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Investigation of factors affecting COVID-19 vaccine acceptance among communities of universities in the United Arab Emirates

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ABSTRACT

The COVID-19 pandemic affected the lives of people living across the world and the development of vaccines against SARS-CoV-2 is considered to be one of the most promising solutions to contain the COVID-19 pandemic. In several countries, we are witnessing hesitancy toward COVID-19 vaccines, which is a complex phenomenon influenced by a variety of factors. A cross-sectional study was performed to comprehensively investigate the impact of factors like demography, COVID-19 pandemic-induced behavior, and vaccine attitude on COVID-19 vaccine acceptance (VA) among communities of five different universities in the United Arab Emirates (UAE). To investigate the effect of demography and COVID-19 pandemic-induced behavioral factors, Analysis of Variance was perfomed. The effect of COVID-19 vaccine attitudes on COVID-19 VA was examined through partial least squares-structural equations modeling. The results of the study showed no difference among the population in accepting COVID-19 vaccines due to their demographic factors. The effect of pandemic-induced behavioral factors on COVID-19 VA suggested that the people of UAE accepted COVID-19 vaccines irrespective of the movement and travel restrictions imposed due to the pandemic. The results on the effect of vaccine attitudes on COVID-19 VA showed that vaccine benefit attitudes, safety concerns, and trust in health-care professionals (TrHP) were found to be significant factors in VA. Furthermore, TrHP was found to reduce the negative effect of safety concerns related to COVID-19 VA. The findings broadly highlight that COVID-19 VA in the UAE was not hampered by demographic factors and the pandemic-induced behavioral constraints. The study also showed that people with co-morbidities had lower level of COVID-19 VA than people with no co-morbidities. To improve COVID-19 VA, the perceived benefits with COVID-19 vaccine and TrHP must be enhanced and simultaneously safety concerns of the vaccines need to be addressed.

Introduction

The COVID 19 pandemic has affected the lives of people across the world. It has necessitated countries to impose movement and travel restrictions, which resulted in economic and social isolation of economies.[1] The SARS-CoV-2 disease 2019 (COVID-19) pandemic was reported to have started during the end of 2019 and since the year 2021, many COVID-19 vaccines have been made available globally. These vaccines varied in terms of their mechanism of action to protect against the SARS-CoV-2 by reducing the severity of its signs and symptoms in the vaccinated individuals.[2,3] The virus has fewer opportunities to mutate if its spread is restricted.[4] Globally, millions of people are still hesitating to take the COVID-19 vaccine.[5–7] Around the globe, medical care systems are trying to establish public conviction on validity and safety of the COVID-19 vaccines, but regrettably the hesitancy of getting the vaccine still persists.[8] The rate of vaccination against COVID-19 is still very low across several countries, as only 57.8% of global population was fully vaccinated until March 2022.[9] Low vaccination rates result in increase in the emergence of new variants of COVID-19 virus.[10] The new variant of SARS-CoV-2, Omicron was identified in Africa wherein only 11% of population was fully vaccinated until

February 2022.[11,12] It is the responsibility of all countries across the world to vaccinate their residents and control the emergence of new variants and their spread. This also necessitates the policymakers to learn from countries that are successful in COVID-19 vaccination programs to enhance their own vaccination programs.

The UAE is the second country in the world after British Overseas Territory of Gibraltor to achieve the milestone of highest rate of COVID-19 vaccination in the world.[9] Until March 2022, around 96.97% of the eligible UAE population was doubly vaccinated and 100% of the eligible UAE population had received a single dose.[13] This milestone is considered to be highly significant due to the fact that the population size of Gibraltor is very small (around 33,000) in comparison to UAE, which has a population of more than 9.8 million.[9] Even though, the COVID-19 vaccination program has been successful in the UAE, there are limited number of research studies that have investigated the factors contributing to such a massive acceptance of COVID-19 vaccine. Albahri et al. studied COVID-19 vaccine acceptance among general adult population in the UAE.[14] Elbarazi et al. conducted a qualitative study for exploring COVID-19 vaccine hesitancy among health-care providers in the UAE.[15] Alsuwaidi et al. investigated the determinants of vaccine hesitancy among Arab

parents in the UAE.[16] Ahamed et al. conducted a study to understand the perception of Sinopharm vaccine in the UAE.[17] The purpose of our study is to investigate the demographic, behavioral, and attitudinal factors affecting COVID-19 VA among communities of different universities in the UAE. There has been no other study conducted that has comprehensively investigated the effects of all these factors that influence the COVID-19 VA among communities of different universities in the UAE. COVID-19 VA has been examined in different contexts and several studies have investigated the effects of demographic variables, such as gender, age, education, occupation, and nationality.[18–21] The pandemic-induced behavioral constraints, such as movement and travel restrictions for the individuals who are not vaccinated are considered to be important factor toward the implemenation of COVID-19 vaccination programs.[22–24] Previous studies in COVID-19 VA have examined the effects of attitudinal variables, such as benefit attitudes,[25–27] safety concerns[25,27,28] and trust in health-care professionals.[6,28]

Methods

A cross-sectional survey among students, staff, and parents who are 18 years and above from five different educational institutions in the UAE was conducted using online survey questionnaire. The online survey was conducted during the period from January 2021 till mid June 2021. The university communities included in the study were students, staff, and parents. The parents were also considered as part of the university community in this study as they follow the progress of their wards' education and the universities are required to coordinate with parents for overall development of the students.[29]

The questionnaire measured four aspects; (a) COVID–19 pandemic-induced behavioral factors that would influence VA; (b) attitudes toward COVID-19 vaccine; (c) COVID-19 VA; (d) demographic factors that influence acceptance of COVID-19 vaccine. The attitudinal factors, such as SaCn, BeAtt and TrHP and VA are measured using the measures used in the previous vaccination studies. The measures include 7-point (1 – strongly disagree and 7 – strongly agree) multi-item Likert scale statements to measure each of the above-mentioned attitudinal constructs. The vaccine hesitancy/acceptance was measured by the scale used by Shapiro et al.[30] TrHP construct was measured by the scale used by Karlsson et al.[31] The SaCn and BeAtt were measured by the scale used by Cataldi et al.[32] This questionnaire has been reviewed and approved according to Zayed University procedures of research involving human-related subjects. It was also approved by the Ministry of Health and Prevention Research Ethics Committee Reference No: MOHAP/DXB-REC/JFF/No.06/2021.

The findings of our study would serve as a guide to researchers and policymakers across the world to devise their COVID-19 vaccination programs effectively. The demographic factors explored are gender, age, education level, nationality, and marital status. The effect of COVID-19 pandemic-induced

behavioral factors on VA, such as movement restriction between cities, restrictions on international travel, work from home for employees and online classes for students was investigated. In addition, role of other behavioral factors, such as prior vaccination and co-morbidity health status, were explored. The role of attitudinal factors, such as benefit attitudes toward COVID-19 vaccine (BeAtt), safety concerns toward COVID-19 vaccine (SaCn) and trust in health-care professional (TrHP) in VA were investigated. Furthermore, the study examined the moderation effect of TrHP in the association of BeAtt and SaCn on VA.

The questionnaire was prepared both in English and Arabic language. The questionnaire was first prepared in English, which was translated into Arabic language by an expert. The Arabic language questionnaire was then independently back translated to English by another expert. The inconsistencies in the Arabic language questionnaire were removed through consultations. The questionnaire was created in Microsoft Forms that has the provision of both English and Arabic versions and the respondent could choose to respond in any of the versions of the questionnaire. The link of questionnaire was e-mailed to the students, staff, and parents. The respondents self-administered the questionnaire and answered the questions. We used purposive and convenience sampling method to select the respondents. For the respondents in the category of parents, the questionnaire link was sent to the students and these students were requested to help their parents to fill the questionnaire. Inclusion criteria used in the study was that the respondents were required to be part of any of the above mentioned groups. The respondents whose age was less than 18 years and the respondents who did not agree to be part of the study were excluded from the study. Assuming a vaccine acceptance of 50% in February 2021 with a margin of error of 3% (95% confidence interval 47%–53%), the minimum sample size calculated for the study was 1067 using the formula[33] below mentioned:

$$N = \frac{P(100\% - P)}{(SE)^2}$$

N-Sample size; *P*-Estimated percentage; *SE*-Standard Error

Statistical analysis

We used two statistical technques to analyze the collected data. To analyze the effect of demographic and pandemic-induced behavioral factors on VA, we used analysis of variance (ANOVA) through IBM SPSS. The ANOVA is used to test the difference in the means of two or more groups of a sample. The ANOVA is a useful technique to investigate the relationship between categorical independent variables and a dependent variable that is measured on an interval scale. The equation[34] for ANOVA is mentioned below:

$$SS_y = SS_x + SS_e$$

SS_y denotes total variation in dependent variable, Y.
SS_x denotes the variation in Y related to the variation in the means of groups of independent variable, X.
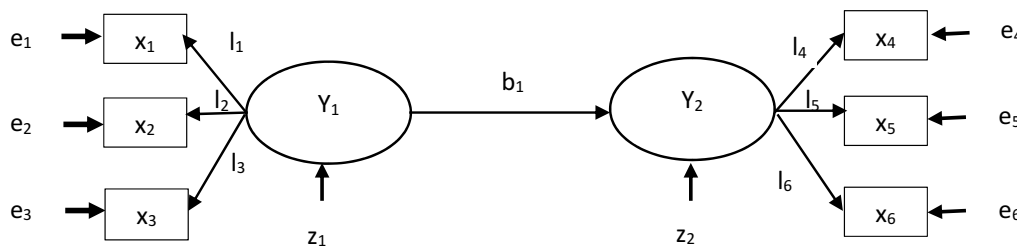
Figure 1. Partial least squares path modeling with latent variables.

SS_e denotes the variation within each group of X but not accounted for by independent variable, X.

To examine the effect of attitudinal constructs, such as BeAtt, SaCn, and TrHP on VA, partial least squares structural equations modeling (PLS-SEM) through SmartPLS 3.0 was used. The attitudinal and vaccine acceptance constructs are measured using multi-item scales and these constructs are considered to be latent variables. PLS-SEM is an appropriate tool to assess the measurement properties of these latent variables and the structural relationship between these variables.[35] PLS-SEM draws both measurement and structural models. By using weighted sum of all items, the measurement model estimates each construct used in the study.[36] The results of measurement model produces statistics to evaluate the measurement properties of the measured latent variables. The structural model shows the relationship between dependent and independent variables through multiple linear regressions.[36] The model for PLS-SEM[36] is presented in Figure 1 with two latent variables as an example and their indicators.

Y_1 and Y_2 are latent variables that are measured by their respective indicators (items) denoted as $x_1, x_2 \ldots x_6$. Y_2 is a dependent latent variable and Y_1 is indepdent latent variable and has an error term z_1 and z_2 respectively. The strength of the relationship between Y_1 and Y_2 is represented by a path coefficient, b_1. The strength of the relationship between $x_1, x_2, x_3 \ldots x_6$ is represented by factor loading $l_1, l_2, l_3 \ldots l_6$ respectively. $e_1, e_2, e_3 \ldots e_6$ represents random measurement error.

Results

Sample characteristics and analysis of the effect of demographic factors

The study reported responses from 2021 respondents, out of which 77 respondents declined to participate in the study. Two hundred and ninety-one respondents were under the age of 18 years and were not allowed to participate in the study. As a result, the sample size was 1,653 with a response rate of 81.79%.

The collected data was first analyzed to understand the sample characteristics, which are presented in Table 1. The majority (81.67%) of the respondents filled in the English version of the questionnaire. Most of the respondents (64.85%) were students and the majority (80.04%) of the respondents were female. Most (68.12%) of the respondents were in the age category of 18–25 years. In regard to the education status of the respondents, high-school education and undergraduate education were the major categories with

Table 1. Sample characteristics and effect of demographic factors.

Demographic factors (Independent variables)	Dependent variable: Vaccine Acceptance				
	No. of respondents	Percentage	Mean	F-Value	p-Value
Language of the respondents					
English	1350	81.67			
Arabic	303	18.33			
Category of university communities					
Student	1072	64.85	53.26	1.63	0.20
Staff	78	4.72	55.81		
Parent	503	30.43	53.87		
Gender					
Male	330	19.96	54.11	0.74	0.39
Female	1323	80.04	53.43		
Age					
18 to 25 Years	1126	68.12	53.37	0.71	0.59
26 to 35 Years	242	14.64	53.29		
36 to 45 Years	172	10.41	55.03		
46 to 55 Years	79	4.78	54.20		
56 Years or More	34	2.06	53.03		
Education					
None	40	2.42	48.70	2.226	0.06
High school	659	39.87	54.24		
Diploma	196	11.86	54.05		
Undergraduate	599	36.24	53.02		
Postgraduate	159	9.62	53.43		
Nationality					
UAE	1378	83.36	53.74	0.961	0.41
Other GCC	61	3.69	52.79		
Arab	93	5.63	51.49		
Others	121	7.32	53.52		

39.87% and 36.24%, respectively. The majority (83.36%) of the respondents were UAE nationals and most of the respondents (68.20%) showed marital status as "single".

The effect of demographic and COVID-19 pandemic-induced behavioral factors on COVID-19 VA was investigated by the Analysis of Variance (ANOVA) using IBM SPSS. The VA score of the respondents was computed with the summation of all the reliable and valid items and the summated VA score was used as dependent variable. Table 1 also shows the results of ANOVA regarding the effect of different demographic factors that would influence VA. The results establish that the demographic factors, such as the category of university community (F-value = 1.20; p-value = .31), gender (F-value = .74; p-value = .39), age (F-value = .71; p-value = .59), and nationality (F-value = .96; p-value = .41) play no role in VA in the UAE. However, education level was found to have an effect on the VA (education level (F-value = 2.226; p-value = .06)).

Effect of COVID-19 pandemic-induced behavioral factors

The results of the analysis of the effects of COVID-19 pandemic-induced behavioral factors on COVID-19 VA is shown in Table 2. Behavioral factors such as mode of classes for the students (F-value = .78; p-value = .51), mode of work for the employed (F-value = .76; p-value = .47), and vaccination before international travel (F-value = 1.66; p-value = .16) were found to not affect COVID-19 VA in the UAE. However, the behavioral factors, such as planned international travel for the next one year (F-value = 11.30; p-value = .00) and travel in and out of Abu Dhabi emirate (state) (F-value = 4.95; p-value = .00) were found to have a significant effect on VA in the UAE. Interestingly, the means of VA of the respondents who did not have international travel plans and the respondents who did not move in and out of Abu Dhabi emirate were higher than the means of VA of the respondents who had plans for international travel and who moved in and out of Abu Dhabi emirate. The presence of co-morbid diseases (F-value = 10.65; p-value = .00) was found to significantly affect VA. Surprisingly, means of VA of people who did not have co-morbid diseases were significantly higher than the people who had co-morbid diseases. Previous flu vaccination frequency (F-value = 13.70; p-value = .00) was found to have a significant effect on VA in the UAE. Furthermore, COVID-19 vaccination was found to significantly affect (F-value = 258.90; p-value = .00) VA and the mean of VA of vaccinated respondents was significantly higher than the non-vaccinated respondents.

Effect of COVID-19 vaccine benefit attitudes

To test the effects of COVID-19 vaccine attitudes on COVID-19 VA, partial least squares-structural equations modeling (PLS-SEM) using SmartPLS 3.0 software[37] was performed. The results of PLS-SEM were assessed on two important aspects, such as the measurement model and the structural model. The measurement model validates the reliability and validity of the scales used in the study and the structural model evaluates the significance of the effects of independent variables on the dependent variable.

Measurement model

Tables 3 and 4 show the results of the measurement model of the study. Table 5 explains the structural model of the study. Table 3 lists all the items used to measure the constructs such as safety concerns (SaCn), benefit attitudes (BeAtt), trust in health-care professionals (TrHP), and COVID-19 VA. Table 3 also shows the loading of each item of each construct with their respective constructs with loading more than .50 and the lesser loading of the items with other constructs.[38] The items with less factor loading and higher cross-loading were removed from the study. The results shown in Table 3 indicate a satisfactory convergent and discriminant validity of the scales used in the study.

Table 4 shows the reliability and validity of the scales used in the study. Reliability was established by Cronbach's Alpha and composite reliability that was found to exceed the minimum cutoff of .70.[38] Convergent validity was established by Average Variance Extracted (AVE). AVEs of all the four constructs used in the study exceeded the cutoff of .50, establishing satisfactory convergent validity. The discriminant validity was established by Fornell and Larcker's criterion of the square root of AVEs and should be more than inter-construct correlations.[38] The diagonal values in Table 4 are the square root of the respective constructs, which were found to be more than its correlation with other constructs. This result established satisfactory discriminant validity of the measures of the study.

Structural model

Table 5 shows the results of two PLS structural models, the first is main effects model and the second is moderation effects model. In the main effects model, BeAtt, SaCn, and TrHP were included as independent variables with VA as the dependent variable. Both the structural models were first assessed for explanatory power through the R^2 value, which is supposed to be more than .40 for a satisfactory explanatory power.[38] The main effects model produced R^2 value of .39 and the moderation effects model produced R^2 of .40 and hence shows the satisfactory explanatory power of both the models. It means that 39% and 40% of the variance in the dependent variable, VA is explained by the independent variables used in the main

Table 2. Analysis of behavioral factors - analysis of variance (ANOVA).

COVID 19 Pandemic-induced behaviour factors (independent variables)	Dependent variable: Vaccine acceptance			
	No. of respondents	Mean	F-Value	p-Value
Mode of classes for students				
Face-to-face classes	43	50.33	0.78	0.51
Online classes	844	53.24		
Blend of face-to-face and online classes	237	53.65		
No classes	23	53.22		
Mode of work for employed				
Go to the office physically	185	55.41	0.76	0.47
Work from home	297	54.00		
Combination of both the above	218	54.85		
International travel for next year?				
Yes	556	52.07	11.30	0.00
No	1,097	54.32		
Travel in and out of Abu Dhabi emirate?				
Yes	561	52.58	4.95	0.03
No	1,092	54.07		
Flu vaccine frequency in the past?				
Twice every year	91	50.25	13.70	0.00
Once every year	343	57.04		
I almost take the flu vaccines every 2 years	120	51.89		
I took the flu vaccine only once previously	470	54.82		
Never	629	51.53		
Vaccination before international travel?				
Yes, every time	137	53.78	1.66	0.16
Almost every time	115	53.29		
Only when I travel to Mecca or some countries in South Asia	303	54.70		
Once or twice only	179	54.85		
Never	915	52.91		
Co-morbidity diseases for Covid-19?				
Yes	267	51.21	10.65	0.00
No	1,386	54.02		
Vaccinated for Covid-19?				
Yes	1,064	57.09	258.90	0.00
No	589	47.19		

Table 3. Outer loadings and cross-loadings.

Indicators/Constructs	BeAtt	SaCn	TrHP	VA
The benefit of the COVID-19 vaccine (BeAtt)				
BEA1. Good hygiene will make COVID-19 disappear from society–the vaccine is not necessary (R)	**.78**	−.45	−.03	0.27
BEA2. Good hand hygiene and other preventive efforts are enough for avoiding the COVID-19 even without vaccination (R)	**.76**	−.45	−.05	0.26
BEA3. It is not worth getting the COVID-19 vaccine, as the COVID-19 symptoms are not serious (R)	**.85**	−.50	0.06	0.38
BEA4. I do not need a vaccine for COVID-19 as it's a temporary disease (R)	**.86**	−.60	0.10	0.46
Safety concern of COVID-19 vaccine (SaCn)				
SC1. I believe there has not been enough research on the safety of COVID-19 vaccines	−.43	**.72**	0.05	−.24
SC2. I believe that my immune system could be weakened by COVID-19 vaccines	−.59	**.77**	0.01	−.33
SC3. I am concerned that the ingredients in COVID-19 vaccines are unsafe	−.40	**.77**	0.03	−.30
SC4. I am concerned that COVID-19 vaccines have serious side effects	−.43	**.78**	0.04	−.24
SC5. As COVID-19 vaccines are new, I am not sure about taking it	−.54	**.83**	−.03	−.39
Trust in healthcare professionals (TrHP)				
Tr 1. When healthcare professionals make medical decisions, they have the patients' best interest in mind	0.11	0.01	**.84**	0.38
Tr 2. Parents/patients should leave the decisions that concern their or their children's health in the healthcare professionals' hands	−.09	0.09	**.75**	0.25
Tr 3. Doctors need to be authoritative toward their patients for optimum care	0.05	−.03	**.80**	0.35
COVID-19 Vaccine Acceptance (VA)				
VA1. COVID-19 vaccines are important for my health	0.37	−.35	0.32	**.83**
VA2. COVID-19 vaccines are effective	0.29	−.30	0.33	**.77**
VA3. All COVID-19 vaccines offered by the government program in UAE are beneficial.	0.31	−.28	0.35	**.77**
VA4. Getting the vaccine is a good way to protect myself from COVID-19.	0.41	−.33	0.31	**.86**
VA5. Generally, I do what my doctor or healthcare provider recommends about COVID-19 vaccines.	0.32	−.26	0.36	**.77**
VA6. The information I receive about COVID-19 vaccines from the vaccine program is reliable and trustworthy.	0.32	−.25	0.38	**.71**
VA7. Having myself vaccinated for COVID-19 is important for the health of others in my community	0.40	−.29	0.35	**.81**
VA8. Everyone must get vaccinated for COVID-19 once the vaccine is available	0.44	−.37	0.32	**.83**
VA9. COVID-19 vaccination should be compulsory for everyone	0.20	−.31	0.27	**.67**
VA10. Those who are not COVID-19 vaccinated are risking their health or the health of their family	0.38	−.35	0.28	**.78**
VA11. I am motivated to get the COVID-19 vaccine when I see some influential leaders/celebrities getting vaccinated	0.16	−.25	0.24	**.59**

Table 4. Construct reliability and validity.

				Inter-construct correlations			
Constructs	Cronbach's Alpha	Composite Reliability	AVE	BeAtt	SaCn	TrHP	VA
Benefit of COVID-19 vaccine (BeAtt)	0.84	0.89	0.66	**.81**			
Safety concern of COVID-19 vaccine (SaCn)	0.83	0.88	0.60	−.62	**.77**		
Trust in healthcare professionals (TrHP)	0.71	0.84	0.63	0.05	0.02	**.80**	
COVID-19 Vaccine Acceptance (VA)	0.93	0.94	0.59	0.44	−.40	0.42	**.77**

AVE-Average variance extracted. Values in the diagonal are the square root of respective construct's AVEs and they are in a bold highlight and show that these values are more than respective construct's inter-correlations with other constructs.

Table 5. Results of PLS structural models.

	Dependent variable: Vaccine Acceptance			
	Main effects model		Moderation effects model	
Independent variables	Std. path co-efficients	t-value	Std. path co-efficients	t-value
Benefit of COVID-19 vaccine (BeAtt)	0.27	11.05*	0.28	10.95*
Safety concern of COVID-19 vaccine (SaCn)	−.23	8.35*	−.22	7.72*
Trust in healthcare professionals (TrHP)	0.41	14.23*	0.38	14.40*
TrHP X BeAtt			−.06	1.87
TrHP X SaCn			−.14	4.46*
R^2	0.39		0.40	
Q^2	0.222		0.232	

* *p* value <.01 level; ** *p* value <.05 level.

effects model and moderation effects model, respectively. The structural models were assessed for predictive relevance by Q^2 value, which was produced by following the blindfolding approach available in SmartPLS 3.0.[38] The Q^2 is supposed to be more than zero for a satisfactory predictive relevance. In both main effects (.222) and moderation effects (.232) model, it exceeded zero which establishes satisfactory predictive relevance.[38] Furthermore, the structural model was assessed for predictive power by assessing the significance of path coefficients. The independent variables, such as BeAtt and TrHP

were found to have a significant positive effect on VA (path coefficient for BeAtt = .27 with *p*-value <.01 level; path coefficient for TrHP = .41 with *p*-value <.01 level). The SaCn was found to have a negative effect on VA (path coefficient for SaCn = > −.23 with *p*-value <.01 level).

In the moderation effects model, the moderation effect of TrHP in association with BeAtt and SaCn on VA was tested. The results suggested that in the presence of TrHP, negative effect of SaCn on VA was significantly reduced (moderation effect path coefficient for SaCn = > −.14 with *p*-value <.01 level). However,

the moderation effect of TrHP was found to have no impact on the effect of benefits perception on VA (moderation effect path coefficient for BeAtt = > −.06 with non-significant p-value).

Discussion

This study investigated the role of demographic, COVID-19 pandemic-induced behavioral and attitudinal factors in the acceptance of COVID-19 vaccine among communities of different universities in the UAE. The results of the study suggested that the demographic factors, such as category of university community, age, gender, and nationality did not play a role in the acceptance of the COVID-19 vaccine. These results imply to the policymakers that the COVID-19 pandemic situation necessitated the people to accept the COVID-19 vaccination irrespective of the category of community in the society, age level, gender, or nationality. This is considered to be a highly welcoming phenomenon for COVID-19 vaccination program in the UAE that the communities of different universities in the UAE embraced the COVID-19 vaccination program without any major reservations irrespective of variation in demographic factors. Previous studies that investigated the effect of demographic factors on VA showed mixed results. For example, in regard to effect of age, Martin et al.,[20] Malik et al.[21] and Skjefte et al.[28] found that the elderly individuals were found to have higher VA than the younger. In contrast, Harapan et al.[19] and Solís Arce et al.[39] found no difference in VA between different age groups. With respect to the effect of gender on VA, previous studies found mixed results. Dror et al.,[5] Solís Arce et al.,[39] Kreps et al.[40] and Shekar et al.[41] found higher levels of VA among males than females. Schernhammer et al., which studied vaccine hesitancy in Austria found that it was higher in females and young adults.[42] Our finding is consistent with Syed Alwi et al.[18] and Harappan et al.[19] who found no effect of gender on COVID-19 VA. Our study found a significant effect of education level on VA. The respndents who had no formal education were found to have lower levels of VA than the respondents who had formal education. This finding is consistent with the results of Solís Arce et al.[39] and El-Mohandes et al.[43] This finding implies that the policymakers need to reach out to the group of people with lower levels of education with appropriate messaging strategies.[39] Lim et al. studied vaccine acceptance in a university amongst students and found that many students were still hesistant to take vaccines.[44]

The results regarding COVID-19 pandemic-induced behavioral factors produced interesting findings. These findings are unique and no previous studies on VA have examined pandemic-induced behavioral factors on the VA. Kaufman et al. did a qualitative study in prioritized adults, health, and aged caretakers to take COVID-19 vaccines and observed that adults had taken the vaccines so that they could travel and not be in quarantine.[45] It was expected that the behavioral factors, such as mode of classes for the students, mode of work for the employees, travel restrictions, previous vaccination behavior, and presence of co-morbidity would enhance VA. About the mode of classes (whether online or on-campus), the results suggested that this factor had no effect on VA. A major consequence of the COVID-19 pandemic was that the travel and movement of the people was restricted for months. It was reasonably expected that if people required the need for international travel and travel between the emirates (states) within the UAE, they would have higher VA than those who did not have any such requirements. The results showed that the respondents who were not traveling between the emirates showed more VA than the travelers in between the emirates. Currently, traveling around the globe requires that people need to be vaccinated. Many of the countries have foregone mandatory quarantine periods for the people who are completely vaccinated and this could have been the major cause for accepting COVID-19 vaccines. It was expected that the respondents who were planning to embark on international travel in the next year would have more VA. On the contrary, the results showed less VA among respondents who plan to embark on international travel than those who had no such plans. These results imply that international travel and movement restrictions themselves do not lead to VA.

Flu vaccination frequency was considered to know whether the respondents showed more COVID-19 VA due to higher flu vaccination frequency. The results of the study supported our expectations that previous flu vaccinations would enhance VA. This finding is similar to other findings, which showed that during the H1N1 pandemic, health-care workers who were previously getting themselves vaccinated with influenza vaccine were more receptive to the H1N1 vaccines.[46] Pastorino et al. also showed flu vaccination uptake resulted in increased uptake of COVID-19 vaccines.[47]

The results regarding acceptance of COVID-19 vaccine among people with co-morbid diseases showed that people with co-morbidities had lower COVID-19 VA when compared to people without co-morbidities. Our findings are not in agreement with the findings of Jiménez-Garcia et al. who studied the acceptance of the influenza vaccine among the diabetic population and observed that having chronic diseases, such as chronic lung disease and previous uptake of vaccine increased the vaccine acceptance.[48] Increased uptake of the vaccine was observed amongst co-morbid patients when advised by health-care professionals and when they had increased visits to health-care professionals. Most of the time the refusal to take vaccine was the belief that they were not at risk.[48] Briggs et al. observed that older patients' acceptance of pneumococcal vaccine was very poor as they had a very poor perception of their age.[49] Our findings are similar to a study conducted by Bödeker et al. regarding influenza vaccination uptake in people with underlying chronic diseases found that respondents who were above 60 years or who suffered from underlying chronic diseases believed that influenza vaccination would result in influenza.[50] They observed that the most common reason for poor VA was mistrust of vaccination and perception that influenza was not dangerous.[50] On the contrary, Serrazina et al. who studied the VA in multiple sclerosis patients found that the patients with co-morbidities were more willing to take vaccines and found that one way to increase vaccine acceptance was to involve physicians who would insist on patients getting themselves vaccinated.[51]

Regarding the effect of COVID-19 vaccine attitudes on COVID-19 VA, the results suggested a significant positive effect of benefit attitudes toward vaccine (BeAtt) and trust in health-care professionals (TrHP) on VA. A study by Davis et al. related to COVID-19 vaccine showed a similar finding that enhancing the efficacy perception amongst population increased the vaccine acceptance.[52] The study found that the safety concerns toward COVID-19 vaccine (SaCn) showed a significant negative effect on VA. Even before the COVID-19 vaccines were rolled out by various companies, vaccine hesitancy related to safety concerns was an issue. Almaghaslah et al. identified that even though the participants were aware of the likelihood of getting the infection, the efficacy and safety of the vaccine were considered as barriers to vaccination.[53] Alabdulla et al. found that while studying vaccine hesitancy in Qatar, a substantial population was not ready to get vaccinated, especially the females.[54] The reasons cited for not accepting the vaccine were concerns around the safety of the COVID-19 vaccine and its long-term side effects. Schernhammer et al. observed that trust in government was very important for COVID-19 vaccine acceptance.[42]

In our study, the moderation effect of TrHP in the association of BeAtt and SaCn with COVID-19 VA was assessed. Our results showed that the TrHP reduced the effect of SaCn on VA while the TrHP did not impact the effect of BeAtt on VA. This is an interesting finding that could lead to major policy-level implications. This finding re-emphasizes the importance of enhancing TrHP as it directly improves the level of VA and further reduces the negative effect of SaCn on VA. The study by Ozisik et al. identified that in the adult population, vaccination was low for tetanus and influenza, but when doctors recommended the vaccine to the patients, they reacted positively to vaccine acceptance and the rates of vaccinations increased.[55] These results imply that the healthcare policymakers need to convey the benefits of vaccines through health-care professionals to increase VA. Similarly, there should also be concerted efforts and campaigns in improving the image and credibility of the health-care professionals so as to improve VA rates. The policymakers also need to conduct campaigns to reduce the safety concerns of individuals to enhance VA rates.

Limitations and future research

Most importantly, the findings of this study are specifically applicable only to the university communities in the UAE and therefore the findings of the study cannot be generalized to general population in other contexts. The researchers and policymakers in other contexts may apply these findings with caution. With respect to effect of attitudinal factors on VA, the PLS-SEM main effects model suggests a R^2 of .39, which means the variation in the depedent variable, VA is explained by the independent variables included in the study to the extent of only 39% suggesting 61% variation was not explained by the independent variables included in the study. There could be other factors not included in the study that might possibly affect the VA. The future research could possibly examine the effects of the pandemic-induced behavioral constraints in the general population. Furthermore, effect of other context-specific pandemic-induced behavioral constraints on VA can be examined in future research. For example, effect of

mandatory vaccination certificates for receiving certain government services on VA might be examined (Mills 2022 26). Future research could also investigate the effects of availability of tele-health in COVID-19 vaccine acceptance.[56] Regarding attitudinal factors, future research could investigate the effects of perceived self-efficacy about vaccines and perceived social cause of herd immunity.

Conclusion

This study filled the research gap in COVID-19 vaccine acceptance studies by comprehensively examining the factors that impact VA among communities of different universities in the UAE. The findings suggested that demographic factors except education level played no role in the VA in the UAE, which would require further investigation in other countries. The COVID-19 pandemic-induced behavioral constraints such as work from home for the employees and online classes for the students did not play a role in VA. Our study also found that people with co-morbid diseases had less VA than the people with no co-morbid diseases. This finding is highly significant in the studies on COVID-19 VA, which needs further investigation in other contexts. The findings on the effect of attitudinal factors toward COVID-19 vaccine contributes to the extant research by recognizing the importance of increasing perceived benefits and reducing safety concerns toward COVID-19 vaccine and improving trust in health-care professionals in the acceptance of COVID-19 vaccine. Furthermore, the study also found that by enhancing the trust in health-care professionals, the safety concerns toward COVID-19 vaccines could be reduced.

Abbreviations

COVID-19	Coronavirus disease 19
UAE	Unted Arab Emirates
VA	COVID-19 vaccine acceptance
ANOVA	Analysis of variance
PLS-SEM	Partial least squares-structural equations modeling
BeAtt	COVID-19 vaccine benefit attitudes
SaCn	Safety concerns toward COVID-19 vaccines
TrHP	Trust in healthcare professionals

Ethics approval and consent to participate

This questionnaire was reviewed and approved according to Zayed University procedures of research involving human-related subjects. It was also approved by the Ministry of Health and Prevention Research Ethics Committee Reference No: MOHAP/DXB-REC/JFF/No.06/2021. The respondents participated in the survey after providing informed consent.

Author contributions

AS, MEG, and WKA conceptualized the study and prepared the questionnaire. MEG and BHA coordinated the data collection. WKA performed statistical analysis. AS, MEG, WKA, and BHA drafted the initial manuscript.

AS reviewed and revised the final manuscript. FMH critically reviewed the manuscript. All authors read and approved the final manuscript.

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Availability of data materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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