JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Coronavirus Pandemic

COVID-19 vaccine hesitancy in Egypt: a cross-sectional study

May Ahmed Shawki[1], Ahmed Kamel[2], Shaza Gamal[2], Maggie Magdy Abbassi[2], Samar Farghali Farid[2], Nirmeen Ahmed Sabry[2]

[1] Clinical Pharmacy Department, Faculty of Pharmacy, Ain Shams University, Cairo, Egypt
[2] Clinical Pharmacy Department, Faculty of Pharmacy, Cairo University, Giza, Egypt

Abstract

Introduction: Coronavirus disease 2019 (COVID-19) vaccine hesitancy is a major problem. This study aimed to determine the factors associated with COVID-19 vaccine acceptance.

Methodology: A cross-sectional survey-based study was conducted on a sample of the Egyptian population using an online survey distributed through social media platforms, including Facebook, WhatsApp, and LinkedIn. The questionnaire was composed of five parts: part I describing the research questionnaire and its aim, part II assessing the demographic data, part III assessing knowledge and attitude towards COVID-19 infection, and part IV and V evaluating knowledge regarding COVID-19 vaccines, factors affecting vaccine acceptance and participants' attitude toward vaccination. Regression models were used to assess factors associated with vaccine acceptability.

Results: A total of 24376 responses were included in the statistical analysis. Females represented more than two-thirds of the study sample (70.5%,) and 18-24 years was the most commonly reported age group. Around one-third of the sample were healthcare professionals (HCPs). Only 14.3% of the participants received or registered to receive the vaccine, while 47% refused to be vaccinated. Regression analysis revealed that male gender, secondary education, older age, married or divorced status, presence of comorbidities, and higher level of knowledge regarding the vaccine were significantly associated with high vaccine acceptance. The most important vaccine attributes influencing vaccine selection in the current work were efficacy and safety.

Conclusions: Vaccine hesitancy is currently a major challenge. Governments should design educational campaigns that provide trusted data related to vaccine efficacy and safety to encourage vaccination and enhance awareness.

Key words: COVID-19; Vaccine; Hesitancy; Survey.

J Infect Dev Ctries 2023; 17(9):1188-1198. doi:10.3855/jidc.17794

(Received 13 December 2022 – Accepted 24 February 2023)

Introduction

Coronavirus disease-19 (COVID-19) is an infectious pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that belongs to family Coronaviridae [1]. The virus was first discovered at the end of 2019 in Wuhan city in China and was determined to be transmitted through contact with respiratory droplets [2]. Up to 30% of infected people may be asymptomatic, while symptomatic patients can be presented with cough, fever, anosmia, dysgeusia, myalgia, headache, sore throat, and gastrointestinal manifestations [3]. The most common complications of COVID-19 are acute respiratory distress syndrome (ARDS) necessitating mechanical ventilation, acute cardiac injury, and sepsis [4]. The diagnosis of COVID-19 is based on detection of viral RNA via real-time polymerase chain reaction (RT-PCR), computed tomography (CT) imaging showing ground-glass opacities, and serum acute phase reactant including elevated C-reactive protein (CRP), ferritin, and d-dimer [5,6].

Coronavirus infection represents a great challenge. The total number of confirmed infected patients worldwide until 23rd June 2022 was 539,893,858, with 6,324,112 deaths [7]. Many countries underwent different stages of lockdown since March 2020 with negative economic and social consequences [8]. Up till now, there is no effective treatment against COVID-19, and therapy mainly focuses on supportive management [9].

Prevention is the most important measure against COVID-19 [10],. Currently, many vaccines are available against COVID-19 and approved by the World Health Organization (WHO), including Pfizer/BioNtech Comirnaty vaccine, Moderna COVID-19 vaccine (mRNA 1273), Sinopharm COVID-19 vaccine, SII/Covishield (AstraZeneca/AZD1222) vaccine, Janssen/Ad26.COV 2.S vaccine, Sinopharm

COVID-19 vaccine and Sinovac-CoronaVac vaccine [11], in addition to the Russian Sputnik V vaccine [12]. Around 11,912,594,538 vaccine doses have already been received worldwide until 23rd June 2022 [7].

Despite the availability of vaccines, many people have shown hesitancy towards receiving them with major concerns about their safety and the fear of harm that might be associated with vaccines [13]. Vaccine acceptance has been reported to be 67% in the United States [14]. Hesitancy could be attributed to the lack of knowledge and suspicion of the potential benefits of vaccines [15]. In addition, social media have been involved in propagating misinformation about vaccines that might support the belief that vaccines are not safe [16]. In Egypt, only 34.92% received the complete vaccination protocol until 25th June 2022 [17]. Knowing the factors affecting the acceptance of COVID-19 vaccines may help overcome vaccine hesitancy and help extend vaccination to achieve herd immunity. The current study aimed to assess the perception of the Egyptian population towards available COVID-19 vaccines and determine the factors affecting their decision regarding vaccination.

Methodology

Ethical consideration

The study was revised and approved by the Research Ethics Committee of the Faculty of Pharmacy, Cairo University. Accepting to fill the questionnaire was considered as a consent to participate in this research.

Study design

A cross-sectional study using a validated questionnaire was conducted on Egyptian participants who can read and write the Arabic language and can use the internet.

Questionnaire construction

The questionnaire was developed by the authors based on the available literature about COVID-19 vaccination and factors that would affect its acceptance [18-20] and was adapted to the Egyptian culture. The questionnaire was developed in the English language followed by Arabic translation of questions, then back translation to English to check the accuracy of the questions.

For accuracy, clarity, and content validity, the first version of the questionnaire was distributed to ten healthcare professionals (HCPs). Based on the feedback received, the second version of the questionnaire was developed.

For internal consistency and reliability assessment, the second version of the questionnaire was distributed to a pilot sample of fifty respondents (HCPs and non-HCPs). Reliability was calculated using Cronbach's alpha for internal consistency and intra-class correlation coefficient (ICC) for inter-rater reliability. Pearson's correlation coefficients were calculated to estimate the test-retest reliability. Analysis showed excellent internal consistency (Cronbach's alpha = 0.95), inter-rater reliability (intraclass correlation coefficient = 0.97), and test-retest reliability ($r = 0.94$, $p < 0.001$). The data of the pilot study was not included in the final analysis.

Finally, an online form of the questionnaire was developed using Survey Monkey and was distributed through the most commonly used social media platforms in Egypt, including Facebook, WhatsApp, and LinkedIn.

Questionnaire components

The questionnaire (Supplementary Item 1) was composed of five parts. In the first part, participants were informed about the research and its aim. The participants were informed that their responses were confidential. The second part included participants' general and demographic data. The second part also evaluated different aspects of personal and/or family history related to COVID-19 infections. Prior exposure status was assessed using two variables: prior exposure to COVID-19 (yes vs. no) and admission to hospital (yes vs. no). The two variables were later merged to create a new variable with four possible options: infected and admitted to the hospital, infected but not admitted, not sure, and no prior infection.

The third part evaluated the knowledge of the respondents regarding whether COVID-19 infection could occur several times, whether infection could result in a long-term acquired immunity, and their perception of the severity of COVID-19 infection.

In the fourth part, participants were requested to answer questions about their knowledge regarding the COVID-19 vaccine and their source of information, available vaccine types in Egypt, expected duration of protection when vaccinated, their opinion about the safety and efficacy of these vaccines, and current vaccination status. Knowledge regarding the COVID-19 vaccine was assessed using six multiple-choice questions (MCQ). Respondents were awarded one point for each correct answer, and the total number of points was used to construct a scale that can be used as a measure of knowledge. One Likert-scale item was used to assess the acceptability of the COVID-19 vaccine;

"Were you vaccinated against COVID-19 infection?" with four possible choices: 1) No, I don't want to receive the vaccine, 2) I have not registered yet but intend to, 3) I registered but haven't received it yet, 4) Yes, I received one of the available vaccines. Choices 3 and 4 were combined as one category (registered/received the vaccine).

The last part of the questionnaire was designed to assess factors affecting vaccine selection and the participants' attitude toward vaccination. The influence of friends and family was considered negative if they knew someone who refused to take the vaccine but did not know anyone who took it, positive if opposite, and neutral if otherwise.

To ensure accuracy of the responses, response time and the IP address were recorded for each respondent. Respondents who completed the questionnaire in a time frame ranging from 2.75 minutes (5th quantile) and 29.85 minutes (95th quantile) of the time spent to complete the questionnaire in the whole sample were kept in the analysis; the rest were excluded. The R relocate package was used to match the IP of the respondents to their country. Only respondents who lived in Egypt were included in the analysis.

Statistical analysis

Statistical analysis was performed using R version 3.6.3. Counts and percentages were used to summarize the distribution of categorical variables. The mean ± standard deviation (SD) was used for normal continuous variables. Chi square test of independence (or Fisher-Exact) test was used to assess the bivariate association between categorical variables. Unpaired t-test and One Way ANOVA were used to compare the mean of continuous dependent variables between independent variables with two and more than two levels, respectively. Ordinal logistic regression was used to identify predictors of vaccination status (not vaccinated, intend to receive the vaccine, registered/vaccinated). Predictors included age, gender, education, the influence of family and friends, prior COVID-19 exposure status, death of relative, HCPs, perceived health state (ordinal), and whether respondents were following information related to COVID-19 vaccine. Knowledge score was also included in the model. Hypothesis testing was performed at 5% level of significance.

Results

The questionnaire was attempted by 31000 respondents between 27th April and 19th May 2021, and completed by 27327 respondents with a response rate

Table 1. Descriptive characteristics of the study sample (data summarized as counts and percentages).

Parameters	n = 24376 (%)
Age	
< 18 years	962 (3.95%)
> 55 years	1001 (4.11%)
18-24	12640 (51.9%)
25-34	5205 (21.4%)
35-44	2645 (10.9%)
45-55	1923 (7.89%)
> 55 years	1001 (4.11%)
Gender	
Female	17188 (70.5%)
Marital status	
Divorced	379 (1.55%)
Married	7518 (30.8%)
Single	16210 (66.5%)
Widower	269 (1.10%)
Highest educational level	
High school or an equivalent degree	1675 (6.87%)
Secondary education or less	476 (1.95%)
University education or higher	22225 (91.2%)
Current employment status	
Government sector	4553 (18.7%)
Housewife	1723 (7.07%)
Other	542 (2.22%)
Private sector	5369 (22.0%)
Retired	478 (1.96%)
Student	10936 (44.9%)
Unemployed	775 (3.18%)
Having children	
No	858 (10.5%)
Yes	7308 (89.5%)
Current residence	
Greater Cairo (Cairo, Giza, Qalyubiyya)	18119 (74.3%)
Alexandria (Matrouh, Beheira, Alexandria)	862 (3.54%)
Delta (Dakahlia, Gharbia, Kafr Elshaikh, Monofia, mietta)	2563 (10.5%)
Middle Upper Egypt (New Valley, Assiut)	281 (1.15%)
North Upper Egypt (Minya, Beni Suef, Faiyum)	768 (3.15%)
South Upper Egypt (Red Sea, Sohag, Qena, Aswan, uxor)	835 (3.43%)
Suez Canal (Sinai, Suez, Sharqia, Port Said, Ismailia)	948 (3.89%)
Living setting	
Rural	2561 (10.5%)
Urban	21815 (89.5%)
Living alone	
No	23535 (96.5%)
Healthcare provider	
No	17227 (70.7%)
Categories of healthcare profession	
Dentistry	894 (12.4%)
Medicine	2031 (28.3%)
Nursing	207 (2.88%)
Pharmacy	3587 (49.9%)
Physical therapy	465 (6.47%)
Presence of comorbidities	
I don't have any of these conditions	20637 (84.7%)
Heart problems	433 (1.78%)
Hypertension	1935 (7.94%)
Diabetes	879 (3.61%)
Rheumatic diseases or autoimmune diseases	523 (2.15%)
Lung diseases	724 (2.97%)
Previous clots	233 (0.96%)
Cancer	87 (0.36%)
Self-reported general health state	
Poor	165 (0.68%)
Fair	2390 (9.80%)
Good	9961 (40.9%)
Very good	8897 (36.5%)
Excellent	2963 (12.2%)

of 88%. Further, 1589 respondents were excluded as they did not meet the inclusion and exclusion criteria for time to completion. The average time to completion was 8 minutes (n = 25738). Of these, 24376 responses were from Egypt. Baseline characteristics and responses to questions related to COVID-19 infections and vaccines categorized according to vaccine status are summarized in Supplementary Table 1.

Demographic data

Female gender represented the majority of respondents to this questionnaire (70.5%, n = 17188). The most commonly reported age range of 18-24 years accounted for 51.9% (n = 12640) of the study sample. Around one-third of the participants were HCPs (29.3%, n = 7149), and around two-thirds of them were single (n = 16210). The majority of the respondents had a university or higher education degree (91.2%, n = 22225), with 74.3% (n = 18119) of the respondents residing in Greater Cairo. Most of the respondents did not have any comorbidities (84.4%). The sociodemographic characteristics of the respondents are shown in Table 1.

History of COVID-19 infection

Around 22% of the participants were infected with COVID-19, of which 62% recovered within 1-2 weeks, while 50% of them had a family member infected with COVID-19 with a death rate of 19.2%. Data regarding COVID-19 infection are presented in Table 2.

Knowledge, attitudes, and practices towards COVID-19 and related vaccines

The most commonly reported source of information about the COVID-19 vaccine was social media (68.7%), followed by online search (33%), family, friends, and colleagues (30.7%), international platforms like World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) (28.3), television (27.9), physician or caregiver (10.3%), and newspaper (6.8%). Around 6.6% reported not following any news.

Comparisons between HCPs and non-HCPs regarding knowledge, attitudes, and practices towards COVID-19 and related vaccines are presented in Table 3. The responses indicated poor knowledge about the COVID-19 vaccine among HCPs and non-HCPs, with approximately two to three questions answered correctly in each group. Generally, HCPs showed better knowledge regarding COVID-19 vaccines than non-HCP, although the differences did not exceed 1–5% for most of the comparisons. Less than half of both groups (~40%) followed the precautionary measures to a lower extent than before. The great majority of respondents (~90%) knew that one could get COVID-19 infection more than once. Only 50% of non-HCPs knew that COVID-19 infection does not provide long-term immunity compared to 70.9% of HCPs. Efficacy was the most preferred vaccine attribute in both groups, followed by safety.

Table 2. Exposure to COVID-19 in respondents and their families (data was summarized as counts and percentages).

Parameter	N (%)
Previous COVID-19 infection: n = 24376	
Infection with hospital admission	211 (0.87%)
Infection only	5395 (22.1%)
No	9777 (40.1%)
Not sure	8993 (36.9%)
Time taken to recover from COVID-19 infection n = 5613	
> 4 weeks	547 (9.75%)
1 - 2 weeks	3494 (62.2%)
3 - 4 weeks	1572 (28.0%)
Family member had previous COVID-19 infection n = 24346	
Infection with hospital admission	2744 (11.3%)
Infection and not sure regarding admission	460 (1.89%)
Infection only	9130 (37.5%)
No	7251 (29.8%)
Not sure	4761 (19.6%)
Time taken by family member to recover from COVID-19: n = 12370 infection:	
> 4 weeks	1752 (14.2%)
1 - 2 weeks	6045 (48.9%)
3 - 4 weeks	4573 (37.0%)
Family member died because of COVID-19: n = 12370	
No	9999 (80.8%)
Yes	2371 (19.2%)

Interestingly, approximately 50% of the respondents in both groups (3177 out of 7194 in HCP and 8327 out of 17227 in non-HCPs) did not want to receive the vaccine. Only 17.5% (1256 out of 7194) and 13% (2232 out of 17226) of HCPs and non-HCPs respectively received or registered to receive the vaccine. Hesitancy rate was 37.6% (2707 out of 7194) and 38.9% (6686 out of 17226) among HCPs and non-HCPs, respectively (Supplementary Table 1).

Table 3. Vaccination status, preferences, and knowledge regarding COVID-19 vaccines.

Parameter	Overall	Non-HCP	HCP	*p*
		N = 17227	N = 7149	
General knowledge				
Aware of any vaccines against COVID-19 infection				< 0.001
I don't know	863 (3.54%)	771 (4.48%)	92 (1.29%)	
No	536 (2.20%)	456 (2.65%)	80 (1.12%)	
Yes	22977 (94.3%)	16000 (92.9%)	6977 (97.6%)	
Follow the precautionary measures				< 0.001
No	665 (2.73%)	554 (3.22%)	111 (1.55%)	
Yes, to a greater extent as before	3234 (13.3%)	2280 (13.2%)	954 (13.3%)	
Yes, to a lower extent as before	10136 (41.6%)	7237 (42.0%)	2899 (40.6%)	
Yes, to the same extent as before	10341 (42.4%)	7156 (41.5%)	3185 (44.6%)	
Perceived severity and spread of the COVID-19 infection at the present time				< 0.001
Doesn't exist any more	36 (0.15%)	29 (0.17%)	7 (0.10%)	
Present with higher severity	15921 (65.3%)	10916 (63.4%)	5005 (70.0%)	
Present with lower severity	2032 (8.34%)	1559 (9.05%)	473 (6.62%)	
Present with the same severity	6387 (26.2%)	4723 (27.4%)	1664 (23.3%)	
Knowledge regarding COVID-19				
People can get COVID-19 infection more than once				< 0.001
No	507 (2.08%)	396 (2.30%)	111 (1.55%)	
Not sure	2256 (9.26%)	1897 (11.0%)	359 (5.02%)	
Yes	21613 (88.7%)	14934 (86.7%)	6679 (93.4%)	
Previous infection with COVID-19 provides long term immunity				< 0.001
No	14511 (59.5%)	9440 (54.8%)	5071 (70.9%)	
Not sure	8384 (34.4%)	6671 (38.7%)	1713 (24.0%)	
Yes	1481 (6.08%)	1116 (6.48%)	365 (5.11%)	
Vaccination status and preferred vaccine attributes				
Factors affecting the choice of the vaccine				
Lowest price	4.21 (1.10)	4.16 (1.14)	4.31 (1.00)	< 0.001
Least side effects	2.52 (1.11)	2.55 (1.12)	2.44 (1.08)	< 0.001
Longest duration of protection	2.60 (1.06)	2.61 (1.08)	2.58 (1.00)	0.066
Highest efficacy	1.87 (1.10)	1.91 (1.13)	1.78 (1.04)	< 0.001
Country of origin	3.81 (1.20)	3.77 (1.23)	3.90 (1.12)	< 0.001
Top vaccine attribute				< 0.001
Efficacy	6474 (50.3%)	4374 (49.1%)	2100 (52.9%)	
Safety	2756 (21.4%)	1846 (20.7%)	910 (22.9%)	
Duration of action	2051 (15.9%)	1467 (16.5%)	584 (14.7%)	
Price	586 (4.55%)	450 (5.05%)	136 (3.42%)	
Country of origin	1008 (7.83%)	766 (8.60%)	242 (6.09%)	
COVID-19 vaccination status				< 0.001
I do not want to receive the vaccine	11504 (47.2%)	8327 (48.3%)	3177 (44.4%)	
I intend to but haven't registered yet	9375 (38.5%)	6668 (38.7%)	2707 (37.9%)	
I registered but didn't receive it yet	2092 (8.58%)	1581 (9.18%)	511 (7.15%)	
Yes, I received one of the available vaccines	1405 (5.76%)	651 (3.78%)	754 (10.5%)	
Received vaccine				< 0.001
BionTech/Pfizer	22 (1.57%)	17 (2.62%)	5 (0.66%)	
China's Sino pharm vaccine	533 (38.0%)	216 (33.2%)	317 (42.0%)	
I don't know	63 (4.49%)	48 (7.38%)	15 (1.99%)	
J & J	1 (0.07%)	1 (0.15%)	0 (0.00%)	
Moderna	2 (0.14%)	0 (0.00%)	2 (0.27%)	
Oxford University's AstraZeneca vaccine	763 (54.3%)	359 (55.2%)	404 (53.6%)	
Russia's Sputnik V vaccine	20 (1.42%)	9 (1.38%)	11 (1.46%)	
Knowledge regarding COVID-19 vaccine				
Duration of immunity for COVID-19 vaccine				< 0.001
< 1 year**	5979 (24.5%)	3542 (20.6%)	2437 (34.1%)	
A year or more	1450 (5.95%)	883 (5.13%)	567 (7.93%)	
Life-long immunity	16171 (66.3%)	543 (3.15%)	233 (3.26%)	
I don't know	776 (3.18%)	12259 (71.2%)	3912 (54.7%)	
COVID-19 vaccine is effective and can protect against the infection				< 0.001
No	5774 (23.7%)	3984 (23.1%)	1790 (25.0%)	
Not sure	13965 (57.3%)	10149 (58.9%)	3816 (53.4%)	
Yes**	4637 (19.0%)	3094 (18.0%)	1543 (21.6%)	
COVID-19 vaccine is safe				< 0.001
No	5660 (23.2%)	4038 (23.4%)	1622 (22.7%)	
Not sure	14655 (60.1%)	10455 (60.7%)	4200 (58.7%)	
Yes**	4061 (16.7%)	2734 (15.9%)	1327 (18.6%)	
COVID-19 infection can be prevented without vaccination				< 0.001
No**	7329 (30.1%)	4891 (28.4%)	2438 (34.1%)	
Not sure	8581 (35.2%)	6255 (36.3%)	2326 (32.5%)	
Yes	8466 (34.7%)	6081 (35.3%)	2385 (33.4%)	
Precautionary measures can be stopped following COVID-19 vaccination				< 0.001
No**	19862 (81.5%)	13637 (79.2%)	6225 (87.1%)	
Not sure	3176 (13.0%)	2546 (14.8%)	630 (8.81%)	
Yes	1338 (5.49%)	1044 (6.06%)	294 (4.11%)	
Vaccinated people may get re-infected by COVID-19				< 0.001
No	1007 (4.13%)	787 (4.57%)	220 (3.08%)	
Not sure	7408 (30.4%)	5911 (34.3%)	1497 (20.9%)	
Yes**	15961 (65.5%)	10529 (61.1%)	5432 (76.0%)	
Overall knowledge score	2.37 ± 1.3	2.23 ± 1.28	2.71 ± 1.27	$p < 0.001$

Data was summarized using counts and percentages for categorical variable and mean ± standard deviation for continuous variables. Hypothesis testing was performed using Chi square test of independence for and unpaired t-test for categorical variables and continuous variables respectively. **: correct answers for knowledge questions.

Causes for vaccine reluctance included a belief that vaccine is not safe (63.5%, n = 7306), concerns regarding possible side effects (58.6%, n = 6740), the vaccine being not protective against infection (35.8%, n = 4113), lack of clinical data (34.8%, n = 4007), the preferred vaccine being unavailable in Egypt (11%, n = 1264), thinking that the vaccine was not needed if they are following proper precautionary measures (10.7%, n = 1233), family and friends not receiving it (6.2%, n = 709), the vaccine being expensive (4.25%, n = 486), physician recommendation (2%, n = 227), and bad experience with a previous vaccine (1.6%, n = 178).

The responses showed a meaningful difference in the knowledge regarding duration of immunity (Δ = 10%, $p < 0.001$) and whether vaccination prevents re-infection (Δ = 14%, $p < 0.001$) between HCP and non-HCP. Differences in the percentage of correct answers for the remaining knowledge questions, although statistically significant, were not meaningful and did not exceed 5% in most cases. The reported side effects of the COVID-19 vaccine are presented in Supplementary Figure 1.

The attitudes of the respondents towards the COVID-19 vaccine are presented in Table 4. Less than one-half of the non-HCPs (40.1%) did not know the difference between COVID-19 vaccines compared to only 15.7% of HCPs ($p < 0.001$). One-third of the respondents were willing to advise their family/friends against the vaccine, compared to 40% willing to provide encouragement. Moreover, slightly less than 20% of the respondents were willing to receive a locally manufactured COVID-19 vaccine if one will be

Table 4. Attitude towards COVID-19 vaccination.

	ALL	Non-HCP	HCP	*p*
	N = 24376	N = 17227	N = 7149	
Difficulty to register to receive the vaccine				0.030
No	3253 (92.9%)	2061 (92.2%)	1192 (94.2%)	
Yes	247 (7.06%)	174 (7.79%)	73 (5.77%)	
Preferred vaccine given the choice				< 0.001
China's Sino pharm vaccine	1905 (14.8%)	1210 (13.6%)	695 (17.5%)	
I don't know the difference between them	4197 (32.6%)	3573 (40.1%)	624 (15.7%)	
Moderna/Pfizer vaccine	3299 (25.6%)	1939 (21.8%)	1360 (34.2%)	
No specific preference	1386 (10.8%)	905 (10.2%)	481 (12.1%)	
Oxford University's AstraZeneca vaccine	1597 (12.4%)	925 (10.4%)	672 (16.9%)	
Russia's Sputnik V vaccine	491 (3.81%)	351 (3.94%)	140 (3.52%)	
Willing to encourage family, friends, and colleagues, to take the vaccine				< 0.001
No	7268 (29.8%)	5206 (30.2%)	2062 (28.8%)	
Not sure	7223 (29.6%)	5189 (30.1%)	2034 (28.5%)	
Yes	9885 (40.6%)	6832 (39.7%)	3053 (42.7%)	
Know anyone who refused to take the vaccine				< 0.001
No	8353 (34.3%)	6750 (39.2%)	1603 (22.4%)	
Not sure	2441 (10.0%)	1904 (11.1%)	537 (7.51%)	
Yes	13582 (55.7%)	8573 (49.8%)	5009 (70.1%)	
Know anyone who took the vaccine				< 0.001
No	6554 (26.9%)	5433 (31.5%)	1121 (15.7%)	
Not sure	904 (3.71%)	763 (4.43%)	141 (1.97%)	
Yes	16918 (69.4%)	11031 (64.0%)	5887 (82.3%)	
Vaccine should be obligatory				< 0.001
No	10164 (41.7%)	6979 (40.5%)	3185 (44.6%)	
Not sure	6033 (24.7%)	4426 (25.7%)	1607 (22.5%)	
Yes	8179 (33.6%)	5822 (33.8%)	2357 (33.0%)	
Perceived priority in receiving Covid-19 vaccines				
Healthcare providers	2.08 (1.44)	2.20 (1.49)	1.79 (1.26)	< 0.001
School and university students	4.48 (1.36)	4.47 (1.37)	4.52 (1.31)	0.002
Elderly patients	2.85 (1.48)	2.80 (1.50)	2.96 (1.43)	< 0.001
Patients with chronic disease(s)	2.61 (1.33)	2.60 (1.35)	2.64 (1.28)	0.058
Employees in schools and universities who are in contact with students	4.26 (1.26)	4.25 (1.27)	4.29 (1.23)	0.035
Employees in public/private sector	4.72 (1.32)	4.69 (1.34)	4.81 (1.27)	< 0.001
If a locally manufactured vaccine was made available in Egypt, are you willing to receive it?				< 0.001
No	6338 (26.0%)	4277 (24.8%)	2061 (28.8%)	
Not sure	12874 (52.8%)	9108 (52.9%)	3766 (52.7%)	
Yes	5164 (21.2%)	3842 (22.3%)	1322 (18.5%)	

Data were summarized using counts and percentages for categorical variable and mean ± standard deviation for continuous variables. Hypothesis testing was performed using Chi-square test of independence for and unpaired t-test for categorical variables and continuous variables respectively.

available. Approximately 40% of HCPs and non-HCPs thought that the COVID-19 vaccine should not be obligatory.

Predictors of vaccine acceptability

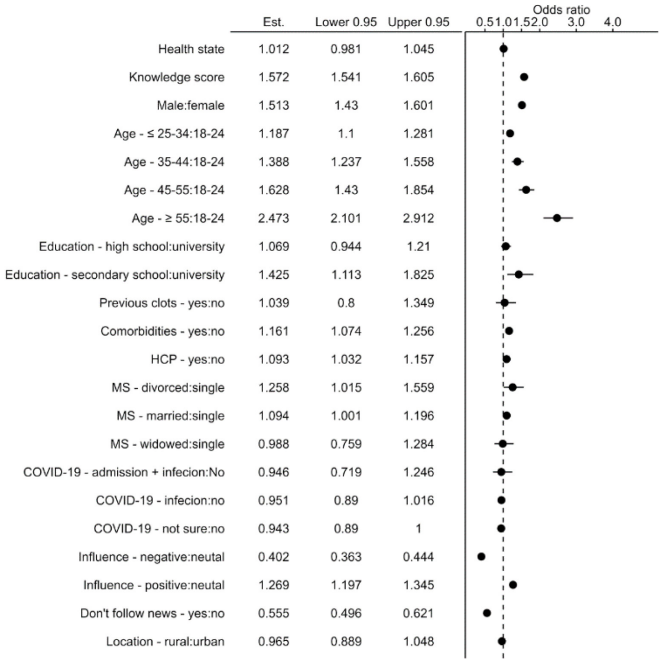
Figure 1 shows that males were more likely to accept COVID-19 vaccine than females (OR = 1.508, $p < 0.001$). The perceived health status did not have a statistically significant association with willingness to receive the vaccine (OR = 1.007, $p > 0.689$). Education had a statistically significant association with willingness to receive the vaccine. Respondents with secondary education were more willing to receive the vaccine than respondents who completed college or post-graduate degrees (OR = 1.464, $p < 0.001$). Marital status had a statistically significant association with the intent to receive the vaccine, with married and divorced respondents showing higher willingness than single respondents (OR = 1.1, $p < 0.05$). Patients with comorbidities were more likely to receive COVID-19 vaccine (OR = 1.141, $p < 0.001$). The vaccination status was not significantly different between patients who were infected, whether hospitalized (OR = 0.979, $p = 0.48$) or not (OR = 0.966, $p = 0.38$), and patients who were not previously infected. Interestingly, the willingness to receive the vaccine was not significantly different between HCP and non-HCP (OR = 1.04, $p = 0.177$).

The willingness to receive the vaccine increased with the increase in age, with respondents aged > 55 years showing the highest acceptability and willingness (OR = 2.293, $p < 0.001$). Friends and family significantly affected the decision to receive the vaccine. Respondents who reported knowing relatives/friends who did not receive the vaccine were less willing to receive it (OR = 0.405, $p < 0.001$), while respondents who knew friends/family members who received the vaccine were more willing to receive it (OR = 1.3, $p < 0.001$). The knowledge score showed a positive association with the willingness to receive the vaccine (OR = 1.557, $p < 0.001$), indicating that a one-point increase in the knowledge score is associated with a 55.7% increase in the willingness to receive the vaccine. The living setting (urban vs. rural) did not show a statistically significant association with the willingness to receive the vaccine (OR = 0.969, $p = 0.447$). Those who did not follow any news were significantly less likely to accept vaccination than those who followed any source of information (OR=0.5. $p < 0.001$).

Discussion

This is the first large-scale survey to be conducted after Egypt started a national campaign to vaccinate people over 18 years against COVID-19. Despite the fact that vaccine was much awaited by many people, the most common problem facing the vaccination process is vaccine hesitancy. The current study has shown low vaccine acceptance where only 14% received or registered to receive the vaccine. The acceptance rate was very low compared to other surveys conducted before releasing the vaccines. In online surveys conducted in the USA, the acceptance rate of the COVID-19 vaccines was high, with around 30% to 48 % of respondents reporting definite willingness to take the vaccine [21,22]. In China, around 28.7% of the respondents to an online survey showed definite intention to receive the vaccine when available [23]. In Scotland, the vaccine acceptance rate reached 74% [24]. The low acceptance rate for COVID-19 vaccines among Egyptians can be attributed to several factors where there is an evident uncertainty clouding the COVID-19 vaccines. Firstly, the novel mRNA-based vaccines, which were a new technology, could be received with some skepticism due to the lack of any reported prior experience or successes with such

Figure 1. Predictors of vaccine acceptability.



Analysis was performed using ordinal logistic regression; MS: marital status; HCP: healthcare professional; Est: estimate (odds ratio); Lower 0.95: lower limit of 95% confidence interval; Upper 0.95: upper limit of 95% confidence interval; respondents < 18 years were excluded from the analysis.

technology. Also, the speed of vaccine development and emergency authorization in less than a year may have lowered the acceptance level.

Determining sociodemographic factors affecting vaccine acceptance is very important. It helps governments direct their educational intervention to the targeted population to enhance awareness on the importance of COVID-19 vaccination. The current study results showed that 75% of those who refused to receive vaccines were females. This was the same in surveys conducted in the USA [21,22]. On the contrary, a global survey conducted in 19 countries showed that males were less likely to accept vaccines [25]. The impact of peer social influences on vaccination hesitancy among young women was a significant finding in vaccine hesitancy. Also, a recent article citing expert opinions suggested that concerns about fertility and lack of trust in the government were the most likely barriers to vaccination [26].

Several studies revealed that those with older age are more likely to accept vaccines [25,27,28]. This was comparable to the current results, and this could be attributed to the fact that older age is a risk factor for a complicated COVID-19 infection [29]. In addition, older people are more likely to have comorbidities associated with severe infection. This was shown in the current study, where people with comorbidities were more likely to accept vaccines than those with no comorbidities. In addition, some young adults falsely think they are not at risk of contracting the virus because they are less likely to get severely ill than older adults.

Moreover, married and divorced participants were more likely to receive the vaccine than single participants. Approximately 70% of those refusing or hesitant to receive the vaccine were single. Usually, single participants are younger than married and divorced.

Although higher education and graduate degrees were associated with a higher vaccine acceptance rate in previous studies [22,25], the current study showed that participants with university and higher education are less likely to receive vaccines than secondary education. This may be attributed to their knowledge about and fear of the expected side effects and vaccines safety. Also, academically qualified people can be less inclined to trust policy makers [30]. This is a very important observation because governments need to include those with higher education in their targeted educational interventions, which represents a major sector of the population, and not only focus on those with lower education. Also, universities need to participate in awareness programs and address vaccine hesitancy on campus and in the surrounding community.

The regression model in the current study revealed no significant difference in being HCPs or not and vaccine acceptance. Interestingly, around 44% of HCPs in this study reported that they did not want to receive the vaccine although 70% of them believed that COVID- 19 existed in a more severe form than before. This could be attributed to the lack of availability of evidence-based data about vaccines, as more than 50% of HCPs reported that they were not sure regarding the safety and efficacy of the available vaccines. This contradicted the results of the two surveys conducted among French and French-speaking HCPs that showed a vaccine acceptance rate of 76.9% among HCPs [31,32]. In these surveys, it has been reported that physicians had a higher perceived risk of COVID-19 compared to nurses, and hence are more likely to accept the vaccine. Physicians represented 28.8% of the HCP in the current work. Pharmacists represented the greatest majority (49.9%) of the HCP, and this could explain the lower rate of acceptance of COVID-19 vaccines as most pharmacists are not in direct contact of COVID 19 patients in Egypt; thus, might have a lower perceived risk of COVID 19 infection compared to a physician. The HCPs are the most trusted source of medical education in any community, especially community pharmacists who are in direct contact with the population and are easily accessible compared to other HCPs. Pharmacists can help provide accurate information to the general population in a friendly language and intervene against misinformation regarding the efficacy and safety of available vaccines [33]. Future vaccine communication should target HCPs to address the perceived high risk of COVID-19 infection and the importance of the vaccine, as this would help spread this awareness to the community.

Knowledge is an important factor in vaccine hesitancy. Those who registered/received the vaccine in the current work had a significantly higher knowledge score about COVID-19 vaccines (mean ± SD: 3.3 ± 1.43) compared to those who were hesitant (mean ± SD: 2.44 ± 1.34) or refused to receive the vaccine (mean ± SD: 2.04 ± 1.06). Also, those who did not follow any source of information were less likely to accept the vaccine than those who followed news about the vaccine. This emphasizes that nations should put great efforts into improving awareness regarding COVID-19. Communication of reliable information about the importance of the vaccine and different types of available vaccines is essential in this stage. The current

study showed that around 40% of hesitant participants did not know the difference between the available vaccines, and this might be a contributing factor for their hesitancy due to their inability to select the most preferred one from their point of view.

In addition, concerns regarding vaccine efficacy and side effects might greatly contribute to vaccine hesitancy [13]. In the current study, the most commonly reported factors for vaccine reluctance and hesitancy were that vaccines were not safe or might cause adverse effects, in addition to the probability of lack of efficacy. More than 75% and 90% of hesitant participants and those who refused the vaccine respectively believed that the vaccine might not be safe and might not be effective. Besides, efficacy and safety were the most important vaccine attributes reported in the current work. This was in agreement with a systematic review including surveys covering more than 30 countries [34]. In an online survey in Indonesia, the acceptance of a vaccine with 95% effectiveness was 93.3% versus an acceptance rate of 67% for a 50% effective vaccine [27]. Hence, it is recommended that the government communicates transparent information regarding the safety and efficacy of available vaccines and conducts effective surveillance programs to convey awareness messages about vaccination [35]. The educational campaign should focus on delivering information through different methods, particularly social media, the most commonly reported source of information about COVID-19 vaccines in the current study. In a previous study, it has been reported that around 55.7% of participants rely on the internet and social media as sources of information about COVID-19 and its vaccines [36]. Hence, HCPs and academic organization engagement to provide accurate scientific information might help overcome the spread of misinformation about the vaccine [37].

Despite the belief that the vaccine can protect against infection (the strongest predictor of vaccine acceptability in China) [23], around 65.5% of the respondents in the current work reported that they could be reinfected after vaccination and around 5.5% thought that they would be able to stop precautionary measures after vaccination. These might be major drivers for not receiving the vaccine. To overcome this issue, educational intervention should focus on the fact that despite vaccination, life will not return normal, and precautionary measures cannot be discarded; however, it will help to reduce the severity of the infection and reduce mortality [38].

The study was limited by being conducted through an online survey indicating that only educated internet users could respond. Thus, a significant proportion of the Egyptian population who were illiterate were not included. Larger studies with face-to-face surveys might be helpful to know the predictors of vaccine acceptability in this population. Also, the study was cross-sectional, and therefore causality cannot be established.

Conclusions

The current results suggest low acceptability of the COVID-19 vaccine in Egypt with a similar pattern across HCP and non-HCP, although the HCP were more knowledgeable about vaccines than non-HCP. Predictors for vaccine acceptability were older age, male gender, and level of education. Moreover, the efficacy and safety of available vaccines were major concerns of all participants.

Acknowledgements

The authors would like to thank the teaching assistants in the department of Clinical Pharmacy, Cairo University for their valuable role in the development and validation of the questionnaire.

Authors' contributions

All authors contributed to idea and study design. Data collection was done by Ahmed Kamel, Shaza Gamal, Maggie M Abbassi, Samar F Farid and Nirmeen A Sabry; data analysis and interpretation were done by Ahmed Kamel, May A Shawki, Maggie M Abbassi, Samar F Farid and Nirmeen A Sabry; the manuscript was drafted by Ahmed Kamel and May A Shawki; the manuscript was revised by Shaza Gamal, Maggie M Abbassi, Samar F Farid and Nirmeen A Sabry. All authors approved the final submitted version of the manuscript.

References

1. Mohamadian M, Chiti H, Shoghli A, Biglari S, Parsamanesh N, Esmaeilzadeh A (2021) COVID-19: virology, biology and novel laboratory diagnosis. J Gene Med 23: e3303. doi: 10.1002/jgm.3303.
2. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC (2020) Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. JAMA 324: 782-793. doi: 10.1001/jama.2020.12839.
3. Salian VS, Wright JA, Vedell PT, Nair S, Li C, Kandimalla M, Tang X, Carmona Porquera EM, Kalari KR, Kandimalla KK (2021) COVID-19 transmission, current treatment, and future therapeutic strategies. Mol Pharm 18: 754-771. doi: 10.1021/acs.molpharmaceut.0c00608.
4. Lotfi M, Hamblin MR, Rezaei N (2020) COVID-19: transmission, prevention, and potential therapeutic opportunities. Clin Chim Acta 508: 254-266. doi: 10.1016/j.cca.2020.05.044.

5. Alsharif W, Qurashi A (2021) Effectiveness of COVID-19 diagnosis and management tools: a review. Radiography (Lond) 27: 682-687. doi: 10.1016/j.radi.2020.09.010.
6. Henry BM, de Oliveira MHS, Benoit S, Plebani M, Lippi G (2020) Hematologic, biochemical and immune biomarker abnormalities associated with severe illness and mortality in coronavirus disease 2019 (COVID-19): a meta-analysis. Clin Chem Lab Med 58: 1021-1028. doi: 10.1515/cclm-2020-0369.
7. WHO (2021) WHO Coronavirus (COVID-19) dashboard. Available: https://covid19.who.int/. Accessed: 25 June 2022.
8. Chung JY, Thone MN, Kwon YJ (2021) COVID-19 vaccines: the status and perspectives in delivery points of view. Adv Drug Deliv Rev 170: 1-25. doi: 10.1016/j.addr.2020.12.011.
9. Dos Santos WG (2020) Natural history of COVID-19 and current knowledge on treatment therapeutic options. Biomed Pharmacother 129: 110493. doi: 10.1016/j.biopha.2020.110493.
10. Samudrala PK, Kumar P, Choudhary K, Thakur N, Wadekar GS, Dayaramani R, Agrawal M, Alexander A (2020) Virology, pathogenesis, diagnosis and in-line treatment of COVID-19. Eur J Pharmacol 883: 173375. doi: 10.1016/j.ejphar.2020.173375.
11. WHO (2022) Coronavirus disease (COVID-19): vaccines. Available from: https://www.who.int/news-room/q-a-detail/coronavirus-disease-(covid-19)-vaccines?adgroupsurvey={adgroupsurvey}&gclid=CjwKCAjwv_iEBhASEiwARoemvJKfcH1CMyfIi7i5Jd8YouQJk-_fDDjNgzBb7xbsoJW9BfXUNzukQxoCLusQAvD_BwE. Accessed: 25 June 2022.
12. Jones I, Roy P (2021) Sputnik V COVID-19 vaccine candidate appears safe and effective. Lancet 397: 642-643. doi: 10.1016/S0140-6736(21)00191-4.
13. Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrachi M, Zigron A, Srouji S, Sela E (2020) Vaccine hesitancy: the next challenge in the fight against COVID-19. Eur J Epidemiol 35: 775-779. doi: 10.1007/s10654-020-00671-y.
14. Malik AA, McFadden SM, Elharake J, Omer SB (2020) Determinants of COVID-19 vaccine acceptance in the US. eClinicalMedicine 26: 100495. doi: 10.1016/j.eclinm.2020.100495.
15. Trogen B, Pirofski LA (2021) Understanding vaccine hesitancy in COVID-19. Med (N Y) 2: 498-501. doi: 10.1016/j.medj.2021.04.002.
16. Wilson SL, Wiysonge C (2020) Social media and vaccine hesitancy. BMJ Glob Health 5: e004206. doi: 10.1136/bmjgh-2020-004206.
17. Ritchie H, Ortiz-Ospina E, Beltekian D, Mathieu E, Hasell J, Macdonald B, Giattino C, Appel C, Rodés-Guirao L, Roser M: statistics and research: Coronavirus (COVID-19) vaccinations. Available: https://ourworldindata.org/covid-vaccinations?country=~EGY. Accessed: 25 June 2022.
18. Lackner CL, Wang CH (2021) Demographic, psychological, and experiential correlates of SARS-CoV-2 vaccination intentions in a sample of Canadian families. Vaccine X.8: 100091. doi: 10.1016/j.jvacx.2021.100091.
19. Chen M, Li Y, Chen J, Wen Z, Feng F, Zou H, Fu C, Chen L, Shu Y, Sun C (2021) An online survey of the attitude and willingness of Chinese adults to receive COVID-19 vaccination. Hum Vaccin Immunother 17: 2279-2788. doi: 10.1080/21645515.2020.1853449.
20. Yu Y, Lau JTF, She R, Chen X, Li L, Li L, Chen X (2021) Prevalence and associated factors of intention of COVID-19 vaccination among healthcare workers in China: application of the Health Belief Model. Hum Vaccin Immunother 17: 2895-2902. doi: 10.1080/21645515.2021.1909327.
21. Reiter PL, Pennell ML, Katz ML (2020) Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? Vaccine 38: 6500-6507. doi: 10.1016/j.vaccine.2020.08.043.
22. Guidry JPD, Laestadius LI, Vraga EK, Miller CA, Perrin PB, Burton CW, Ryan M, Fuemmeler BF, Carlyle KE (2021) Willingness to get the COVID-19 vaccine with and without emergency use authorization. Am J Infect Control 49: 137-142. doi: 10.1016/j.ajic.2020.11.018.
23. Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP (2020) Understanding COVID-19 vaccine demand and hesitancy: a nationwide online survey in China. PLoS Negl Trop Dis 14: e0008961. doi: 10.1371/journal.pntd.0008961.
24. Williams L, Flowers P, McLeod J, Young D, Rollins L, The Catalyst Project T (2021) Social patterning and stability of intention to accept a COVID-19 Vaccine in Scotland: will those most at risk accept a vaccine? Vaccines (Basel) 9: 17. doi: 10.3390/vaccines9010017.
25. Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, Kimball S, El-Mohandes A (2021) A global survey of potential acceptance of a COVID-19 vaccine. Nat Med 27: 225-228. doi: 10.1038/s41591-020-1124-9.
26. Knight H, Jia R, Ayling K, Bradbury K, Baker K, Chalder T, Morling JR, Durrant L, Avery T, Ball J (2021) Understanding and addressing vaccine hesitancy in the context of COVID-19: development of a digital intervention. Public Health 201: 98-107. doi: 10.1016/j.puhe.2021.10.006.
27. Harapan H, Wagner AL, Yufika A, Winardi W, Anwar S, Gan AK, Setiawan AM, Rajamoorthy Y, Sofyan H, Mudatsir M (2020) Acceptance of a COVID-19 vaccine in Southeast Asia: a cross-sectional study in Indonesia. Front Public Health 8: 381. doi: 10.3389/fpubh.2020.00381.
28. Wong MCS, Wong ELY, Huang J, Cheung AWL, Law K, Chong MKC, Ng RWY, Lai CKC, Boon SS, Lau JTF, Chen Z, Chan PKS (2021) Acceptance of the COVID-19 vaccine based on the health belief model: a population-based survey in Hong Kong. Vaccine 39: 1148-1156. doi: 10.1016/j.vaccine.2020.12.083.
29. Chen Y, Klein SL, Garibaldi BT, Li H, Wu C, Osevala NM, Li T, Margolick JB, Pawelec G, Leng SX (2021) Aging in COVID-19: vulnerability, immunity and intervention. Ageing Res Rev 65: 101205. doi: 10.1016/j.arr.2020.101205.
30. Patel PR, Berenson AB (2013) Sources of HPV vaccine hesitancy in parents. Hum Vaccin Immunother 9: 2649-2653. doi: 10.4161/hv.26224.
31. Gagneux-Brunon A, Detoc M, Bruel S, Tardy B, Rozaire O, Frappe P, Botelho-Nevers E (2021) Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey. J Hosp Infect 108: 168-173. doi: 10.1016/j.jhin.2020.11.020.
32. Verger P, Scronias D, Dauby N, Adedzi KA, Gobert C, Bergeat M, Gagneur A, Dubé E (2021) Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020. Euro Surveill 26: 2002047. doi: 10.2807/1560-7917.ES.2021.26.3.2002047.
33. Marwitz KK (2021) The pharmacist's active role in combating COVID-19 medication misinformation. J Am Pharm Assoc 61: e71-e74. doi: 10.1016/j.japh.2020.10.022.

34. Lin C, Tu P, Beitsch LM (2020) Confidence and receptivity for COVID-19 vaccines: a rapid systematic review. Vaccines (Basel) 9: 16. doi: 10.3390/vaccines9010016.
35. Schoch-Spana M, Brunson EK, Long R, Ruth A, Ravi SJ, Trotochaud M, Borio L, Brewer J, Buccina J, Connell N, Hall LL, Kass N, Kirkland A, Koonin L, Larson H, Lu BF, Omer SB, Orenstein WA, Poland GA, Privor-Dumm L, Quinn SC, Salmon D, White A (2020) The public's role in COVID-19 vaccination: human-centered recommendations to enhance pandemic vaccine awareness, access, and acceptance in the United States. Vaccine 39: 6004-6012. doi: 10.1016/j.vaccine.2020.10.059.
36. Reuben RC, Danladi MMA, Saleh DA, Ejembi PE (2021) Knowledge, attitudes and practices towards COVID-19: an epidemiological survey in north-central Nigeria. J Community Health 46: 457-470. doi: 10.1007/s10900-020-00881-1.
37. Hernandez RG, Hagen L, Walker K, O'Leary H, Lengacher C (2021) The COVID-19 vaccine social media infodemic: healthcare providers' missed dose in addressing misinformation and vaccine hesitancy. Hum Vaccin Immunother 17: 2962-2964. doi: 10.1080/21645515.2021.1912551.
38. Laine C, Cotton D, Moyer DV (2021) COVID-19 vaccine: promoting vaccine acceptance. Ann Intern Med 174: 252-253. doi: 10.7326/M20-8008.

Corresponding author

Nirmeen A Sabry, PhD
Professor of Clinical Pharmacy, Clinical Pharmacy Department, Faculty of Pharmacy,
Cairo University, Nile Corniche, El Sayeda Zeinab, , Giza, Egypt.
Tel: +202 01111506622
Fax: (00202) 23628246
Email: nirmeen.sabry@pharma.cu.edu.eg

Conflict of interests: No conflict of interests is declared.

Annex – Supplementary Items

Supplementary Item 1. The English version of the questionnaire.

Socio-demographic characteristics

1. Age o < 18 years o 18-24 o 25-34 o 35-44 o 45-55 o > 55 years
2. Gender o Male o Female
3. In which governorate do you currently live?
    - Greater Cairo (Cairo, Giza, Qalyubiyya) o Alexandria (Matrouh, Beheira, Alexandria) o Delta (Dakahlia, Gharbia, Kafr Elshaikh, Monofia, Damietta) o Suez Canal (Sinai, Suez, Sharqia, Port Said, Ismailia) o North Upper Egypt (Minya, Beni Suef, Faiyum) o Middle Upper Egypt (New Valley, Assiut)
    - South Upper Egypt (Red sea, Sohag, Qena, Aswan, Luxor)
4. Marital Status o Married o Single o Divorced o Widow/er
5. Do you have children? o Yes o No
6. What is your current residence?
    - Urban o Rural
7. What is your educational level?
    - Less than high school o High school o University degree or above
8. What is your current employment status? o Employed in the government/public sector o Employed in the private sector
    - Retired o Student o Housewife
    - Unemployed
    - If other, please specify
9. Are you a healthcare provider?
    - Yes
    - No

IF YES

10. What is your health profession?
    - Medicine o Pharmacy o Dentistry o Nursing o Physical Therapy
11. Do you live alone? o Yes
    - No
12. Do you have any of the following health problems (You can choose more than one answer) o Heart problems o Diabetes
    - Lung problems (e.g. asthma)
    - Hypertension
    - Rheumatic diseases or autoimmune diseases (e.g. systemic lupus) o Previous clots o Cancer
    - I don't have any of these conditions
13. How would you describe your general health?

    Excellent
    Very good
    Good
    Fair
    Poor

Experience and Current Behavior With COVID-19 Infection

14. Were you infected with COVID-19? o Yes o No
    o Not sure

IF YES

15. How long did it take to recover from COVID-19 infection?
    o 1-2 weeks o 3-4 weeks o More than 4 weeks
16. Did you need to be hospitalized? o Yes
    o No
17. What were the complications you suffered from after recovering from Covid-19 infection? (You can choose more than one answer) o I didn't suffer from any symptoms
    - Fatigue o Shortness of breath o Cough o Chest pain
    - Difficulty in concentrating or thinking
    - Depression o Tachycardia o Smell problems o taste problems o Hyperglycemia o Eye inflammation or redness o Blood clots

- Hair fall o Nausea
- Headache
- If other, please specify

18. Did a family member get COVID-19 infection? o Yes o No
    o Not sure

IF YES

19. How long did they take to recover from COVID-19 infection?
    o 1-2 weeks o 3-4 weeks o More than 4 weeks
20. Did they need to be hospitalized? o Yes
    - No
    - I don't know
21. What were the complications they suffered from after recovering from Covid-19 infection? (You can choose more than one answer) o They didn't suffer from any symptoms
    - Fatigue
    - Shortness of breath o Cough o Chest pain
    - Difficulty in concentrating or thinking
    - Depression o Tachycardia o Smell problems o taste problems o Hyperglycemia o Eye inflammation or redness o Blood clots
    - Hair fall o Nausea
    - Headache
    - If other, please specify
22. Did a family member die from COVID-19 infection? o Yes o No
23. Do you think that people can get COVID-19 infection more than once? o Yes o No
    - Not sure
24. Do you think that previous infection with COVID-19 gives long term immunity? o Yes o No
    - Not sure
25. What do you think of the severity and spread of the COVID-19 infection at the present time? o Present with the same severity o Present with lower severity o Present with higher severity o Doesn't exist any more
26. Do you follow the precautionary measures (wearing face masks – keeping social distancing – using alcohol, etc.)? o Yes, to a lower extent as before o Yes, to the same extent as before o Yes, to a greater extent as before
    - No

Knowledge, Perception and Practice towards COVID-19 Vaccine

27. Are you aware that there is a vaccine against COVID-19 infection? o Yes
    - No
    - I don't know
28. How do you know and follow the news about COVID-19 vaccination? (You can choose more than one answer) o Personal physician or care giver o Family, friends, and colleagues
    - Social media o Television o National news papers o Online searches
    - International platforms (WHO, CDC, etc.) o I am not following any news
29. What are the COVID-19 vaccines available in Egypt?
    - China's Sino pharm vaccine o Russia's Sputnik V vaccine o Oxford University's AstraZeneca vaccine o Moderna/Pfizer vaccine o I don't know

Knowledge questions about COVID-19 Vaccines (questions 30-35)

30. COVID-19 vaccine provide immunity against the virus for o Few months o A year or more o Life-long immunity o I don't know
31. Do you think that COVID-19 vaccine is effective can protect you against the infection?
    - Yes o No
    - Not sure
32. Do you think that COVID-19 vaccine is safe? o Yes o No
    - Not sure
33. Do you think that COVID-19 infection can be prevented without vaccination? o Yes o No
    - Not sure
34. Do you think that taking COVID-19 vaccine will allow you to stop taking the precautionary measures? o Yes o No

- Not sure

35. Do you think vaccinated people may get infected by COVID-19 again? o Yes o No
    - Not sure
36. **Were you vaccinated against COVID-19 infection?** o Yes, I received one of the available vaccines o No, I don't want to receive the vaccine o I registered but haven't received it yet o I intend to but haven't registered yet

IF YES

37. Which vaccine did you receive?
    - China's Sino pharm vaccine o Russia's Sputnik V vaccine o Oxford University's AstraZeneca vaccine o Moderna/Pfizer vaccine o I don't know o If other, please specify
38. Did you experience any of the following side effects? (you can choose more than one answer) o No side effects
    - Pain or swelling or redness at the site of injection
    - Tiredness o Headache o Fever o Muscle pain o Chills o Allergic reaction o Diarrhea o Nausea o Tinnitus o Tachycardia o Hypotension o Blood clots o If other, please specify

IF YES OR REGISTERED BUT DIDN'T RECEIVE IT

39. Did you have any difficulty in registering to receive the vaccine? o Yes o No

IF YES OR REGISTERED BUT DIDN'T RECEIVE IT YET OR DIDN'T REGISTER YET BUT PLAN TO

40. If you had the option to select the type of vaccine to have it, which vaccine would you prefer to take? (You can choose more than one answer)
    - China's Sino pharm vaccine o Russia's Sputnik V vaccine o Oxford University's AstraZeneca vaccine o Moderna/Pfizer vaccine o I don't have a preferred choice o I don't know the difference between them
41. Arrange the following factors according to their importance to you when choosing the vaccine? o Lowest price o Least side effects o Longest period of protection o Highest efficacy o Country of origin IF NO
42. What are the reasons for not wanting to receive the vaccine? (you can choose more than one answer).
    - I don't think that COVID-19 vaccine is safe
    - I don't think that COVID-19 vaccine will protect me against infection o I think it may be expensive and I cannot afford it o There is not enough clinical data for it o My family and friend will not take it o This is my physician's recommendations
    - I am maintaining the protective measures so I don't think I need the vaccine o I don't think the vaccine I want is available in Egypt
    - I am concerned about its possible side effects o I had a bad experience with a prior vaccination o If other, please specify.

Attitude toward COVID-19 Vaccines:

43. Are you willing to encourage family, friends, and colleagues, to take the vaccine? o Yes o No
    o Not sure
44. Do you know anyone who refused to take the vaccine? o Yes o No
    o Not sure
45. Do you know anyone who already took the vaccine? o Yes o No
    o Not sure
46. Do you think that vaccine should be obligatory to everyone? o Yes o No
    o Not sure
47. Arrange the following categories according to who should be vaccinated first?
    Healthcare providers
    School and university students
    Elderly patients
    Chronic disease patients
    Employees (including staff) in schools and universities
    Employees in Public/private sector
48. If a locally manufactured vaccine was made available in Egypt, Are you willing to receive it?
    - Yes
    - No (with reason) o Not sure

Supplementary Table 1. Baseline characteristics and responses to questions related to COVID-19 infections and vaccines categorized according to vaccine status.

	Refused	Hesitant	Received / Registered	*p*
	N = 11504	N = 9375	N = 3497	
Age				< 0.001
< 18 years	548 (4.76%)	376 (4.01%)	38 (1.09%)	
18-24	6366 (55.3%)	5112 (54.5%)	1162 (33.2%)	
25-34	2397 (20.8%)	1973 (21.0%)	835 (23.9%)	
35-44	1126 (9.79%)	955 (10.2%)	564 (16.1%)	
45-55	751 (6.53%)	661 (7.05%)	511 (14.6%)	
> 55 years	316 (2.75%)	298 (3.18%)	387 (11.1%)	
Gender				< 0.001
Female	8689 (75.5%)	6329 (67.5%)	2170 (62.1%)	
Current residence				< 0.001
Alexandria	376 (3.27%)	325 (3.47%)	161 (4.60%)	
Delta	1139 (9.90%)	1079 (11.5%)	345 (9.87%)	
Greater Cairo	8671 (75.4%)	6825 (72.8%)	2623 (75.0%)	
Middle Upper Egypt	134 (1.16%)	122 (1.30%)	25 (0.71%)	
North Upper Egypt	360 (3.13%)	321 (3.42%)	87 (2.49%)	
South Upper Egypt	394 (3.42%)	325 (3.47%)	116 (3.32%)	
Suez Canal	430 (3.74%)	378 (4.03%)	140 (4.00%)	
Marital status				< 0.001
Divorced	155 (1.35%)	132 (1.41%)	92 (2.63%)	
Married	3101 (27.0%)	2755 (29.4%)	1662 (47.5%)	
Single	8131 (70.7%)	6405 (68.3%)	1674 (47.9%)	
Widower	117 (1.02%)	83 (0.89%)	69 (1.97%)	
Having children				0.001
No	382 (11.3%)	329 (11.1%)	147 (8.06%)	
Yes	2991 (88.7%)	2641 (88.9%)	1676 (91.9%)	
Living setting				< 0.001
Rural	1226 (10.7%)	1104 (11.8%)	231 (6.61%)	
Urban	10278 (89.3%)	8271 (88.2%)	3266 (93.4%)	
Highest educational level				< 0.001
High school or an equivalent degree	860 (7.48%)	681 (7.26%)	134 (3.83%)	
Secondary education or less	224 (1.95%)	202 (2.15%)	50 (1.43%)	
University education or higher	10420 (90.6%)	8492 (90.6%)	3313 (94.7%)	
Current employment status				< 0.001
Government sector	2028 (17.6%)	1591 (17.0%)	934 (26.7%)	
Housewife	752 (6.54%)	690 (7.36%)	281 (8.04%)	
Other	256 (2.23%)	195 (2.08%)	91 (2.60%)	
Private sector	2344 (20.4%)	2029 (21.6%)	996 (28.5%)	
Retired	166 (1.44%)	149 (1.59%)	163 (4.66%)	
Student	5557 (48.3%)	4414 (47.1%)	965 (27.6%)	
Unemployed	401 (3.49%)	307 (3.27%)	67 (1.92%)	
Healthcare provider				< 0.001
No	8327 (72.4%)	6668 (71.1%)	2232 (63.8%)	
Yes	3177 (27.6%)	2707 (28.9%)	1265 (36.2%)	
Healthcare profession				< 0.001
Dentistry	361 (11.3%)	377 (13.9%)	156 (12.3%)	
Medicine	750 (23.5%)	769 (28.3%)	512 (40.3%)	
Nursing	106 (3.32%)	85 (3.12%)	16 (1.26%)	
Pharmacy	1757 (55.0%)	1303 (47.9%)	527 (41.4%)	
Physical therapy	218 (6.83%)	186 (6.84%)	61 (4.80%)	
Live alone				< 0.001
No	11165 (97.1%)	9056 (96.6%)	3314 (94.8%)	
Yes	339 (2.95%)	319 (3.40%)	183 (5.23%)	
Comorbidities				< 0.001
No comorbidities	9954 (86.5%)	8084 (86.2%)	2599 (74.3%)	
Heart problems	162 (1.41%)	140 (1.49%)	131 (3.75%)	< 0.001
Hyperglycemia	295 (2.56%)	281 (3.00%)	303 (8.66%)	< 0.001
Lung diseases (e.g. asthma)	311 (2.70%)	259 (2.76%)	154 (4.40%)	< 0.001
Hypertension	785 (6.82%)	664 (7.08%)	486 (13.9%)	< 0.001
Rheumatic diseases or autoimmune diseases	260 (2.26%)	168 (1.79%)	95 (2.72%)	0.003
Previous clots	85 (0.74%)	77 (0.82%)	71 (2.03%)	< 0.001
Cancer	29 (0.25%)	28 (0.30%)	30 (0.86%)	< 0.001
Self-reported general health state				0.139
Excellent	1431 (12.4%)	1124 (12.0%)	408 (11.7%)	
Fair	1159 (10.1%)	881 (9.40%)	350 (10.0%)	
Good	4677 (40.7%)	3852 (41.1%)	1432 (40.9%)	
Poor	94 (0.82%)	51 (0.54%)	20 (0.57%)	
Very good	4143 (36.0%)	3467 (37.0%)	1287 (36.8%)	

Previous COVID-19 infection				< 0.001
Infection and hospital admission	95 (0.83%)	68 (0.73%)	48 (1.37%)	
Infection only	2444 (21.2%)	2132 (22.7%)	819 (23.4%)	
No	4598 (40.0%)	3616 (38.6%)	1563 (44.7%)	
Not sure	4367 (38.0%)	3559 (38.0%)	1067 (30.5%)	
COVID-19 complications				0.195
No	10992 (95.5%)	8913 (95.1%)	3323 (95.0%)	
Yes	512 (4.45%)	462 (4.93%)	174 (4.98%)	
Family member got COVID-19 infection				< 0.001
No	3413 (29.7%)	2758 (29.5%)	1080 (30.9%)	
Not sure	2286 (19.9%)	1896 (20.3%)	579 (16.6%)	
Yes	5792 (50.4%)	4707 (50.3%)	1835 (52.5%)	
Family member died because of COVID-19				0.042
No	4655 (80.1%)	3872 (82.0%)	1472 (80.1%)	
Yes	1153 (19.9%)	852 (18.0%)	366 (19.9%)	
Knowledge and attitudes regarding COVID-19				
People can get COVID-19 infection more than once				< 0.001
No	278 (2.42%)	168 (1.79%)	61 (1.74%)	
Not sure	1040 (9.04%)	929 (9.91%)	287 (8.21%)	
Yes	10186 (88.5%)	8278 (88.3%)	3149 (90.0%)	
Previous infection with COVID-19 provides long term immunity				< 0.001
No	6898 (60.0%)	5404 (57.6%)	2209 (63.2%)	
Not sure	3934 (34.2%)	3407 (36.3%)	1043 (29.8%)	
Yes	672 (5.84%)	564 (6.02%)	245 (7.01%)	
Perceived severity and spread of the COVID-19 infection at the present time				< 0.001
Doesn't exist any more	26 (0.23%)	6 (0.06%)	4 (0.11%)	
Present with higher severity	7433 (64.6%)	6103 (65.1%)	2385 (68.2%)	
Present with lower severity	1044 (9.08%)	775 (8.27%)	213 (6.09%)	
Present with the same severity	3001 (26.1%)	2491 (26.6%)	895 (25.6%)	
Follow the precautionary measures				< 0.001
No	452 (3.93%)	166 (1.77%)	47 (1.34%)	
Yes, to a greater extent as before	1406 (12.2%)	1289 (13.7%)	539 (15.4%)	
Yes, to a lower extent as before	5091 (44.3%)	3878 (41.4%)	1167 (33.4%)	
Yes, to the same extent as before	4555 (39.6%)	4042 (43.1%)	1744 (49.9%)	
Aware of any vaccines against COVID-19 infection				< 0.001
I don't know	451 (3.92%)	365 (3.89%)	47 (1.34%)	
No	325 (2.83%)	180 (1.92%)	31 (0.89%)	
Yes	10728 (93.3%)	8830 (94.2%)	3419 (97.8%)	
Source of information				
I don't follow any news	1059 (9.21%)	458 (4.89%)	86 (2.46%)	< 0.001
Personal physician or care giver	981 (8.53%)	959 (10.2%)	566 (16.2%)	< 0.001
Family, friends, and colleagues	3418 (29.7%)	3008 (32.1%)	1061 (30.3%)	0.001
Social media	7826 (68.0%)	6621 (70.6%)	2292 (65.5%)	< 0.001
Television	3077 (26.7%)	2723 (29.0%)	996 (28.5%)	0.001
Newspaper	680 (5.91%)	647 (6.90%)	321 (9.18%)	< 0.001
Online search	3280 (28.5%)	3305 (35.3%)	1470 (42.0%)	< 0.001
International platforms (WHO, CDC, etc.)	2745 (23.9%)	2759 (29.4%)	1399 (40.0%)	< 0.001
Knowledge regarding COVID-19 vaccine				
Duration of immunity for COVID-19 vaccine				
< 1 year	2451 (21.3%)	2119 (22.6%)	1409 (40.3%)	< 0.001
A year or more	498 (4.33%)	628 (6.70%)	324 (9.27%)	
I don't know	8257 (71.8%)	6274 (66.9%)	1640 (46.9%)	
Life-long immunity	298 (2.59%)	354 (3.78%)	124 (3.55%)	
COVID-19 vaccine is effective and can protect against the infection				< 0.001
No	4093 (35.6%)	1193 (12.7%)	(14.0%)	
Not sure	6545 (56.9%)	5826 (62.1%)	(45.6%)	
Yes	866 (7.53%)	2356 (25.1%)	(40.5%)	
COVID-19 vaccine is safe				< 0.001
No	4510 (39.2%)	905 (9.65%)	(7.01%)	
Not sure	6441 (56.0%)	6414 (68.4%)	(51.5%)	
Yes	553 (4.81%)	2056 (21.9%)	(41.5%)	
COVID-19 infection can be prevented without vaccination				< 0.001
No	2285 (19.9%)	3288 (35.1%)	(50.2%)	
Not sure	4062 (35.3%)	3530 (37.7%)	(28.3%)	
Yes	5157 (44.8%)	2557 (27.3%)	(21.5%)	
Precautionary measures can be stopped following COVID-19 vaccination				< 0.001
No	9434 (82.0%)	(79.7%)	(84.6%)	
Not sure	1548 (13.5%)	(14.0%)	(8.89%)	
Yes	522 (4.54%)	(6.26%)	(6.55%)	
Vaccinated people may get re-infected by COVID-19				< 0.001
No	(3.12%)	(5.18%)	(4.63%)	

Not sure	(28.6%)	(35.5%)	(22.6%)	
Yes	(68.3%)	(59.3%)	(72.8%)	
Preferred vaccine given the choice				< 0.001
China's Sino pharm vaccine		(12.4%)	(21.2%)	
don't know the difference between them		(39.1%)	(15.2%)	
Moderna/Pfizer vaccine		(23.3%)	(31.7%)	
No specific preference		(10.2%)	(12.2%)	
Oxford University's AstraZeneca vaccine		(11.4%)	(15.0%)	
Russia's Sputnik V vaccine		(3.51%)	(4.63%)	
Important factor in vaccine selection				
Highest efficacy		4.17 (1.11)	4.29 (1.06)	0.009
Lowest price		2.48 (1.11)	2.62 (1.10)	< 0.001
Country of origin		2.64 (1.06)	2.51 (1.05)	< 0.001
Longest duration of protection		1.88 (1.11)	1.82 (1.09)	< 0.001
Least side effects		3.83 (1.21)	3.75 (1.17)	< 0.001
Preferred vaccine attribute				
Country of origin		(7.92%)	(7.61%)	
Highest efficacy		(49.6%)	(52.0%)	
Least side effects		(22.4%)	(18.8%)	
Longest duration of protection		(15.4%)	(17.4%)	
Lowest price		(4.73%)	(4.06%)	
Willing to encourage family, friends, and colleagues, to take the vaccine				< 0.001
No	6647 (57.8%)	477 (5.09%)	(4.12%)	
Not sure	3989 (34.7%)	2806 (29.9%)	428 (12.2%)	
Yes	868 (7.55%)	6092 (65.0%)	2925 (83.6%)	
Know anyone who refused to take the vaccine				< 0.001
No	3632 (31.6%)	4076 (43.5%)	645 (18.4%)	
Not sure	1150 (10.00%)	1050 (11.2%)	241 (6.89%)	
Yes	6722 (58.4%)	4249 (45.3%)	2611 (74.7%)	
Know anyone who took the vaccine				< 0.001
No	3880 (33.7%)	2445 (26.1%)	229 (6.55%)	
Not sure	439 (3.82%)	409 (4.36%)	56 (1.60%)	
Yes	7185 (62.5%)	6521 (69.6%)	3212 (91.9%)	
Vaccine should be obligatory				< 0.001
No	7412 (64.4%)	2086 (22.3%)	666 (19.0%)	
Not sure	3025 (26.3%)	2451 (26.1%)	557 (15.9%)	
Yes	1067 (9.28%)	4838 (51.6%)	2274 (65.0%)	
If a locally manufactured vaccine was made available in Egypt, Are you willing to receive it?				< 0.001
No	4660 (40.5%)	1153 (12.3%)	525 (15.0%)	
Not sure	6098 (53.0%)	5225 (55.7%)	1551 (44.4%)	
Yes	746 (6.48%)	2997 (32.0%)	1421 (40.6%)	
Health state	3.49 (0.87)	3.50 (0.84)	3.49 (0.85)	0.489
Knowledge score	2.04 (1.06)	2.44 (1.34)	3.30 (1.43)	< 0.001

Supplementary Figure 1. The reported side effects of the COVID-19 vaccine.