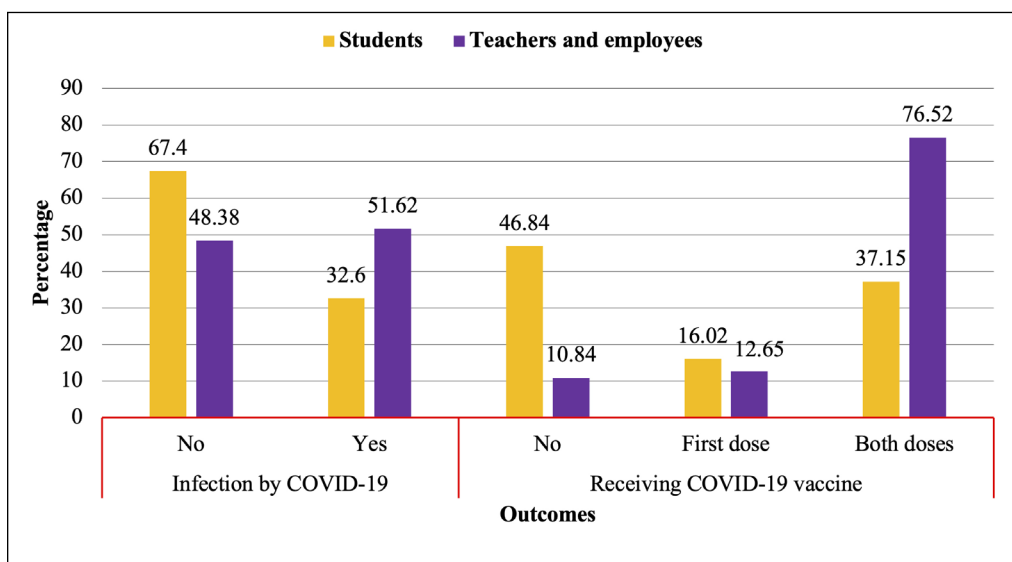
Additionally, we found that older students ( $p < 0.0001$ ) and those who had had previous infections ( $p < 0.0001$ ) were more likely to be fully vaccinated. McElfish et al<sup>25</sup> reported that vaccine hesitancy was more common among younger people, with low-level education, and people who were less fearful of COVID-19<sup>25</sup>. Similar results were reported in this region as well<sup>26</sup>. Other studies<sup>10</sup> showed that previous COVID-19 infection resulted

in a high level of vaccine hesitancy. Generally, people with prior COVID-19 infection have unfavorable experiences with the disease, therefore they look for protective measures against the virus.

Concerning staff and their COVID-19 vaccine administration with the same variable studied among students, we found that males and staff from science and engineering were significantly more likely to be partially and fully vaccinated. However, older age ( $p < 0.0001$ ) and high academic titles ( $p < 0.0001$ ) were associated with full vaccination only. Our finding was in concordance with Dowdle et al<sup>27</sup> who demonstrated that males, people aged > 60 years, and science faculties were significantly more likely to accept vaccine administration<sup>27</sup>. The lower vaccine uptake among females might be assumed due to fear of reduction in fertility<sup>27</sup>.

**Limitations**

The main limitations of this study were: (1) the data on previous COVID-19 infection rates could underestimate the true percentage because of the missed asymptomatic COVID-19 cases. (2) Although this study was performed in the largest university in Duhok



**Figure 1.** Prevalence rate of COVID-19 infection and receiving between students and staff.



governorate, the data may not be completely factual. (3) In addition, we did not record the post-vaccination infections in this study.

## CONCLUSIONS

The relatively high infection rate among students (32.60%) and staff (51.61%) could be a significant risk factor for spreading SARS-CoV-2 in our community. Staff and students who were involved in practical sessions and those from medical science faculties should follow strict preventive measures. The vaccination coverage among the staff (89.16%) is in line with the WHO target of 70% of the general population. Nevertheless, the vaccination coverage among students is under target vaccination coverage (53.16%). It is recommended to increase the vaccination rate among students by addressing its importance against COVID-19. The most commonly administered vaccine was Pfizer and senior students from medical sciences had a significantly higher prevalence rate of partial and full vaccination.

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The authors declare they have no conflict of interest.

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### INFORMED CONSENT:

The students and the staff gave us written consent to participate in the study.

### AUTHORS' CONTRIBUTIONS:

Muayad Aghali Merza: design, review, analysis, and approval.

Deldar Morad Abdulah: design, review, statistical calculations, writing manuscript, approval.

Diyar Hashim Malo: data collection, coordination, and approval.

Dilshad AbdulJabbar Haleem: data collection, coordination, and approval.

Dawood Sulaiman Atrushi: coordination, administration, and approval.

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