RESEARCH ARTICLE

Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among Egyptian medical students

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Abstract

Background: Vaccine hesitancy poses serious challenges for achieving coverage for population immunity. It is necessary to achieve high COVID-19 vaccination acceptance rates and medical students' coverage as future health care providers. The study aimed to explore the level of COVID-19 vaccine hesitancy and determine the factors and barriers that may affect vaccination decision-making.

Methods: A cross-sectional study was carried out among medical students in Tanta and Kafrelsheikh Universities, Egypt. Data collection was done via an online questionnaire during January 2021 from 2133 students.

Results: The majority of the participant students (90.5%) perceived the importance of the COVID-19 vaccine, 46% had vaccination hesitancy, and an equal percentage (6%) either definitely accepted or refused the vaccine. Most of the students had concerns regarding the vaccine's adverse effects (96.8%) and ineffectiveness (93.2%). The most confirmed barriers of COVID-19 vaccination were deficient data regarding the vaccine's adverse effects (potential 74.17% and unknown 56.31%) and insufficient information regarding the vaccine itself (72.76%).

Conclusion: The government, health authority decision-makers, medical experts, and universities in Egypt need to work together and make efforts to reduce hesitancy and raise awareness about vaccinations, consequently improving the acceptance of COVID-19 vaccines.

KEYWORDS
COVID-19, medical students, vaccine acceptance, vaccine hesitancy

1 | INTRODUCTION

The pandemic of COVID-19 is considered a global challenge for all countries worldwide to contain its spread. Efforts and campaigns of prevention, early diagnosis, and medical management are being led by the World Health Organization (WHO) and numerous research teams and clinical experts worldwide. There are no specific antiviral medications for COVID-19, and among the used drugs, a few have shown potential to reduce mortality among patients with COVID-19 (e.g., corticosteroids and antibody-based immunotherapeutics). Also, compliance of humans with social distancing and using face masks for an extended period is unguaranteed. Thus, the best strategy to control and gradually silencing this pandemic is to develop an effective vaccine.[1-4]

A remarkable effort has been made in the eleven months since discovering the SARS-CoV-2 virus and its genome. The scientific community has contributed to the creation of more than 300 vaccine projects. More than 40 new vaccines are currently undergoing clinical evaluation, a few of them obtained the Food and Drug Administration's (FDA) Emergency Use Authorization (EUA), and are now used in many countries, for example, Pfizer BioNTech and Moderna vaccines,[5] but

coverage rate is an essential factor that decides successful vaccination. Vaccine development was typically taking years. So, the public acceptance for a new vaccine of COVID-19 developed within a short period remains uncertain despite the availability.[6,7] Lessons learned from the previous pandemics of influenza when the vaccine was introduced, and the acceptance rate was variably low in many countries urges proper understanding of the vaccine hesitancy problem.[8-11]

The concept of "vaccine hesitancy" means to delay accepting or refusing vaccination although the vaccination services are made available, that is, no demand for offered and available vaccines. It is a continuum between those who accept vaccines without a doubt to complete refusal without a doubt.[12] Vaccine hesitancy affects the hesitant individual and, consequently, the whole community as a high coverage rate is necessary to confer herd immunity needed to flatten the epidemic curve.[13,14]

Vaccine hesitancy is multidimensional and specific to one's environment, fluctuating by time, setting, and vaccines themselves. It is prompted by factors like complacency, convenience, and confidence. Complacency means the low perception of disease risk; hence, vaccination seems unnecessary. Confidence denotes trust in vaccination safety, effectiveness, and competence of healthcare systems. Convenience involves availability, affordability, and delivery of vaccines in a comfy context.[15] Several determinants modify vaccination decisions and determine whether to refuse, delay, or accept some or all vaccines. These include contextual influences that arise from historical, socioeconomic, cultural, ecological, health system/institutional, and political factors.[12] Concerns about the efficacy or safety, the country of manufacture of the vaccine, the antivaccine movements, and the belief of rushed vaccine development and production, besides rumors and misinformation, were important COVID-19 vaccination hesitancy causes.[16]

There are also individual and group influences that arise from the personal perception of the vaccine, beliefs, or attitudes toward vaccination, such as perceived efficacy or benefits of vaccines, safety concerns or side effects, and social/peer environment. Besides, specific issues directly related to the vaccine or vaccination like the introduction of a new vaccine or formulation or a new recommendation for a current vaccine, method of administration, development of the vaccination program, reliability and/or source of supply, schedule, cost, the strength of recommendations, knowledge base and/or attitude. Numerous COVID-19 vaccination studies have documented an association between some of these factors and the acceptance of the COVID-19 vaccine.[17-19]

World Health Organization considers vaccine hesitancy as a significant threat to global health. Reported COVID-19 vaccine acceptance rates varied worldwide,[19] but a recent global report on COVID-19 vaccine acceptance illustrated that nearly 30% of the investigated participants would refuse or hesitate to take a COVID-19 vaccine when it is available.[20] The Middle East is among the regions with the lowest rates of vaccine acceptance globally.[19]

As the vaccine development process progresses, it is crucial to boost the acceptance of the new vaccines. Developing effective COVID-19 vaccination strategies necessitate a proper understanding of the factors that would impact the decision of vaccination as these factors may change for individuals who accept and be determined to take the vaccine from those who do not.[21]

The Egyptian Drug Authority (EDA) has approved the Sinopharm Chinese vaccine as the first primary one. In January, Egypt began its vaccination program, starting with medical teams in quarantine hospitals to be at the top of the vaccination priority categories, then medical teams, and set up a public immunization website for registration to start with high-risk groups. Late in January, Egypt obtained the second batch of AstraZeneca vaccine as part of the COVID-19 Vaccines Global Access (COVAX) Facility.[22]

Most of the studies were conducted among healthcare providers or the general population, and limited literature has examined these factors in other risky groups of COVID-19. Young adults, specifically college students, are at risk of being infected with COVID-19 and transmitting the infection to others owing to the sense of invulnerability.[24] Experience with the ongoing pandemic has demonstrated medical students' ability to volunteer in health care assistant positions that can be of real help to healthcare systems during times of emergency.[25]

A recent study was conducted to describe the existing profile of potential COVID-19 vaccine acceptance among Egyptian health care providers (medical students constituted 39.8% of participants), reported that 45.9% accept to receive the vaccine (only 13.5% totally accept the vaccine, and 32.4% were hesitant but somewhat agree) and 40.9% refused to take the vaccine. They concluded that the intention to accept COVID-19 vaccination among Egyptian health care workers (HCWs) is lower than in western countries but better than the African ones. Vaccine hesitancy in Egyptian HCWs could be a significant obstacle influencing the COVID-19 acceptance decision.[26]

As medical students are likely to be exposed to COVID-19 patients, achieving high vaccination coverage rates for COVID-19 in this group is mandatory as soon as the vaccine is widely available as they can be used as vaccination role models for the public. They are the future health care providers and the notable influencers for people and their communities. Besides, they will be responsible for making recommendations for vaccination and providing guidance to vaccine-positive patients. Given that limited research has addressed COVID-19 vaccine acceptance among medical students, the current study was formulated targeting medical students of Tanta and Kafrelsheikh Universities in Egypt to explore the level of COVID-19 vaccine hesitancy and to determine the factors and barriers that may affect their vaccination decision making.

2 | MATERIALS AND METHODS

2.1 | Study settings

A cross-sectional study was conducted during January 2021 in Tanta and Kafrelsheikh Universities, two central public universities in the Delta region that recruit students from lower Egyptian governorates. Our target population was medical students at both universities (a total of 27715 students).[27] distributed through faculties of Medicine, Pharmacy, Dentistry, Nursing, and Physiotherapy. The Egyptian medical educational system varies according to the college's type; the faculty of medicine consisted of 6 years of university education, followed by one year of internship, and was modified in 2019 to be five years, followed by two

internships. Dentistry education consists of five years, followed by 1 year of internships which is the same in the pharmacy but without training. The nursing and physiotherapy faculties comprised four years of education, followed by one year of internship. The students' groups are freshmen in 1st year, sophomores in 2nd year, juniors in 3rd and seniors in 4th, 5th, or 6th years—according to the college type—and graduates in the internship.

2.2 | Study sample

Using Epi-Info 7.2.3.0 software statistical package created by Center for Disease Control and Prevention, Atlanta, Georgia, USA and based on the expected frequency of 50%, an acceptable margin of error of 2.5%, level of confidence of 95%, the minimum required sample size was calculated to equal 1456 student. They were approached by convenience sampling using a self-administered online questionnaire hosted in Microsoft form and distributed through official university platforms and informal students' groups on social media like Facebook. Some students' representatives from each faculty were also engaged in distributing the questionnaire's link directly to their colleagues. The form was open for one week from 8th to 15th January 2021 and then closed when not receiving any new responses for 24 h.

2.3 | Study tool

The questionnaire was designed and pretested by the researchers after an extensive literature review.[24,28-30] It addressed the following data: Personal characteristics; gender, age, residence, college, academic year, family income, and socioeconomic status. It also included questions about self-perception of own health status, risk perception percentage of getting COVID-19 infection, previous infection with COVID-19 or infection in a close social network, seasonal influenza vaccination, and knowledge and information sources COVID-19. Lastly, level of acceptance or hesitancy about COVID-19 vaccine, beliefs regarding COVID-19 vaccination (16 questions), perceived barriers and motivators of COVID-19 vaccination (13 questions), and type of COVID-19 vaccine preference. The questionnaire form was pretested on 20 students who were not included in the final analysis; its internal consistency was assessed by calculating the Cronbach's alpha as 0.790. Most of the questions were assigned to be mandatory answered items to avoid incompleteness and missing data.

2.4 | Statistical analysis of data

Data were extracted from the form to Excel sheet and statistically analyzed using IBM SPSS software version 26. Qualitative data were presented as frequencies and percentages, and a chi-square test was used for analysis. Quantitative variables were presented as mean and standard deviation, and ANOVA was used for analysis. Multivariate logistic regression was applied to predict factors affecting vaccine acceptance among respondents. The adopted significance level is $p < .05$.

2.5 | Ethical consideration

Research ethical approval from the Tanta Faculty of Medicine Research Ethical Committee (REC) was obtained (code:34400/1/21). An informative statement was added at the beginning of the anonymous online questionnaire, and the participants were provided with informed consent to be digitally signed before starting the survey. Confidentiality and privacy of data were guaranteed during the study, and the collected personal information was stored in secure folders that could only be accessed by the researchers and protected from any unauthorized access.

3 | RESULTS

3.1 | Participant characteristics in relation to COVID-19 vaccination acceptance status

The study included 2133 participants from five medical colleges in Tanta and Kafrelsheikh universities; their mean age was 20.24 ± 1.8 years. The acceptance group represented 34.9% of students (746 out of 2133), the hesitant group was 45.7% (974 out of 2133), and the refusal group constituted only 19.4% (413 out of 2133).

Regarding factors associated with COVID-19 vaccine acceptance among the respondent medical students: The majority (65.2%) of surveyed students were females, 68.4% were students in Medicine and Physiotherapy (34.1% and 34.3%, respectively), more than half had just enough income (57.3%), and most of them had average socioeconomic status (77.5%). However, there was no statistically significant difference between the groups of students accepting, hesitating, or refusing the vaccine regarding those variables. The highest percentage, 47% (38 out of 81), of vaccine acceptance, was reported among graduate respondents, while the highest percentage of hesitancy and refusal was reported among juniors 50.5% (140 out of 277) and 22.0% (61 out of 277), respectively, with a statistically significant difference ($p = .011$).

Most of the respondents reported average to very good health status (95.4%). Of the small percentage who reported bad health status, more than half were hesitant about the vaccine (53.8%; 42 out of 78), and one-third (33.3%; 6 out of 18) of the students with very bad health status accepted the vaccination, and the difference between the groups was statistically significant ($p = .001$). Overall, 38.7% of respondents reported ˃80% risk of infection with COVID-19, 26.2% reported ˃60% risk, 25.6% reported ˃40% risk. More than half of respondents (56.4%) were not infected with COVID-19, and only 4.4% had confirmed infection with no statistically significant difference between different groups of students. On the other hand, 51.5% of respondents had confirmed COVID-19 infection in their close social network, and of those, 35.4% accepted the vaccine, 46.1% (507 out of 1099) were hesitant, and 18.5% (203 out of 1099) refused the vaccine with a statistically significant difference ($p = .001$). Most respondents (89.7%) never received the seasonal influenza vaccine compared to only 2.6% who used to receive it annually, but the difference between groups was not statistically significant. Most respondents (91.3%) reported inadequacy of the available safety data for

TABLE 1 Factors associated with COVID-19 vaccine acceptance among respondent medical students

Factors	Overall respondents (n = 2133)		COVID-19 vaccine acceptance group (n = 746)[a]		COVID-19 vaccine hesitant group (n = 974)		COVID-19 vaccine refusal group (n = 413)[b]		p
	n	%	n	%	n	%	n	%	
Age (years), mean ± SD	20.24	± 1.78	20.24	± 1.853	20.26	± 1.77	20.20	± 1.67	.232
Sex									
Men	742	34.8	276	37.2	331	44.6	135	18.2	.263
Women	1391	65.2	470	33.8	643	46.2	278	20.0	
College									
Medicine	727	34.1	261	35.9	340	46.8	126	17.3	.725
Physical medicine	732	34.3	245	33.5	330	45.1	157	21.4	
Dentistry	256	12.0	71	27.7	137	53.5	48	18.8	
Nursing	274	12.8	130	47.4	98	35.8	46	16.8	
Pharmacy	144	6.8	39	27.1	69	47.9	36	25.0	
Academic year									
Freshman	496	23.3	165	33.3	235	47.4	96	19.4	.011[c]
Sophomore	676	31.7	266	39.3	283	41.9	127	18.8	
Junior	277	13.0	76	27.4	140	50.5	61	22.0	
Senior	603	28.3	201	33.3	284	47.1	118	19.6	
Graduate	81	3.8	38	46.9	32	39.5	11	13.6	
Family income									
Not enough	195	9.1	68	34.9	85	43.6	42	21.5	.762
Enough but no saving	1223	57.3	437	35.7	559	45.7	227	18.6	
Enough and saving	715	33.5	241	33.7	330	46.2	144	20.1	
Socioeconomic status									
Low	69	3.2	27	39.1	132	43.9	14	20.3	.093
Average	1654	77.5	585	35.4	28	40.6	299	18.1	
High	109	5.1	41	37.6	770	46.6	24	22.0	
Prefer Not to disclose	301	14.1	93	30.9	44	40.4	76	25.2	
Self-perception of own health status									
Very bad	18	0.8	6	33.3	3	16.7	9	50.0	.001[b]
Bad	78	3.7	15	19.2	42	53.8	21	26.9	
Average	536	25.1	123	22.9	242	45.1	171	31.9	
Good	1129	52.9	210	18.6	535	47.4	384	34.0	
Very good	372	17.4	6	33.3	152	40.9	161	43.3	
Risk perception percentage of getting COVID-19 infection									
0% -	70	3.3	20	28.6	26	37.1	24	34.3	.095
20% -	135	6.3	40	29.6	65	48.1	30	22.2	
40% -	545	25.6	200	36.7	241	44.2	104	19.1	
60% -	558	26.2	193	34.6	260	46.6	105	18.8	
> 80%	825	38.7	293	35.5	382	46.3	150	18.2	
Previous infection with COVID-19									
I do not know	470	22.0	155	33.0	225	47.9	90	19.1	.259
Yes & confirmed	94	4.4	29	30.9	46	48.9	19	20.2	
Yes, but not confirmed	367	17.2	118	32.2	164	44.7	85	23.2	
Not infected	1202	56.4	444	36.9	539	44.8	219	18.2	

(Continues)

TABLE 1 (Continued)

Factors	Overall respondents (n = 2133)		COVID-19 vaccine acceptance group (n = 746)[a]		COVID-19 vaccine hesitant group (n = 974)		COVID-19 vaccine refusal group (n = 413)[b]		p
	n	%	n	%	n	%	n	%	
COVID-19 infection in close social network									
Do not know	208	9.8	53	25.5	103	49.5	52	25.0	.001[b]
Yes & confirmed	1099	51.5	389	35.4	507	46.1	203	18.5	
Yes, but not confirmed	364	17.1	114	31.3	184	50.5	66	18.1	
Not infected	462	21.7	190	41.1	180	39.0	92	19.9	
Seasonal influenza vaccination									
Never	1914	89.7	647	33.8	890	46.5	377	19.7	.078
Last year	112	5.3	50	44.6	44	39.3	18	16.1	
Current flu season (2020–2021)	51	2.4	23	45.1	19	37.3	9	17.6	
Annually	56	2.6	26	46.4	21	37.5	9	16.1	
Adequacy of the available safety data for the new vaccine									
No	1947	91.3	617	31.7	926	47.6	404	20.7	.0001[b]
Yes	186	8.7	129	69.4	48	25.8	9	4.8	

[a]Vaccine acceptance = definitely accept + accept with some hesitancy.
[b]Vaccine refusal = definitely refuse + refuse with some hesitancy.
[c]Significant.

the new vaccines, and of the 8.7% who reported adequacy of safety data, 69.4% (129 out of 186) accepted the vaccine compared to 25.8% (48 out of 186) were hesitant, and 4.8% (9 out of 186) refused the vaccine (p = .0001). Other characteristics are shown in Table 1.

3.2 | COVID-19 vaccine acceptance and hesitancy among respondents

Near half (46%) of respondents showed hesitancy, and 6% either accepted the vaccine or refused it definitely (Figure 1A). Despite the reported hesitancy, most respondents (71%) intend to receive the vaccine but will postpone this for a while, and only 13% intend to receive it as soon as possible (Figure 1B). Approximately 46% (83 out of 181) of respondents who self-rated their level of knowledge about COVID-19 as very good were vaccine acceptors, while 45.5% (10 out of 22) of respondents with a very bad level of knowledge refused it (Figure 1C). Social media, scientific websites, and healthcare providers were the primary sources of information about COVID-19. Meanwhile, magazines and newspapers were the least (Figure 1D).

3.3 | Participants' beliefs regarding COVID-19 vaccination

Most participants believe that COVID-19 vaccination is important (90.5%), everyone in the community should get it once available

(92.6%), vaccination should be compulsory for the general population (69.7%), especially for health care workers (HCWs; 92.1%). Despite that good percentage of students believed that the way to overcome the COVID-19 pandemic is mass vaccination (67.9%) and that getting vaccinated is the best preventive measure (56.5%), most of them had concerns regarding the adverse effects of the vaccine (96.8%), its ineffectiveness (93.2%) and enough testing (80.2%), safety (54.0%), and 63.3% had concerns for the acquisition of COVID-19 from the vaccine itself. Most students were not against vaccination in general (95.1%), and 76.4% had no prior bad experience with any vaccines or their adverse reactions. Students perceived themselves at elevated risk to acquire COVID-19 (77.6%) and at a considerable risk of developing complications if they have been infected (75.9%; Table 2).

3.4 | Reported barriers and motivators of COVID-19 vaccination

The most-reported barriers of COVID-19 vaccination were insufficient information regarding adverse effects of the vaccine (potential 74.2% and unknown 56.3%), insufficient information regarding the vaccine itself (72.8%), financial cost hindrance if the vaccine is not free (68.0%), and insufficient trust in the vaccination source (55.1%). On the other hand, fear of infecting their family, especially parents, or being infected themselves were the most reported motivators (77.7% and 35.1%, respectively; Table 3).
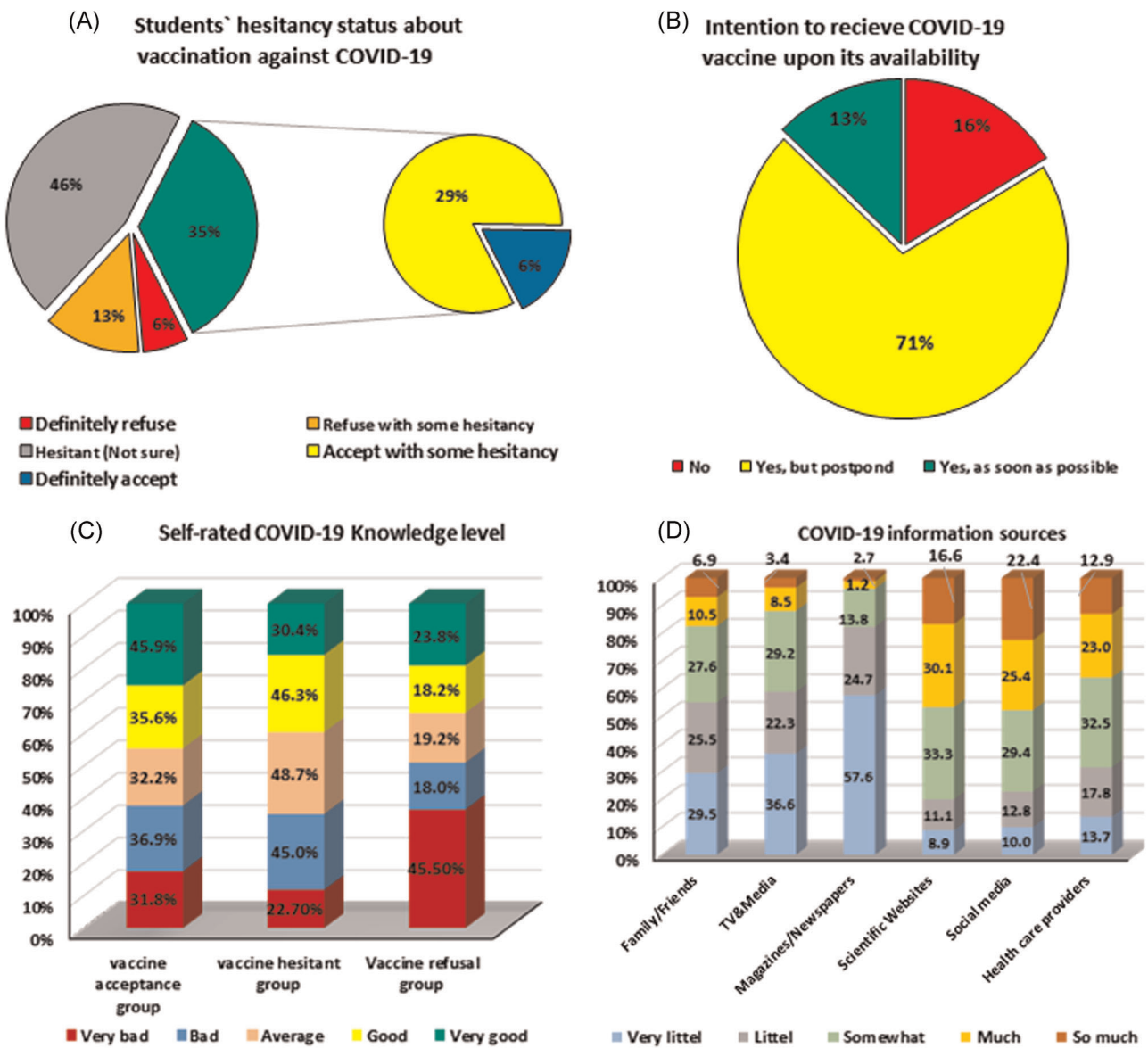
FIGURE 1 COVID-19 vaccine acceptance and hesitancy among respondents

Figure 2 portrays that 65.6% of respondents did not know the difference between types of available COVID-19 vaccines, while 22% preferred Pfizer-BionNTech one.

3.5 | Predictors associated with vaccine acceptance among medical students

Table 4 illustrates that being a pharmacy student, higher academic year and graduates, average to very good self-perception of own health status, good self-rated COVID-19 knowledge level, and presence of confirmed COVID-19 infection in close social network were the significant predictors of COVID-19 vaccine acceptance among studied medical students ($p < .05$).

4 | DISCUSSION

Vaccine hesitancy is a limiting step in global attempts to control the current pandemic with its adverse health and socioeconomic consequences. Understanding the student's attitude upon the COVID-19 vaccine and raising their acceptance is essential in planning an appropriate post-pandemic strategy.[31]

In the present study, 35% of the students accepted the COVID-19 vaccination, 46% were hesitant, and 19% refused (Figure 1A). A lower percentage of hesitancy (32.4%) and a higher level of acceptance (45.9%) were reported among some Egyptian HCWs.[26] The difference may be attributed to the higher age of health care staff (older participants seem to accept more) and the prevalence of co-morbidities or chronic diseases among them. Tam

	Perceived importance			
	Not important		Important	
Statement	**n**	**%**	**n**	**%**
How important do you perceive the COVID-19 vaccine to be?	202	9.5	1931	90.5
How important you think that everyone in the community should get the COVID-19 vaccine once available?	158	7.4	1975	92.6
Vaccination of COVID-19 should always be compulsory once it is available	646	30.3	1487	69.7
Your concerns regarding the COVID-19 vaccination?	282	13.2	1851	86.8
Vaccination of COVID-19 should always be compulsory for HCWs once it is available	169	7.9	1964	92.1
Statement	Disagree		Agree	
	n	*%*	*n*	*%*
I think that approval of the vaccine guarantees its safety	1151	54.0	982	46.0
Do you believe that the way to overcome the COVID-19 pandemic is mass vaccination?	684	32.1	1449	67.9
The best preventive measure for COVID-19 is getting vaccinated	927	43.5	1206	56.5
I think that the vaccine was not tested for enough time	422	19.8	1711	80.2
Concern regarding the adverse effects of the vaccine	68	3.2	2065	96.8
Concern about the ineffectiveness of the vaccine	145	6.8	1988	93.2
having a prior bad experience with any vaccines and their adverse reactions	1629	76.4	504	23.6
I am against vaccination in general	2028	95.1	105	4.9
Concern for the acquisition of Covid-19 from the vaccine	782	36.7	1351	63.3
I think that I am not at a considerable risk of developing complications if I have been infected with Covid-19	1618	75.9	515	24.1
I perceive myself not at elevated risk to acquire Covid-19	1655	77.6	478	22.4

et al., 2020 [23] reported 15.1% as hesitant, 60.6% as acceptance group, and 24.3% as refusal group among college students in South Carolina. In comparison, Lucia et al., 2020,[28] nearly one-quarter of the allopathic medical students in Southeast Michigan were vaccine-hesitant. Our findings are supported by a systematic review of COVID-19, which reported wide variability in COVID-19 vaccine acceptance rates in different countries with low rates in the Middle East.[32] This issue poses a significant problem for ongoing efforts to contain the current pandemic of COVID-19.

The majority of the participants had the intention of the vaccination, and only 16% had no intention (Figure 1B). Similar results were stated by Barello et al., 2020[29] as they found the Italian university students' intention to get the COVID-19 vaccine as 86.1%, and on the other side, 13.9% of them reported no intention. However, the estimated intention to vaccinate is higher among medical students due to higher literacy on health-related issues.[33]

Considerably high level (47.1%) of vaccine hesitancy was found among the senior students (Table 2). Seniors could help control the current pandemic in multiple ways and be prepared for future waves or peaks. Medical schools in some countries as the United States and England prepare students to help medical teams[34] efficiently, so they should be protected and vaccinated as vaccination of healthcare staff and students is a crucial measure in preventing health-related infections resulting from close interaction with high-risk patients.[29]

The high level of vaccine hesitancy among the students was surprisingly associated with a similarly high level of perception of elevated risk of getting COVID-19 infection (Table 1). This finding was in line with Lucia et al., 2020,[28] who reported that more than 2 out of 10 students were vaccine-hesitant despite self-perception of increased risk of exposure to COVID-19 infection. At the same time, this finding contrasts with previous studies, which showed the perception of risk as a key predictor of the intention of prevention and protective health behaviors.[30]

Near half of the vaccine, acceptors rated their COVID-19 related knowledge as good (Table 1; Figure 1C). Similarly, Barello et al. 2020 concluded that the vaccination attitude is affected by students' knowledge regarding health issues.[29]

TABLE 3 The perceived barriers and motivators of COVID-19 vaccination among the study participants

Factors	n (n = 2133)	%
The barriers to receiving the COVID-19 vaccine		
Doubt in vaccine safety	844	39.57
Doubt in vaccine effectiveness	501	23.49
Fear of unknown adverse effects	1201	56.31
Fear of long-term genetic effects of some vaccine types	488	22.88
Fear of (nanochips) implantation via the vaccine	332	15.56
Insufficient trust in the vaccination source (producer)	1175	55.09
Insufficient information regarding the vaccine	1552	72.76
Insufficient information regarding the potential adverse effects	1582	74.17
The financial cost hindrance if the vaccine is not free	1451	68.0
The motivators for receiving the COVID-19 vaccine		
Fear of being infected with COVID-19	749	35.11
Fear of infecting my family with COVID-19, especially my parents	1658	77.73
Belief in the effectiveness and safety of the vaccine	302	14.16
Availability of free vaccines	250	11.72

Most of the study participants perceived COVID-19 vaccination as important, especially for HCWs, and that it should be compulsory once widely available (Table 2). Corresponding findings were reported by Lucia et al., 2020.[28] CDC, 2020, recommends that healthcare personnel, including medical students, receive the first doses of COVID-19 vaccines due to their high risk of exposure.[35]

In this study, most participants reported having concerns regarding vaccine effectiveness, safety, and adverse effects (Table 2 & 3). Similar concerns were reported among Egyptian HCWs.[26] These findings may explain that although the students perceive the importance of the COVID-19 vaccine and agree to make the vaccination mandatory, they still have a significant hesitancy due to a lack of certainty on the safety of vaccinations and unknown potential adverse effects, in addition to misinformation from social media as a source of their knowledge.

Evidence suggests the importance of concentrating on building trust in COVID-19 vaccines. This includes the use of trusted messengers to navigate the COVID-19 information paradigm and confidence-building in vaccines through transparency and expectation management. Communities should be engaged early to listen to concerns, answer questions, and counter misinformation.[36] As public confidence in vaccination is weak; COVID-19 vaccination programs can only succeed if there is a common belief that the provided vaccines are safe and effective.[37] Lucia et al.,[28] emphasized the need for transparency and to answer concerns about vaccine development's speed and safety. Supporting COVID-19 vaccination through public messages and news releases and monitoring and tacking false news is crucial.

In This study, "Fear of being infected or infecting family with, especially parents" was highly reported among COVID-19 vaccination motivators (Table 3). This finding is supported by Brewer et al.[38] who reported that anticipated regret for lack of action (i.e., not getting a vaccination and being infected and/or infecting loved ones) is correlated with a higher likelihood of vaccination. However, a study on Saudi HCWs' willingness for COVID-19 vaccination concluded that the level of concern regarding contracting COVID-19 and infecting household members did not correlate significantly with their likelihood of being vaccinated.[39]

In this study, the main vaccination barriers were insufficient information regarding the vaccine and its potential adverse effects,
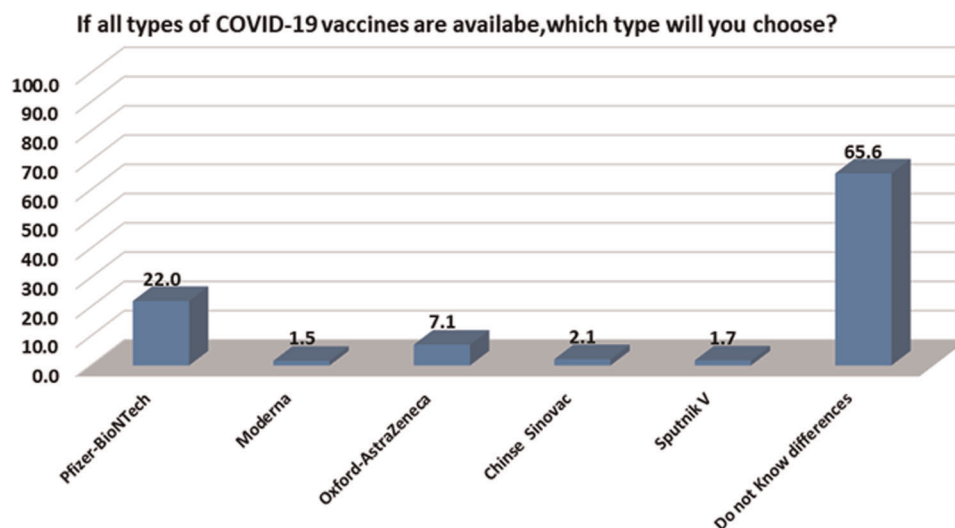

FIGURE 2 Type of COVID-19 vaccine preference among respondents

Predictor Variable	B	Wald	Sig.	Exp(B)	95% CI for EXP (B) Lower	Upper
Age	−0.064	1.057	0.304	0.938	0.831	1.060
Sex: Men #Ref.						
Women	0.140	1.821	0.177	1.150	0.939	1.409
College: Medicine #Ref.						
Physical medicine	0.323	2.249	0.134	1.381	0.906	2.105
Dentistry	0.269	1.501	0.221	1.308	0.851	2.010
Nursing	0.030	0.015	0.903	1.030	0.639	1.661
Pharmacy	0.817	9.470	0.002*	2.264	1.345	3.809
Year: Freshman #Ref.						
Sophomore	−1.025	5.124	0.024*	0.359	0.148	0.872
Junior	−0.874	4.747	0.029*	0.417	0.190	0.916
Senior	−1.034	7.816	0.005*	0.356	0.172	0.734
Graduate	−0.733	6.397	0.011*	0.480	0.272	0.848
Socioeconomic status: Low #Ref.						
Average	−0.242	0.881	0.348	0.785	0.474	1.301
High	−0.001	0.000	0.998	0.999	0.487	2.049
Prefer not to disclose	−0.029	0.016	0.900	0.972	0.620	1.523
Family income: Not enough #Ref.						
Enough but no saving	0.085	0.181	0.671	1.089	0.736	1.611
Enough and saving	0.161	2.073	0.150	1.174	0.944	1.462
Self-perception of own health status: Very bad #Ref.						
Bad	0.179	0.121	0.728	1.196	0.436	3.279
Average	−0.681	5.196	0.023*	0.506	0.282	0.909
Good	−0.392	6.488	0.011*	0.675	0.499	0.913
Very good	−0.310	5.507	0.019*	0.733	0.566	0.950
Self-rated COVID-19 knowledge level: Very bad #Ref.						
Bad	−0.486	0.887	0.346	0.615	0.224	1.691
Average	−0.150	0.324	0.569	0.861	0.514	1.442
Good	−0.459	6.532	0.011*	0.632	0.444	0.898
Very good	−0.339	3.651	0.056	0.713	0.504	1.009
Previous infection with COVID-19: I do not know #Ref.						
Yes & confirmed	−0.003	0.001	0.981	0.997	0.778	1.278
Yes, but not confirmed	−0.164	0.430	0.512	0.849	0.521	1.384
Not infected	−0.141	0.994	0.319	0.868	0.658	1.146
COVID-19 infection in close social network: I do not know #Ref.						
Yes & confirmed	−0.618	9.616	0.002*	0.539	0.365	0.797
Yes, but not confirmed	−0.110	0.740	0.390	0.895	0.696	1.152
Not infected	−0.296	3.357	0.067	0.744	0.542	1.021
Previous seasonal influenza vaccination: Never #Ref.						
Last year	−0.480	2.822	0.093	0.619	0.354	1.083
Current flu season (2020–2021)	−0.168	0.235	0.628	0.845	0.428	1.669
Annually	0.015	0.001	0.970	1.016	0.456	2.263

TABLE 4 Predictors of COVID-19 vaccine acceptance among medical students by logistic regression analysis

Predictor Variable	B	Wald	Sig.	Exp(B)	95% CI for EXP (B)	
					Lower	Upper
Risk perception percentage of getting COVID-19 infection: 0-#Ref.						
20	−0.402	1.948	0.163	0.669	0.380	1.177
40	−0.315	2.156	0.142	0.730	0.479	1.111
60	0.027	0.047	0.829	1.027	0.805	1.311
>80	−0.025	0.042	0.837	0.975	0.767	1.239

*Significant.

The dependent variable is vaccine acceptance (definitely accept and accept with some hesitancy) versus (definitely refuse, refuse with some hesitancy and hesitant responses) #Ref. Reference category.

the accelerated pace of the vaccine production, fear of high financial costs (Tables 2 and 3). Similarly, Lucia et al., 2020 [28] stated that concerns about the vaccine's serious side effects and lack of trusted information contributed to the hesitancy of vaccines. Also, Tam et al.[23] concluded that the adverse outcomes of COVID-19 vaccines as long-term side effects, safety issues, and distrust of vaccines lead to vaccine hesitancy. Misinformation regarding the vaccines and lack of advanced vaccination knowledge can contribute to anxiety, leading to overestimating possible side effects.[40] It is anticipated that many hesitant individuals may accept vaccination if reassured and provided with trustable information that the vaccine is safe and effective.

Gautam et al.[41] checked the responder's affordability and concluded that most responders wish a cheap or a free vaccine from the government. Vaccine cost and effectiveness appear as essential factors to accept vaccination.[42] A study on South Carolina college students reported vaccination costs as one factor that directly affects the students' vaccination behaviors.[23]

Some of the vaccination barriers and beliefs in the present study were false and related to the students' misinformation as genetic effects, acquisition of COVID-19 from the vaccine, and nanochips' implantation (Tables 3 and 4), and this could be attributed to lack of information concerning COVID-19 vaccination in their current curricula, so future inclusion of such topic into medical education could help them to evaluate the risks and benefits of vaccination. The World Health Organization warned that the world is fighting another kind of epidemic called "infodemic" that rapidly spreads fake news, misleading information, and false scientific claims.[43] Lessons learned from past outbreaks of SARS, H1N1, and Ebola illustrated the essential role of health information in disease prevention and vaccine acceptance.[44]

College students use various sources to know about COVID-19 vaccines, including health authorities, personal networks, and social media.[30] Hesitancy is exacerbated by social media, conspiracy theories, and misinformation.[45]

The study participants' reported social media, scientific websites, then health care providers as the most extensive sources to obtain their COVID-19 and vaccine information (Figure 1D). Vaccination decision-making is often affected by social networks' impacts, including family members, colleagues, and healthcare professionals.[38] Harapan et al.[46] asserted that most of the information about COVID-

19 is disseminated via social or online media. This information influences perceptions[47]; these sources are not a preferred knowledge source due to the public's misinformation (conspiracy theory). So, improved information on vaccines has been shown to increase vaccines' acceptance.[48]

Health professionals as a reliable source of COVID-19 information were a higher percentage (75%) in Malik et al.[49] but their study was among the USA's general population. However, it is recommended to organize expert groups for communicating with the public, including health officials and health practitioners, including nurses and ancillary health personnel, to conduct the community messaging to boost trust and increase the acceptance of the COVID-19 vaccine.[50]

Most participants did not know the available types of COVID-19 vaccines, so they do not have a preferred one (Figure 2). However, 46.2% of Egyptian HCWs reported preferring (Pfizer-BioNTech) vaccine due to trust in this brand and the transparency of their vaccine details and information presented to the public.[26] The type of vaccine may affect the individual's attitudes toward vaccination, though Pogue et al.[51] found that the vaccine type did not make a difference to the respondents, as they detected no significant difference in comfort to vaccination.

5 | CONCLUSIONS

This is the first study of vaccine hesitancy among university students—particularly medical students—in Egypt. This study highlighted the following:

- The COIVD-19 vaccine acceptance was only 35%, with considerably high hesitancy and refusal. Notably, the baseline acceptance for vaccination is not high enough in many countries, and the public confidence in vaccination is still weak.
- COIVD-19 vaccine acceptance's key barriers were concerns regarding safety, efficacy, and potential adverse effects, consistent with studies in other countries among different population groups.
- Social media was the commonest knowledge source for COVID-19 and vaccine. Misinformation and false claims led to vaccine hesitancy. Worldwide, online social media facilitate the

uncontrolled spread of fake news and misinformation, leading to infodemic.

6 | RECOMMENDATIONS

Since the hesitancy of COVID-19 vaccination negatively affects the implementation of mass vaccination programs hence the control of the current pandemic, the following measures are recommended to increase vaccine acceptance:

- Provision of evidence-based information for COIVID-19 vaccines with effective and proactive initiatives that keep a vigilant eye to fight misinformation.
- Organizing expert groups from health professionals and scientists for scientific engagement on COVID-19 vaccines to provide truthful and understandable information for reducing confusion and doubt and reconstructing a trusting relationship with the public utilizing social and traditional media.
- Monitoring and confronting misinformation and fake news on COVID-19 Vaccines, especially on the social media platforms.

7 | LIMITATIONS

The current study sample was from medical colleges in only two universities and done on only medically-oriented students, which may affect generalizability to other college populations elsewhere. The online reaching of the participants within a short time. Respondents may also have been predominantly affected by media attention to the COVID-19 vaccine, as this topic has not been formally integrated into their curricula.

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