

ORIGINAL ARTICLE

FACTORS ASSOCIATED WITH VACCINE ACCEPTANCE AND RECOMMENDATION AMONG DENTAL STUDENTS AND FACULTY PREVIOUSLY INFECTED WITH COVID-19; A STUDY FROM SAUDI ARABIA

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ABSTRACT

This study aims to explore vaccine acceptance and recommendation behaviors among clinical dental students and their faculty who were previously infected with SARS-CoV-2. The study was conducted among previously infected dental healthcare personnel (DHCP) in an academic setting to evaluate their willingness to accept vaccines and recommend them to family and patients. Logistic regression was conducted to determine significant variables associated with vaccine attitudes. Among 316 personnel 62 indicated previous infection (19.6%). Personnel who were willing to take the vaccine, or recommend it to patients, or to family were: 67.7%, 87.1%, and 85.5% respectively. Vaccine acceptance was significantly associated with vaccine awareness and number of long-term COVID-19 complications (P=.003, .033 respectively). Vaccine recommendation to family, and patients was significantly associated with vaccine awareness only (P=.005, .006 respectively). It is concluded that some previously infected academic dental personnel are unwilling to accept COVID-19 vaccines or recommend them to others. This was mainly due to lack of vaccine awareness. Efforts directed at increasing COVID-19 vaccine awareness are warranted by dental schools in collaboration with Ministry of Health authorities. It is also necessary to closely monitor, and provide support to personnel affected by long COVID.

Keywords: COVID-19; Dental staff; Vaccine Hesitancy; Awareness

INTRODUCTION

It has been more than two years since the emergence of corona virus disease-19 (COVID-19) in December 2019. The disease was initially considered a viral respiratory infection manifested as pneumonia and associated with systemic manifestations similar to those of influenza including fever, cough, malaise, dyspnea, arthralgia, and myalgia¹. Several extra-pulmonary manifestations and long-term complications were also reported either due to the causative SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2) itself or due to the wide array of its therapeutic modalities². Despite the highly contagious nature and rapid global spread, resulting in large numbers of cases, mortalities and severe long-term complications³, many countries are currently showing signs of recovery from the pandemic associated with the introduction of various vaccines⁴.

Healthcare personnel (HCP) have always been considered a priority group for vaccination, and they were among the first to receive COVID-19 vaccines once distribution started⁵. They were also

considered a trustworthy source whenever vaccine-related information was required by the public⁶. As the number of healthcare personnel infected with SARS-CoV-2 increases, their views and attitudes towards COVID-19 vaccines become crucial, particularly that there is mounting evidence of potential reinfection in association with the waning immunity following recovery⁷. Reinfection with SARS-CoV-2 was reported among healthcare workers even among those not working in the frontline⁸. It was further reported that healthcare workers including dental healthcare personnel (DHCP) are one of the susceptible categories to the symptomatic form of SARS-CoV-2 infection and reinfection⁹. Whereas an estimated proportion of 20% of DHCP were reported to have COVID-19 in Saudi Arabia¹⁰, only 2.6% of dentists in the USA were reported to be positive for COVID-19¹¹. A growing number of studies have provided evidence for vaccinating the previously infected persons.

Previously infected who were not vaccinated were more than twice as likely to be reinfected compared to those who had a full vaccination protocol, indicating the effectiveness of full vaccination

protocols in providing additional protection against reinfection⁷. Furthermore, new virus strains are now appearing, and vaccines with lower efficacy rates are being distributed, which could indicate that higher vaccination rates will be needed to achieve herd immunity¹².

Within the context of healthcare students, studies evaluating their vaccine attitudes reported that medical, nursing, and pharmacy students had an acceptance rate of 76%¹³. A similar rate of positive vaccine attitudes (63% -76.9%) were reported among frontline HCP such as nurses and physicians^{14,15}. As part of the healthcare team, dental students and their faculty play an important role in shaping public healthcare behaviors including vaccine attitudes¹⁶. They are able to influence their patients' attitudes particularly that an estimated 50% of patients get in contact with their dentists at least once a year¹⁷, to receive a wide range of preventive and therapeutic interventions. It has also been argued that immunization training should be included in dental education¹⁸ and that dentists should assume the role of administering and advocating vaccines¹⁹.

There is scarce literature on the attitudes of DHCP including students and their faculty towards COVID-19 vaccines. Furthermore, there are no studies conducted on vaccine acceptance of HCP previously infected with SARS-CoV-2.

Therefore, we conducted this study among clinical dental students and their faculty who were previously infected with COVID-19 to assess their willingness to take COVID-19 vaccines, and to determine whether they will fulfil their duty in recommending vaccination to their families and patients.

METHODS

The study was a cross-sectional observational study conducted among dental faculty and students at Taibah University Dental Hospital located in Al Madinah, western Saudi Arabia. The study was conducted during March-August 2021. Inclusion criteria were clinical dental students (4th, 5th, 6th years, and interns) and faculty currently working at the hospital. Staff who were abroad during the period of the study, and pre-clinical students were not invited and hence were excluded from the study.

Sample size determination was carried out using the epidemiological software: Epi Info™ (CDC, Centers for Disease Control, Atlanta, USA) based on a population number of 344 constituting clinical students and faculty practicing in the hospital at the time of the study. The expected frequency of accepting or recommending vaccination (outcome probability) was assumed to be 70% based on COVID-

19 vaccine acceptance rate among comparable populations that ranged between 63% -76.9% in previous studies¹³⁻¹⁵. Population size was the total number of previously infected personnel in the dental hospital at the time of data collection (n=66). A sample size of 62 participants was determined to provide 97% confidence level at 3% margin of error. The list of all previously infected students and faculty names and their contact details was obtained from the college administration office. All personnel working at the hospital (n=344) including previously infected faculty and students were invited to participate in this study. Non-infected personnel were invited to participate for the calculation of prevalence of infection within the dental hospital. Infected personnel constituted the main study sample as it was the aim of this study to explore attitudes towards vaccination among previously infected personnel.

Data were collected using an anonymous, online questionnaire created using Google Forms™. The questionnaire was composed of 19 closed-ended questions divided into three sections of demographics, COVID-19 clinical disease attributes and outcomes, and finally a section on attitudes towards vaccination (i.e., participants were asked about their acceptance and recommendation of vaccines for themselves, their families and patients). A pilot test was performed to ensure clarity of questions and reproducibility of responses. A group of five students and five faculty were invited to complete the questionnaire on two occasions separated by one week to compare responses. Face validity was carried out within the authors group who did not share in designing the questionnaire. Unclear or vague questions were modified. The calculated Cronbach alpha and Kappa values were considered acceptable (0.72 and 0.77 respectively). Subjects were contacted during working hours and invited to participate. Consenting participants completed the questionnaire in presence of co-investigators without interfering or influencing their responses.

Ethical approval was obtained from Taibah University College of Dentistry Ethics Committee, reference # TUCDREC/17012021/NDar-Odeh.

The Statistical Package for Social Sciences (SPSS) version 21 was used, to calculate descriptives in the form of frequency, percentages, and prevalence. Binary logistic regression analysis was carried out to investigate variables associated with the three vaccine attitudes of infected DHCP including vaccine acceptance and recommending vaccine to family or patients. For the three logistic models, various independent variables were investigated in a pilot study (age groups (<40 years, ≥40 years), Sex, professional role (1=student, 2=faculty),

quarantine practice (as all participants were infected with COVID-19), number of acute COVID-19 symptoms, duration of acute illness (in days), number of long-term complications, and vaccine awareness (0=No, 1= Yes)). As the sample size was judged to be small, only the most important 4 variables were included as dictated by the pilot study to limit the number of variables according to number of events / outcomes available in the study dataset ²⁰. There were no missing values in the questionnaire (all items were marked as mandatory for the progress into the questionnaire).

RESULTS

Out of 344 clinical students and their faculty, a total of 316 participated (response rate=91.9%). A number of 62 participants stated that they had COVID-19. According to the records of the dental hospital, the total infected personnel were 66. This resulted in a response rate of 93.9% among the infected personnel group, and a COVID-19

prevalence of 19.6% among the study sample of 316 participants

Demographics and Clinical disease characteristics

Demographic variables of sex, age, and professional role are presented in figure 1. The sample had a mean age of: 28.88±8 years (range= 20-55 years). None of the demographic variables was significantly associated with infection status (P>0.050). A total of 53 (85.5%) infected personnel reported symptomatic infection with fever, cough, malaise and diarrhea being the most commonly cited symptoms. Average duration of signs and symptoms was 5.2±4.2 days and ranged from 2-25 days. Only 7 (11.3%) of the infected sample did not practice quarantine. Long term complications were reported by 24 infected personnel, and these were mostly respiratory and cardiovascular complications.

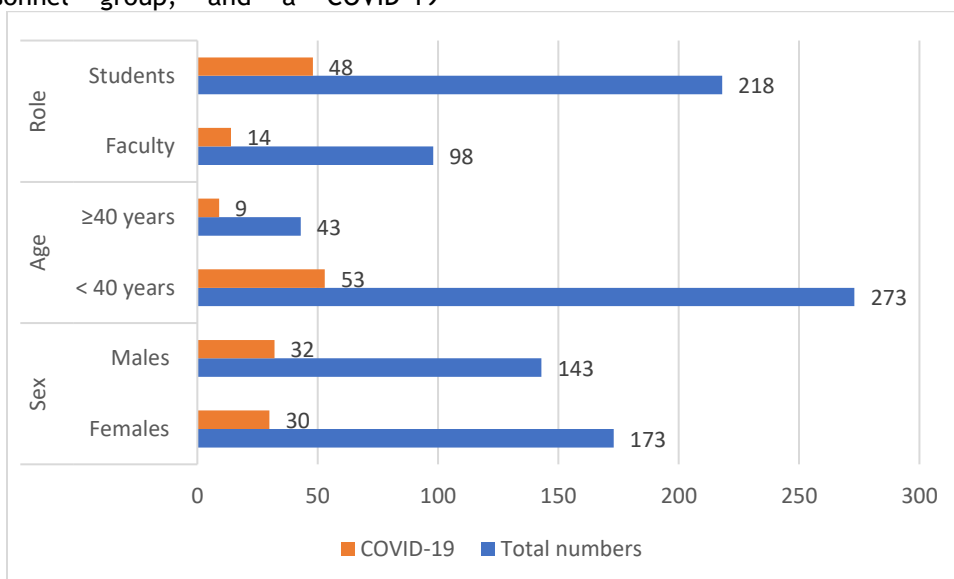


Figure 1: Number of individuals infected with COVID-19 among demographic groups of sex, age and professional role

Regression analysis results

Regression models are presented in tables 1-5. Table-1 presents a comparison of an intercept (constant) models only for the three attitudes towards vaccine with models that include selected variables. Intercept only model is known as a no model, in which the models are predicting acceptance of the vaccine and recommending it to patients and family. The three models without variables are assuming that responses regarding attitude for all subjects are positive attitudes towards vaccines, that is: all subjects were assumed

to accept vaccine for themselves and for others. This assumption yielded an accuracy of prediction equal to 67.7%, 87.1% and 85.5% for the three models respectively. These values are the values prior to introduction of independent variables. However, after the introduction of these variables, these values increased to 79.0%, 91.9% and 90.3% respectively (Table 1), which indicates that accuracy of the model was enhanced when various variables were introduced into the binary logistic model.

Table 1: Comparison of an intercept only model or “a YES only model” and the logistic regression models after the introduction of various variables.

Observed	Predicted attitude						
	Without variables			With variables ^a			
	No	Yes	% Correct	No	Yes	% Correct	
Attitude for vaccination							
Vaccine acceptance	No	0	20	.0%	12	8	60%
	Yes	0	42	100.0%	4	38	90.5%
Overall Percentage				67.7%			80.6%
Recommend vaccine. to patients	No	0	8	.0%	0	8	0%
	Yes	0	54	100.0%	0	54	100.0%
Overall Percentage				87.1%			87.1%
Recommend vaccine to family	No	0	9	.0%	0	9	0%
	Yes	0	53	100.0%	1	52	98.1%
Overall Percentage				85.5%			83.9%

^a Variables were: Age groups, Sex, Professional role, Quarantine practice, Number of acute symptoms, Duration of acute illness, Number of long- term complications, Vaccine Awareness, Constant

B (Beta weights, or values) of the intercepts (or the constants) of the three logistic regression models and odds ratio of actual DHCP accepting vaccines in the three categories are shown in table 2. Nagelkerke R² shows the percentage of variance of the dependent variable that can be accounted for by independent variables in the regression model. In the first logistic regression model (exploring vaccine acceptance), this value is 47.6%, i.e., the model is capable of explaining 47.6% of the variance of the “yes”, with no responses regarding attitude towards vaccine acceptance. This is considered a low value as an acceptable value would probably be

above 60% or 70%. In table 2, values of Hosmer and Lemeshow test are non-significant (>0.05) for vaccine acceptance and recommending vaccine to family, indicating non-significant differences between expected and observed values of the segregated categories in Hosmer and Lemeshow contingency table. This means that the accuracy in these models is better than recommending vaccine to patients. Table 2 also shows that the models were significant at P=0.006, less than 0.001 and less than 0.001 for vaccine acceptance, recommending vaccine to patients and recommending it to family respectively

Table 2: Fit statistics for regression model.

Logistic regression model	Constant B	S.E.	Sig.	Exp B	Nagelkerke R2	Hosmer and Lemeshow Sig
Vaccine acceptance	0.742	.272	0.006	2.100	0.450	0.098
Recommending vaccine to patients	1.910	.379	0.000	6.750	0.426	0.000
Recommending vaccine to family	1.773	.361	0.000	5.889	0.314	0.246

^aVariables were: Age groups, Sex, Professional role, Quarantine practice, Number of acute symptoms, Duration of acute illness, Number of long- term complications, Vaccine Awareness, Constant

Tables 3-5 show significant variables in the equations for logistic regression models of the three attitudes towards vaccination.

First regression model (exploring vaccine acceptance among DHCP) shows that number of long-term complications and vaccine awareness (P= 0.033 and 0.003 respectively) were significant predictor variables (table-3).

Table 3: Variables in the equation for vaccine acceptance.

	B	S.E.	Wald	df	Sig.	Exp(B)
Number of long- term complications	1.833	.860	4.538	1	.033*	6.250
Vaccine Awareness	2.202	.747	8.699	1	.003*	9.044
Professional role	-.951	1.080	.776	1	.378	.386
Age groups	2.326	1.407	2.733	1	.098	10.233
Constant	-2.717	1.447	3.525	1	.060	.066

**Significant variables.*

Second model (table 4) explains that recommendation of vaccine to patients is also significantly associated with vaccine awareness (P=0.006).

Third model (table 5) explains that vaccine recommendation to family is also significantly associated with vaccine awareness (P=0.005).

Table 4: Variables in the equation for attitude to recommending vaccine to patients.

	B	S.E.	Wald	df	Sig.	Exp(B)
Number of long- term complications	-.157	.984	.025	1	.873	.855
Vaccine Awareness	3.525	1.278	7.613	1	.006*	33.953
Professional role	19.284	15804	.000	1	.999	2.38X10 ⁸
Age groups	-18.245	15804	.000	1	.999	.000
Constant	-.875	1.568	.312	1	.577	.417

**Significant variables.*

Table 5: Variables in the equation for attitude to recommending vaccine to family.

	B	S.E.	Wald	df	Sig.	Exp(B)
Number of long- term complications	.122	.897	.019	1	.891	1.130
Vaccine Awareness	2.712	.975	7.734	1	.005*	15.059
Professional role	-.769	1.460	.277	1	.598	.463
Age groups	1.669	1.821	.840	1	.359	5.308
Constant	-.602	1.537	.153	1	.695	.548

No significant variables at the set 0.01 significance level.

DISCUSSION

An effective strategy used when designing campaigns aiming at modifying professional behavior attitudes is to identify which groups that should be targeted in such activities. Healthcare professionals are among the most influential authorities as far as public attitudes and behaviors are concerned. Previous research investigating vaccine attitudes among healthcare workers has shown that several factors could modulate their vaccine attitudes including knowledge about vaccine efficacy and safety profile, which has

helped to build their own confidence in vaccines, and their willingness to recommend vaccines to others²¹. However, as with the situation of COVID-19 infection itself, evidence-based data on its vaccines are still being collected and continuous follow up is needed to form a complete picture about these vaccines. In dealing with an aggressive pandemic like COVID-19, it is important to engage all healthcare personnel taking into consideration the increased workload and limited resources faced by the healthcare systems in its fight against the pandemic which are expected to restrict capacity of frontline HCP, to advise the public and influence

vaccine decisions. Dental practitioners, particularly those working in academic settings certainly have a golden opportunity to advise, influence and address patients' questions and concerns

This study was conducted amongst a characteristic group of DHCP previously infected with SARS-CoV-2 and working within an academic setting to explore important factors that could be associated with vaccine attitudes including vaccine acceptance and recommendation to family and patients. The evidence that supports vaccination for persons previously infected with SARS-CoV-2 is overwhelming. It is believed that vaccination reduces the potential for reinfection because of vaccine-associated induction of higher levels of neutralizing antibodies²². Serological tests conducted among previously infected persons prior to vaccination provided a relatively weaker, and in some cases absent, neutralization response to the Beta variant of SARS-CoV-2 when compared with the original Wuhan-Hu-1 strain²³. When the same persons were vaccinated, serological testing revealed a higher neutralization response to the Beta variant, suggesting that vaccination enhances the immune response even to a variant to which the infected person had not been previously exposed to²³.

Most of the infected personnel in this study indicated vaccine acceptance, however, a higher proportion (86%) of non-dental students in other geographic areas like Italy was reported²⁴. This may be explained by lack of knowledge regarding the importance of vaccination for the previously infected. It could also be explained by the great adverse impact of the pandemic encountered in Italy which was among the countries hit hard by successive severe waves of the pandemic with great impact on the population and the healthcare system. This highlights the importance of appreciating the severe disease outcomes in determining vaccine acceptance²⁵. Locally, in Saudi Arabia where this study was conducted, there was a great impact of the pandemic in terms of total number of cases but not fatalities¹⁰. Before implementing COVID-19 vaccines in Saudi Arabia in December 2020, approximately 35% of healthcare personnel there stated that they would not accept vaccines mainly due to fear the vaccine side effects⁶. This study was conducted over a span of six months from March to August 2021, during which many reports on vaccine efficacy and safety started to emerge and to reassure the population particularly healthcare workers⁴.

In other parts of the world like the USA various university student populations showed variable rates of vaccine acceptance. Only 23% of medical students²⁶, and 50% of non-medical students including dental students^{27,28} were unwilling to take

the vaccine. This emphasizes the possible role that political polarization can play in determining populations' attitudes towards healthcare behaviors and demonstrates that appropriate healthcare policies can be opposed by political agendas that may create confusion and undermine public trust²⁹. Locally in Saudi Arabia it was shown that both the population of healthcare workers⁵, and the general population⁶ have a great trust in the national healthcare system which should create useful opportunities for supporting successful vaccine awareness campaigns⁶.

Indeed, vaccine awareness was the only consistent a significant variable associated with vaccine acceptance and its recommendation to patients and family in this study. Increased awareness on advantages of vaccination is a recommended strategy to counter vaccine hesitancy,³⁰ while lack of awareness is considered a main barrier that compromises providers' communication about vaccines³¹. Furthermore, availability of time and building a doctor-patient relationship based on trust are essential factors for successful efforts in recommending vaccines to patients³². Establishment of COVID-19 information channels to answer queries and address suspicions of the public has contributed to increasing awareness and promoting confidence in COVID-19 vaccination campaigns³³.

Number of long-term complications, or long COVID, was significantly associated only with vaccine acceptance, but not with vaccine recommendation. While vaccine recommendation to others can be considered a moral professional responsibility, vaccine acceptance can be described as a personal choice greatly influenced by individual life experiences. Long COVID could present as one of the most severe outcomes of COVID-19 causing debilitating effects on various organs of the body, therefore it is still being investigated for etiology and management³⁴. On the other hand, scientists are currently investigating the possible association between vaccination and improvement of Long COVID-symptoms. Long COVID symptoms have reportedly improved in an estimated 30-40% of those who get the vaccine compared to only 10-15% who got worse after vaccination³⁵. Although this observation is still under investigation, scientists think that vaccines either reset the immune system, or enhance the immune response against the virus, or terminate the persistent harmful immune response³⁵. It may seem necessary, therefore, to closely monitor individuals with Long COVID and consider them a priority in vaccination campaigns.

Our study has limitations. The study initially included eight independent variables including socio-professional characteristics, disease attributes and vaccine awareness. However, sample

size was judged to be small, and the total number of events necessitated the inclusion of only four variables. Therefore, only the most important four variables, as shown by the pilot study, were included. Also, this study was a single-center study, however, the participating dental hospital was a teaching hospital dedicated to providing free dental services to a high flow of dental patients. This, together with a high response rate, is expected to provide relatively accurate data. Another limitation is represented by the unintended exclusion of participants older than 55 years since the age range of participants covered only young and middle-aged adults. This may result in a non-representative sample. It would be more informative in future studies to include older participants to investigate a possible effect of older age on the variables of this study. On the other hand, the study participants were students and staff, therefore it allowed to compare their responses in addition to comparing sex and age groups. To our knowledge, this is the first study to investigate COVID-19 vaccine attitudes among a unique sample of dental students and their faculty previously infected by SARS-CoV-2. Future studies should aim to investigate defects in vaccine awareness that need improvement, and reasons for hesitation to promote vaccines among family and patients. Further, it is recommended to explore political factors that may challenge adoption of clear, reliable and transparent vaccination policies.

CONCLUSIONS

Education about COVID-19 vaccines and awareness among dental personnel is a crucial factor in determining vaccine acceptance and recommending it to patients. Vaccine awareness campaigns can improve attitudes of dental personnel in academic settings.

Members of the dental team can be trained to actively engage in public awareness and recommendation of COVID-19 vaccination, this in turn will increase their awareness and interest in these vaccines.

Ethics approval and consent to participate: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by Taibah University College of Dentistry Ethics Committee, reference # TUCDREC/17012021/NDar-Odeh. Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

All data underlying the results are available at <https://datadryad.org/stash/share/bNulosDKA5ZMR-2TjssLdmiKnXLSaBLDN5eJqDUjBc>

Competing interests

The authors declare that they have no competing interests

Author Contributions: Conceptualization, Osama Abu-Hammad and Najla Dar-Odeh; Data curation, Rahaf Saeed Aljohani, Rahaf Ayeq, Layan Ghazi and Heba Al-subhi; Methodology, Osama Abu-Hammad, and Najla Dar-Odeh; Formal analysis, Osama Abu-Hammad; Resources, Safa Jambi, Nebras Althagafi, and Malak Abu-Hammad; Writing - original draft, Rawah Eshky and Abdalla Abu-Hammad; Writing - review & editing, Osama Abu-Hammad, Shaden Abu-Hammad, and Najla Dar-Odeh.

ACKNOWLEDGMENTS

First author would like to acknowledge that this study was carried out during his sabbatical leave from The University of Jordan.

Abbreviations

CDC: Centers for Disease Control

COVID-19: corona virus disease-19

DHCP: Dental Healthcare Personnel

HCP: Healthcare personnel

SARS-CoV-2: severe acute respiratory syndrome coronavirus-2

SPSS: The Statistical Package for Social Sciences

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