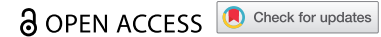





RESEARCH ARTICLE



COVID-19 vaccine knowledge and acceptance among the Libyan population: A cross-sectional study

Rana H. Shembesh ^a, Mohammed S. Beshr ^b, and Mariam M. ALTarhouni ^a

^aFaculty of Medicine, Libyan International Medical University, Benghazi, Libya; ^bFaculty of Medicine and Health Sciences, Sana'a University, Sana'a, Yemen

ABSTRACT

We aim to identify Libyans' knowledge, attitudes, and acceptance regarding the COVID-19 vaccine. A cross-sectional survey was electronically distributed to the Libyan population aged 18 and older between May and September 2023. The questionnaire had three sections: socio-demographics, COVID-19 vaccination and infection, and knowledge and attitudes toward the COVID-19 vaccine. The chi-square test was used to assess the associations. A total of 1,043 respondents completed the questionnaire. Of these, 590 (56.6%) were vaccinated, and 453 (43.4%) were unvaccinated. Only age, educational level, employment status, history of COVID-19 infection, and source of information had a significant association with vaccination status; all shared a p -value $< .05$. However, Monthly income did not. Regarding knowledge, 63.7% agreed that vaccines in general are an effective way to prevent and control infectious diseases, and 76.6% agreed that they can prevent disease and mortality. However, regarding COVID-19 vaccine, 48.4% agreed that the benefits outweigh the risks. Regarding COVID-19 safety, 40.8% responded that COVID-19 vaccines are only slightly safe or not safe at all. COVID-19 vaccine acceptance was at 57.2%, and only age and source of information were significantly associated. Those who held favorable views were more likely to accept the vaccine, while those who had concerns about safety were more vaccine hesitant. There is a gap between the perception of the COVID-19 vaccine compared to other vaccines among Libyans. Our study revealed that 57.2% of Libyans accept the COVID-19 vaccine. However, only 34% of the Libyan population is vaccinated. A comprehensive health policy is needed.

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Introduction

As of early January 2022, COVID-19 has been linked to approximately 289 million confirmed cases and over 5.4 million deaths worldwide.¹ One of the main tools developed during the pandemic to combat the virus was the COVID-19 vaccine. COVID-19 vaccine has effectively reduced hospitalization rates, the risk of severe disease and mortality among those vaccinated.^{2,3}



COVID-19 infection, particularly in Africa, is exacerbated by impractical vaccine programming, limited testing capacity, and poor healthcare systems, potentially leading to vaccine hesitancy and disease spread.⁴ Similarly, Libya's healthcare system was unprepared for the pandemic and faced numerous challenges. The lack of sufficient funding for healthcare facilities has hindered their ability to cope with the COVID-19 pandemic. There was a shortage of protective equipment, inadequate healthcare training, a lack of testing centers, an insufficient number of beds, coupled with the spread of COVID-19 among healthcare workers, had led to the closure of many health facilities during the pandemic.^{5,6}

UNICEF, WHO, and USAID have supported the Libyan Ministry of Health and the National Center for Disease Control (NCDC) in their efforts to develop a national health plan to curb the spread of COVID-19 and deliver the COVID-

19 vaccine. These efforts have reached over 4.8 million individuals with information and recommendations to increase vaccine uptake and curb the pandemic.^{7,8} Despite these efforts, vaccination coverage in Libya remains low, with 34% of the population receiving at least one dose and only 18% completing their primary COVID-19 vaccine series, according to the latest WHO reports.⁹

A survey assessing Libyan knowledge and attitudes toward the COVID-19 pandemic revealed gaps and misinformation regarding the pandemic. Almost half of the participants considered the threat of COVID-19 to be low. Individuals with higher education had better knowledge and attitudes, while those living in the Eastern or Southern regions had lower scores.¹⁰ Another report on Libyan perception of the COVID-19 pandemic have shown that 41% believe the number of COVID-19 cases has been exaggerated, 36.9% believe that traditional remedies can help with COVID-19 infection, and 68.1% were adherent to mask-wearing.¹¹ This may highlight the gaps in messaging and the need for more outreach programs to enhance public perception of health-related issues.

As long as vaccination rates in Libya remain low and vaccine hesitancy persists, coupled with ongoing misinformation about the COVID-19 vaccine from unauthorized media sources, future COVID-19 waves in Libya will remain a risk.

CONTACT Mohammed S. Beshr  mbeshr2020@gmail.com  Faculty of Medicine and Health Sciences, Sana'a University, 40th St, Near Dhamran Center, Saw'an, P.O. Box 13078, Sana'a, Yemen.

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Identifying factors related to vaccine acceptance and hesitancy is crucial for policymakers and public health leaders in order to improve the population's knowledge and raise awareness to control the spread of the virus, prevent future waves, avoid health-related poor outcomes, and decrease the burden on the healthcare system.

This study aimed to examine Libyans' knowledge, attitudes, and acceptance toward the COVID-19 vaccine, in order to identify factors that may cause vaccine hesitancy in Libya, as only 18% have completed their COVID-19 vaccine series.⁹ We hope to provide insights that will be useful for future campaigns aimed at raising awareness and correcting misconceptions, to enhance community confidence in the vaccine.

Materials and methods

Study design and settings

This is a cross-sectional study; it was conducted between May and September 2023. The questionnaire was delivered electronically via Google Forms. We targeted the general population by distributing it through a list of popular online sites in social media platforms. Only those at the age of 18 or above were included in the analysis. The data were collected anonymously, with no identifiable information gathered.

Sample size

It was calculated using Epi Info version 7.2. We used the following assumptions: a Libyan population of 6,812,341, an expected frequency of 47.8% based on a 2021 survey on COVID-19 vaccine acceptance in Jabal Al-Akhdar district in Libya,¹² a margin of error of 4%, and a confidence interval of 95%. The calculated sample size was 600.

Study tools

A self-reported questionnaire, written in Arabic, began with informed consent and an explanation of the nature of the study and how the information would be used.

The questionnaire was divided into three sections, first part is regarding the sociodemographic data: age, gender, nationality, educational status, occupation, employment status, marital status, geographical location, and income.

The second part concerns vaccine status and COVID-19 infection. We asked participants about their vaccination status, the type of vaccine received, and the number of doses. Additionally, we inquired whether participants had been infected with COVID-19 and whether the infection was confirmed.

The third part addresses questions related to knowledge and attitudes, along with an additional question about COVID-19 vaccine acceptance, totaling about 12 questions.

To assess their knowledge of COVID-19 vaccines, five questions were used. Each question was scored from 1 to 5, with 1 being the lowest score and 5 being the highest. The answers were scored as follows: "Strongly agree" received 5 points, "Agree" received 4 points, "Neutral" received 3 points, "Disagree" received 2 points, and "Strongly disagree" received

1 point. Except for one question "Young adults (less than 30 years) and children do not need any vaccination against COVID-19." The scores are calculated in reverse, where "Strongly disagree" received 5 points, while "Strongly agree" received 1 point. The combined score for the five questions ranged from 5 to 25, with 5 been the lowest and 25 the highest. Individuals were categorized into three groups based on their scores: Highly Knowledgeable (scores ranging from 16 to 25), Moderately Knowledgeable (scores from 8 to 15), and Poorly Knowledgeable (scores less than 8).

To assess their attitudes toward COVID-19 vaccines, we ask six questions regarding vaccine safety, effects, availability, ease of access, concerns about the COVID-19 vaccine, and the factors that motivate them to get vaccinated.

Finally, the last question was regarding vaccine acceptance: "Do you accept the COVID-19 vaccine?" had five options: "Strongly accept," "Accept," "Neutral," "Refuse," and "Strongly refuse. Our final questionnaire is presented in the supplementary file.

When we developed our questionnaire, we conducted a literature search of related articles, and we adapted our questions from the following papers.¹³⁻¹⁶ The questions were first formulated in English and then translated into Arabic. After formulating the questions, we consulted with epidemiologists at the Libyan International Medical University and reached a consensus on the final draft and translation. We conducted a pilot survey with 39 participants using the Arabic version of the questionnaire. Subsequently, we performed a reliability analysis on the knowledge and attitudes questions. The Cronbach's alpha coefficient for these questions was 0.683, indicating acceptable internal consistency. None of the pilot subjects included in the final analysis.

Data analysis

We used IBM SPSS version 29 to analyze the data. The chi-square test was used to evaluate associations with vaccination status, as well as associations with the acceptance of COVID-19 vaccine. A p-value of less than 0.05 was considered statistically significant. We calculated the mean and standard deviation for the knowledge scores. Descriptive analysis of the categorical data presented using percentages and frequencies.

Regarding the monthly income question, when analyzing its association with vaccination status and vaccine acceptance using the chi-square test, we included only the first four responses (Less than 1000 LYD, 1000-2500 LYD, 2500-4000 LYD, and more than 4000 LYD) and excluded 'I prefer not to disclose' from the analysis.

Ethical approval

The study proposal was submitted to the Research Ethics Committee of the Libyan International Medical University, Benghazi, Libya, and was subsequently approved. The project number is I-G-00011, and the certificate reference number is AMS-2023-00003. The study was conducted in compliance with the Declaration of Helsinki. The nature and purpose of the study, and how this information may be used, were explained before participants entered the survey.

Participation in this study was voluntary, and no identifiable information was utilized; all responses were kept anonymous, with a corresponding ID number. Access to the responses is secured and is accessible only by the authors.

Results

Background characteristics

A total of 1,043 respondents completed the questionnaire. Females made up 751 (72.0%), while males accounted for 292 (28%). Regarding age, 801 (76.8%) were in the age group 18–30, 121 (11.6%) were in the age group 31–40, 73 (7%) were in the age group 41–50, and 48 (4.6%) were aged 50 and above. In terms of geographic location, 885 (84.9%) live in eastern Libya. Regarding employment, 650 (62.3%) individuals were students, 112 (10.7%) worked in the health sector, 237 (22.7%) were employed in other sectors, and 44 (4.2%) were unemployed.

The main sources of information regarding COVID-19: 360 (34.5%) respondents rely on the World Health Organization (WHO), 160 (15.3%) on the National Center for Disease Control (NCDC), and 69 (6.6%) on social media. Additionally, 325 (31.2%) of respondents use more than one source for COVID-19 news.

Regarding COVID-19 infection, 437 (41.9%) respondents have never had COVID-19, either by symptoms or a test. In the other hand, 213 (20.4%) respondents had COVID-19 symptoms but were not confirmed by a test. Meanwhile, 288 (27.6%) respondents were confirmed to have COVID-19 once, and 101 (9.7%) respondents were confirmed twice. Finally, about 590 individuals (56.6%) were vaccinated, while 453 (43.4%) were unvaccinated. Among those vaccinated, 178 (17%) received a single dose, 359 (34.4%) received two doses, and 53 (5.1%) received two doses plus one booster. A detailed overview of the background characteristics is presented in Table 1.

COVID-19 vaccination status

In our evaluation of vaccination status, 590 (56.6%) were vaccinated, and 453 (43.4%) were unvaccinated. We evaluated the factors associated with vaccination status. There was a significant association with age, particularly in the higher age groups of 41–50 and over 50, which had higher vaccination rates: 71.2% for the 41–50 age group and 70.8% for those over 50 ($X^2 = 12.751$, $p = .005$). Similarly, educational level showed a significant association, with vaccination rates being higher among those with a bachelor's degree (63.2%) and postgraduate education (70.4%) ($\chi^2 = 30.090$, $p < .001$).

Employment was significantly associated with vaccination status ($\chi^2 = 11.868$, $p = .008$). Individuals who were employed had higher vaccination rates, with 58.9% among those working in the health sector and 62.9% among those in other professions. Students had a vaccination rate of 55.2%, while the unemployed had the lowest rate at 36.4%. Similarly, source of information regarding COVID-19 showed a significant association ($\chi^2 = 39.641$, $p < .001$). Those who relied on the WHO and the NCDC were more likely to be vaccinated, with rates of 65.0% and 65.6%,

respectively. In contrast, social media and relying on community opinions were associated with low vaccination rates, at 42% and 35.3%, respectively. History of COVID-19 infection was significantly associated with the vaccination status. Individuals who had confirmed infections once or twice were more likely to be vaccinated ($X^2 = 10.943$, $p = .027$).

On the other hand, variables such as gender, marital status, monthly income, nationality, and geographic location were not associated with vaccination status. All had p-values greater than 0.05, indicating a lack of statistical significance. These associations are illustrated in detail in Table 1.

Knowledge towards COVID-19 vaccine

The knowledge scores ranged from 5 to 23, with a mean of 15.24 (standard deviation, SD, 3.1). We further categorized the respondents into groups: 462 (44%) were highly knowledgeable (scores between 16 and 23), 576 (55%) were moderately knowledgeable (scores between 8 and 15), and only 5 (0.5%) respondents had low knowledge (scores ≤ 7).

About 63.7% of respondents agreed or strongly agreed that vaccination in general is an effective way to prevent and control infectious diseases. Regarding, vaccination against infectious diseases reduces the incidence and mortality, 76.6% agreed or strongly agreed. However, only 59.4% agreed that COVID-19 vaccines are useful in controlling the infection, and only 48.4% felt that the benefits of the COVID-19 vaccine outweigh the risks. Lastly, 45.6% disagreed that young adults and children should not receive the COVID-19 vaccine, while 25.6% agreed with this statement. The detail representation of these questions presented in Table 2.

Attitudes toward COVID-19 vaccine

The first question was, "How safe do you believe the COVID-19 vaccine is?" In response, 9.8% said very safe, 49.4% fairly safe, 27.4% a little safe, and 13.4% not safe at all. To "What are the effects of the COVID-19 vaccine in your opinion?," 15.6% believed it could cause infection, 7.7% thought it prevents infection, and 76.7% said it reduces symptoms and severity. Regarding the ease of obtaining the vaccine in Libya, 73.2% found it "very easy" or "fairly easy" to obtain, while 12.8% found it "somewhat difficult" or "very difficult. Finally, regarding the statement "COVID-19 vaccines are available in Libya," 62.2% agreed or strongly agreed, while 11.1% disagreed or strongly disagreed.

When asked about their concerns regarding the COVID-19 vaccine, 26.3% cited side effects, 15.1% mentioned lack of information, 17.4% expressed distrust in Libya's medical system, and 20.8% had no worries. Finally, we asked the vaccinated individuals what factors drove them to take the vaccine. Of those surveyed, 29.8% were motivated by a sense of duty to help eradicate the epidemic, 22.7% feared COVID-19 infection, 15.8% faced mandatory requirements for work or school, and 13.7% wanted to comply with travel regulations. A detailed representation of the answers is presented in Table 3.

Table 1. Background characteristics and their association with vaccination status, N (%).

Variable	N	Vaccinated	Unvaccinated	X ²	P-value
Total	1043	590 (56.6)	453 (43.4)		
Age				12.751	.005
18–30	801 (76.8)	443 (55.3)	358 (44.7)		
31–40	121 (11.6)	61 (50.4)	60 (49.6)		
41–50	73 (7.0)	52 (71.2)	21 (28.8)		
>50	48 (4.6)	34 (70.8)	14 (29.2)		
Gender				3.699	.054
Female	751 (72.0)	411 (54.7)	340 (45.3)		
Male	292 (28.0)	179 (61.3)	113 (38.7)		
Marital status				0.996	.318
Married	227 (21.8)	135 (59.5)	92 (40.5)		
Unmarried ^a	816 (78.2)	455 (55.8)	361 (44.2)		
Educational level				30.090	<.001
High school	302 (29.0)	146 (48.3)	156 (51.7)		
Diploma	113 (10.8)	53 (46.9)	60 (53.1)		
Bachelor's	323 (31.0)	204 (63.2)	119 (36.8)		
Post-graduate	142 (13.6)	100 (70.4)	42 (29.6)		
Uneducated	163 (15.6)	87 (53.4)	76 (46.6)		
Nationality				0.156	.693
Libyan citizen	1001 (96.0)	565 (56.4)	436 (43.6)		
International citizen	42 (4.0)	25 (59.5)	17 (40.5)		
Geographic location				4.236	.120
Eastern-Libya	885 (84.9)	492 (55.6)	393 (44.4)		
Western-Libya	137 (13.1)	82 (59.9)	55 (40.1)		
Southern-Libya	21	16 (76.2)	5 (23.8)		
Employment status				11.868	.008
In the health sector	112 (10.7)	66 (58.9)	46 (41.1)		
Other sectors	237 (22.7)	149 (62.9)	88 (37.1)		
Student ^b	650 (62.3)	359 (55.2)	291 (44.8)		
Unemployed	44 (4.2)	16 (36.4)	28 (63.6)		
Monthly income ^c				5.929	.115
Less than < 1000 LYD	270 (25.9)	156 (57.8)	114 (42.2)		
1000 – 2500 LYD	179 (17.2)	114 (63.7)	65 (36.3)		
2500 – 4000 LYD	52 (5.0)	38 (73.1)	14 (26.9)		
More than 4000 LYD	20 (1.9)	10 (50.0)	10 (50.0)		
I prefer not to disclose	522 (50.0)	272 (52.1)	250 (47.9)		
Source of information regarding COVID-19				39.641	<.001
World Health Organization (WHO)	360 (34.5)	234 (65.0)	126 (35.0)		
National Center for Disease Control (NCDC)	160 (15.3)	105 (65.6)	55 (34.4)		
Social media	69 (6.6)	29 (42.0)	40 (58.0)		
more than one source	325 (31.2)	158 (48.6)	167 (51.4)		
News and media	78 (7.5)	46 (59.0)	32 (41.0)		
Relying on the opinions of the community	51 (4.9)	18 (35.3)	33 (64.7)		
History of COVID-19 infection				10.943	.027
I Never had it by either symptoms or tests	437 (41.9)	228 (52.2)	209 (47.8)		
Had COVID symptoms but not confirmed by a test	213 (20.4)	118 (55.4)	95 (44.6)		
Confirmed once	288 (27.6)	176 (61.1)	112 (38.9)		
Confirmed twice	101 (9.7)	64 (63.4)	37 (36.6)		
Confirmed three times	4 (0.4)	4 (100)	0		
COVID-19 vaccination status					
Unvaccinated	453 (43.4)	0	453 (100)		
Vaccinated	590 (56.6)	590 (100)	0		
Single dose	178 (17.1)	178 (100)	0		
Two-doses	359 (34.4)	359 (100)	0		
Two-doses and a booster	53 (5.1)	53 (100)	0		

A *p*-value of less than 0.05 indicates statistical significance. ^aincluded unmarried or widowed. ^bundergraduate students who attend college or high school, and at the age of 18 or above. ^cChi-square test was done without including the last option (df = 3, N = 521). Abbreviations. X²: Chi-square test. LYD: Libyan dinar.

COVID-19 vaccine acceptance

In our evaluation of COVID-19 vaccine acceptance rates, we asked at the end of the questionnaire, “Do you accept the COVID-19 vaccine?” The results were as follows: 16.2% strongly accepted, 41.0% accepted, 19.8% were neutral, 10.8% refused, and 12.2% strongly refused.

When we evaluated the associations with our variables, we found that only age and source of information had a significant association with COVID-19 acceptance. Individuals aged 41–50

and those over 50 were more likely to respond with “strongly accept” or “accept.” These findings were supported by the following: $\chi^2 = 24.629$, $p = .017$. Additionally, those who used WHO or NCDC as a source of information were more likely to respond with “strongly accept” and “accept” ($\chi^2 = 93.674$, $p < .001$).

Variables such as gender, marital status, educational level, nationality, geographical location, employment status, monthly income, and history of COVID-19 infection all had *p*-values above 0.05, indicating a lack of statistical

Table 2. Knowledge toward COVID-19 vaccine questions, N (%).

	Vaccination in general is an effective way to prevent and control infectious diseases	Vaccination against infectious diseases reduces both the incidence of diseases and the mortality rate among individuals	The Benefits of COVID-19 vaccine outweigh the risks	The COVID-19 vaccine will generally be effective in controlling the infection	Younger adults under 30 and children do not need to be vaccinated against COVID-19
Strongly agree	240 (23.0)	315 (30.2)	144 (13.8)	162 (15.5)	94 (9.0)
Agree	424 (40.7)	484 (46.4)	361 (34.6)	458 (43.9)	173 (16.6)
Neutral	265 (25.4)	174 (16.7)	363 (34.8)	299 (28.7)	300 (28.8)
Disagree	67 (6.4)	51 (4.9)	89 (8.5)	82 (7.9)	337 (32.3)
Strongly disagree	47 (4.5)	19 (1.8)	86 (8.2)	42 (4.0)	139 (13.3)

Table 3. Attitudes toward COVID-19 vaccine questions, N (%).

Question	N (%)
How safe COVID-19 vaccine in your opinion?	
very safe	102 (9.8)
Fairly safe	515 (49.4)
a little safety	286 (27.4)
Not safe at all	140 (13.4)
What are the COVID-19 vaccine effects in your opinion?	
It can cause COVID-19 infection	163 (15.6)
It prevents COVID-19 infection	80 (7.7)
They reduce the symptoms and severity of COVID-19 infection	800 (76.7)
How easy do you think it is to get the COVID-19 vaccine?	
very easy	290 (27.8)
fairly easy	474 (45.4)
I'm not sure	145 (13.9)
Somewhat difficult	116 (11.1)
very Difficult	18 (1.7)
COVID-19 Vaccines are available in Libya	
Strongly agree	142 (13.6)
Agree	511 (49.0)
Neutral	274 (26.3)
Disagree	85 (8.1)
Strongly disagree	31 (3.0)
Concerns about COVID-19 Vaccine?	
Against vaccines in general	23 (2.2)
I don't trust the medical health system	182 (17.4)
The COVID-19 is virus not dangerous	18 (1.7)
It has not been adequately researched or tested	1 (0.1)
Lack of information	157 (15.1)
Side effects	274 (26.3)
Unsafe	44 (4.2)
not effective	14 (1.3)
Fear of injection	29 (2.8)
Cultural reasons	22 (2.1)
safe with traditional remedies	10 ¹
Other	52 ⁵
I have no worries	217 (20.8)
What drive you to take the vaccine?	
To be able to travel and comply with COVID-19 travel regulations	81 (13.7)
Mandatory requirements for Returning to Work or School	93 (15.8)
Confidence in the decisions of the Libyan government	10 (1.7)
encouragement from the family.	41 (6.9)
fear of COVID-19 infection	134 (22.7)
My duty to society to participate in eradicating the epidemic	176 (29.8)
Other	18 (3.1)
The death of a relative after contracting COVID-19	37 (6.3)
Total = 590	

significance. The detailed illustration of these associations is presented in Table 4.

Associations between vaccine knowledge and attitudes, and vaccine acceptance

Regarding knowledge questions, those who agreed with the statement "Vaccination in general is an effective way to prevent and control infectious diseases" were more

likely to accept the vaccine than those who disagreed. Similar trends were seen for statements such vaccination reduces infectious diseases incidence and mortality, the benefits of COVID-19 vaccine outweighing the risks, and the effectiveness of COVID-19 vaccine in controlling the infection. Those who disagreed with the statement "Younger adults under 30 and children do not need to be vaccinated against COVID-19" were also more likely to accept the vaccine.

Table 4. COVID-19 vaccine acceptance, and their associations, N (%).

Variable	N	Strongly accept	Accept	Neutral	Refuse	Strongly refuse	X ²	P-value
Total	1043	169 (16.2)	428 (41.0)	206 (19.8)	113 (10.8)	127 (12.2)		
Age							24.629	.017
18–30	801 (76.8)	128 (16.0)	319 (39.8)	166 (20.7)	97 (12.1)	91 (11.4)		
31–40	121 (11.6)	13 (10.7)	57 (47.1)	27 (22.3)	6 (5.0)	18 (14.9)		
41–50	73 (7.0)	15 (20.5)	32 (43.8)	11 (15.1)	4 (5.5)	11 (15.1)		
>50	48 (4.6)	13 (27.1)	20 (41.7)	2 (4.2)	6 (12.5)	7 (14.6)		
Gender							4.222	.377
Female	751 (72.0)	119 (15.8)	311 (41.4)	140 (18.6)	82 (10.9)	99 (13.2)		
Male	292 (28.0)	50 (17.1)	117 (40.1)	66 (22.6)	31 (10.6)	28 (9.6)		
Marital status							5.963	.202
Married	227 (21.8)	36 (15.9)	106 (46.7)	38 (16.7)	18 (7.9)	29 (12.8)		
Unmarried	816 (78.2)	133 (16.3)	322 (39.5)	168 (20.6)	95 (11.6)	98 (12.0)		
Educational level							20.235	.210
High school	302 (29.0)	49 (16.2)	112 (37.1)	62 (20.5)	38 (12.6)	41 (13.6)		
Diploma	113 (10.8)	16 (14.2)	45 (39.8)	25 (22.1)	8 (7.1)	19 (16.8)		
Bachelor's	323 (31.0)	47 (14.6)	137 (42.4)	68 (21.1)	40 (12.4)	31 (9.6)		
Post-graduate	142 (13.6)	33 (23.2)	62 (43.7)	24 (16.9)	10 (7.0)	13 (9.2)		
Uneducated	163 (15.6)	24 (14.7)	72 (44.2)	27 (16.6)	17 (10.4)	23 (14.1)		
Nationality							6.104	.192
Libyan citizen	1001 (96.0)	165 (16.5)	120 (12.0)	196 (19.6)	105 (10.5)	415 (41.5)		
International citizen	42 (4.0)	4 (9.5)	7 (16.7)	10 (23.8)	8 (19.0)	13 (31.0)		
Geographical location							4.669	.792
Eastern-Libya	885 (84.9)	142 (16.0)	362 (40.9)	181 (20.5)	94 (10.6)	106 (12.0)		
Western-Libya	137 (13.1)	25 (18.2)	56 (40.9)	23 (16.8)	15 (10.9)	18 (13.1)		
Southern-Libya	21	2 (9.5)	10 (47.6)	2 (9.5)	4 (19.0)	3 (14.3)		
Employment status							11.560	.482
In the health sector	112 (10.7)	19 (17.0)	46 (41.1)	23 (20.5)	7 (6.3)	17 (15.2)		
Other sectors	237 (22.7)	39 (16.5)	107 (45.1)	38 (16.0)	25 (10.5)	28 (11.8)		
Student	650 (62.3)	107 (16.5)	257 (39.5)	137 (21.1)	76 (11.7)	73 (11.2)		
Unemployed	44 (4.2)	4 (9.1)	18 (40.9)	8 (18.2)	5 (11.4)	9 (20.5)		
Monthly income ^a							7.012	.857
Less than < 1000 LYD	270 (25.9)	48 (17.8)	103 (38.1)	57 (21.1)	25 (9.3)	37 (13.7)		
1000 – 2500 LYD	179 (17.2)	35 (19.6)	77 (43.0)	30 (16.8)	14 (7.8)	23 (12.8)		
2500 – 4000 LYD	52 (5.0)	11 (21.2)	24 (46.2)	9 (17.3)	5 (9.6)	3 (5.8)		
More than 4000 LYD	20 (1.9)	5 (25.0)	6 (30.0)	3 (15.0)	2 (10.0)	4 (20.0)		
I prefer not to disclose	522 (50.0)	70 (13.4)	218 (41.8)	107 (20.5)	67 (12.8)	60 (11.5)		
Source of information regarding COVID-19							93.674	<.001
World Health Organization (WHO)	360 (34.5)	77 (21.4)	168 (46.7)	61 (16.9)	27 (7.5)	27 (7.5)		
National Center for Disease Control (NCDC)	160 (15.3)	26 (16.3)	84 (52.5)	27 (16.9)	15 (9.4)	8 (5.0)		
Social media	69 (6.6)	12 (17.4)	17 (24.6)	19 (27.5)	11 (15.9)	10 (14.5)		
more than one source	325 (31.2)	42 (12.9)	111 (34.2)	58 (17.8)	44 (13.5)	70 (21.5)		
News and media	78 (7.5)	9 (11.5)	32 (41.0)	25 (32.1)	7 (9.0)	5 (6.4)		
Relying on the opinions of the community	51 (4.9)	3 (5.9)	16 (31.4)	16 (31.4)	9 (17.6)	7 (13.7)		
History of COVID-19 infection							21.423	.163
Never by either symptoms or tests	437 (41.9)	74 (16.9)	178 (40.7)	78 (17.8)	45 (10.3)	62 (14.2)		
Had COVID symptoms but not confirmed by a test	213 (20.4)	21 (9.9)	90 (42.3)	49 (23.0)	25 (11.7)	28 (13.1)		
Confirmed once	288 (27.6)	61 (21.2)	113 (39.2)	55 (19.1)	33 (11.5)	26 (9.0)		
Confirmed twice	101 (9.7)	13 (12.9)	45 (44.6)	22 (21.8)	10 (9.9)	11 (10.9)		
Confirmed three times	4 (0.4)	0	2 (50)	2 (50)	0	0		
COVID-19 vaccination status								
Unvaccinated	453 (43.4)	17 (3.8)	99 (21.9)	132 (29.1)	90 (19.9)	115 (25.4)		
Vaccinated	590 (56.6)	152 (25.8)	329 (55.8)	74 (12.5)	12 (2.0)	23 (3.9)		
Single dose	178 (17.1)	33 (18.5)	90 (50.6)	39 (21.9)	11 (6.2)	5 (2.8)		
Two-doses	359 (34.4)	98 (27.3)	211 (58.8)	33 (9.2)	11 (3.1)	6 (1.7)		
Two-doses and a booster	53 (5.1)	21 (39.6)	28 (52.8)	2 (3.8)	1 (1.9)	1 (1.9)		

A *p*-value of less than .05 indicates statistical significance. ^aChi-square test was done without including the last option (df = 12, N = 521). Abbreviations. X²: Chi-square test. LYD: Libyan dinar.

Regarding attitude questions, those who thought the vaccines were safe were more likely to accept the vaccine, and those who had safety concerns were more likely to be vaccine hesitant. Those who thought the vaccine prevents COVID-19 and reduces symptoms were more likely to accept the vaccine. The remaining questions and these associations are presented in Table 5.

Discussion

Of the 1043 respondents, 590 (56.6%) were vaccinated, and 453 (43.4%) were unvaccinated. Only age, educational level, employment status, history of COVID-19 infection, and source of information had a significant association with vaccination status. On the other hand, monthly income did not have a significant association with vaccination status.

Table 5. The associations between vaccine knowledge and attitudes, and vaccine acceptance, N (%).

Variable	N	Yes	No	Neutral	X ²	P-value
Total	1043	597 (57.2)	240 ¹⁷	206 (19.8)		
Knowledge toward COVID-19 vaccine					391.42	<.001
Vaccination in general is an effective way to prevent and control infectious diseases						
Strongly agree	240 (23.0)	206 (85.8)	12 ⁵	22 (9.2)		
Agree	424 (40.7)	295 (69.6)	59 (13.9)	70 (16.5)		
Neutral	265 (25.4)	88 (33.2)	79 (29.8)	98 (37)		
Disagree	67 (6.4)	6 ⁹	50 (74.6)	11 (16.4)		
Strongly disagree	47 (4.5)	2 (4.3)	40 (85.1)	5 (10.6)		
Vaccination against infectious diseases reduces both the incidence of diseases and the mortality rate among individuals					188.09	<.001
Strongly agree	315 (30.2)	238 (75.6)	33 (10.5)	44 ¹⁴		
Agree	484 (46.4)	295 (61)	97 ¹⁸	92 ¹⁹		
Neutral	174 (16.7)	49 (28.2)	63 (36.2)	62 (35.6)		
Disagree	51 (4.9)	9 (17.6)	35 (68.6)	7 (13.7)		
Strongly disagree	19 (1.8)	6 (31.6)	12 (63.2)	1 (5.3)		
The Benefits of COVID-19 vaccine outweigh the risks					348.28	<.001
Strongly agree	144 (13.8)	126 (87.5)	10 (6.9)	8 (5.6)		
Agree	361 (34.6)	269 (74.5)	43 (11.9)	49 (13.6)		
Neutral	363 (34.8)	171 (47.1)	69 ¹⁹	123 (33.9)		
Disagree	89 (8.5)	18 (20.2)	55 (61.8)	16 ²⁰		
Strongly disagree	86 (8.2)	13 (15.1)	63 (73.3)	10 (11.6)		
The COVID-19 vaccine will generally be effective in controlling the infection					475.297	<.001
Strongly agree	162 (15.5)	150 (92.6)	8 (4.9)	4 (2.5)		
Agree	458 (43.9)	341 (74.5)	36 (7.9)	81 (17.7)		
Neutral	299 (28.7)	96 (32.1)	96 (32.1)	107 (35.8)		
Disagree	82 (7.9)	10 (12.2)	62 (75.6)	10 (12.2)		
Strongly disagree	42 (4.0)	0 (0)	38 (90.5)	4 (9.5)		
Younger adults under 30 and children do not need to be vaccinated against COVID-19					199.63	<.001
Strongly agree	94 (9.0)	30 (31.9)	52 (55.3)	12 (12.8)		
Agree	173 (16.6)	64 (37)	74 (42.8)	35 (20.2)		
Neutral	300 (28.8)	140 (46.7)	65 (21.7)	95 (31.7)		
Disagree	337 (32.3)	252 (74.8)	35 (10.4)	50 (14.8)		
Strongly disagree	139 (13.3)	111 (79.9)	14 (10.1)	14 (10.1)		
Attitudes toward COVID-19 vaccine						
How safe COVID-19 vaccine in your opinion?					481.05	<.001
very safe	102 (9.8)	93 (91.2)	5 (4.9)	4 (3.9)		
Fairly safe	515 (49.4)	393 (76.3)	34 (6.6)	88 (17.1)		
a little safety	286 (27.4)	99 (34.6)	87 (30.4)	100 (35)		
Not safe at all	140 (13.4)	12 (8.6)	114 (81.4)	14 ¹⁰		
What are the COVID-19 vaccine effects in your opinion?					151.11	<.001
It can cause COVID-19 infection	163 (15.6)	33 (20.2)	95 (58.3)	35 (21.5)		
It prevents COVID-19 infection	80 (7.7)	53 (66.3)	12 ¹⁵	15 (18.8)		

(Continued)

Table 5. (Continued).

Variable	N	Yes	No	Neutral	X ²	P-value
They reduce the symptoms and severity of COVID-19 infection	800 (76.7)	511 (63.9)	133 (16.6)	156 (19.5)	125.07	<.001
How easy do you think it is to get the COVID-19 vaccine?						
very easy	290 (27.8)	212 (73.1)	49 (16.9)	29 ¹⁰ (21.3)		
fairly easy	474 (45.4)	289 (61)	84 (17.7)	101 (21.3)		
I'm not sure	145 (13.9)	37 (25.5)	69 (47.6)	39 (26.9)		
Somewhat difficult	116 (11.1)	54 (46.6)	28 (24.1)	34 (29.3)		
very Difficult	18 (1.7)	5 (27.8)	10 (55.6)	3 (16.7)	122.42	<.001
COVID-19 Vaccines are available in Libya						
Strongly agree	142 (13.6)	111 (78.2)	17 ¹² (17.8)	14 (9.9)		
Agree	511 (49.0)	335 (65.6)	91 (17.8)	85 (16.6)		
Neutral	274 (26.3)	103 (37.6)	83 (30.3)	88 (32.1)		
Disagree	85 (8.1)	40 (47.1)	29 (34.1)	16 (18.8)		
Strongly disagree	31 (3.0)	8 (25.8)	20 (64.5)	3 (9.7)	232.69	<.001
Concerns about COVID-19 Vaccine?						
Against vaccines in general	23 (2.2)	5 (21.7)	14 (60.9)	4 (17.4)		
I don't trust the medical health system	182 (17.4)	65 (35.7)	69 (37.9)	48 (26.4)		
The COVID-19 is virus not dangerous	18 (1.7)	9 (50)	7 (38.9)	2 (11.1)		
It has not been adequately researched or tested	1 (0.1)	0	1 (100)	0		
Lack of information	157 (15.1)	101 (64.3)	24 (15.3)	32 (20.4)		
Side effects	274 (26.3)	166 (60.6)	53 (19.3)	55 (20.1)		
Unsafe	44 (4.2)	5 (11.4)	29 (65.9)	10 (22.7)		
not effective	14 (1.3)	4 (28.6)	4 (28.6)	6 (42.9)		
Fear of injection	29 (2.8)	18 (62.1)	6 (20.7)	5 (17.2)		
Cultural reasons	22 (2.1)	8 (36.4)	7 (31.8)	7 (31.8)		
safe with traditional remedies	10 ¹	4 (40)	4 (40)	2 ¹⁸		
Other	52 ⁵	20 (38.5)	12 (23.1)	20 (38.5)		
I have no worries	217 (20.8)	192 (88.5)	10 (4.6)	15 (6.9)		

A *p*-value of less than .05 indicates statistical significance. Abbreviations. X²: Chi-square test.

Individuals in the higher age groups (40–50 and over 50) had higher vaccination rates. This may be attributed to the fact that COVID-19 adversely affects this age group, hence there is an awareness and willingness to be vaccinated.²¹ Those who obtained their information from WHO and NCDC had higher vaccination rates, and those who depended on social media and community opinions had lower rates. This highlights the need for strategies to enhance public trust and reliance on credible sources of health information, ultimately leading to better health decisions.

In our knowledge questions, when we asked about vaccines in general, 63.7% agreed that vaccines are an effective way to prevent and control infectious diseases, and 76.6% agreed that they can prevent disease incidence and mortality. When we asked questions related to COVID-19, 48.4% agreed that the benefits outweigh the risks, and 45.6% disagreed that individuals under the age of 30 and children should not be vaccinated. Additionally, in the attitudes section when we asked

about COVID-19 safety, 40.8% had answered COVID-19 are little or no safe at all. This may highlight a gap in the prescription of COVID-19 vaccines compared to other vaccines. The questions that had lower scores were of safety concerns. We should investigate the factors driving these prescriptions and how we can raise their awareness, and trust in the vaccine. When asked about their concerns regarding the COVID-19 vaccine, 26.3% cited side effects as their primary concern, 15.1% were concerned due to a lack of information, while 17.4% expressed lack of trust in the medical health system. All of this further supports that efforts should be made to address their concerns, and to enhance their knowledge about the vaccine.

When we evaluated acceptance of COVID-19, 57.2% of respondents answered either “strongly accept” or “accept,” while 23% answered “strongly refuse” or “refuse.” In examining its associations, only age and source of information were significantly associated with COVID-19 acceptance.

Specifically, higher age groups and those who relied on information from WHO and NCDC had higher rates of acceptance. In a study done by Masoud et al. across six Arab countries, similar findings were observed that higher age groups were associated with more vaccine acceptance.²⁰ A study done in Italy among pregnant women, those who used mass media, the internet, and social media platforms had higher rates of vaccine hesitation.¹⁹

In our evaluation of knowledge and attitudes toward COVID-19 vaccine acceptance, we observed that those who had favorable views about the vaccine were more likely to accept the vaccine. Hesitancy was observed among those who had safety concerns. Similar findings were observed in Masoud et al.'s study across six Arab countries, 53.1% reported a fear of vaccinations due to concerns about side effects.²⁰ A survey in Egypt revealed that vaccine hesitancy was higher among those who feared side effects or potential unknown effects and those who lacked confidence in the health system.¹⁸

A study done in Saudi Arabia found that individuals with higher education, those who held positive beliefs toward COVID-19, and those who had previously taken the influenza vaccine were more likely to take the COVID-19 vaccine.²² A multinational survey of Arabic-speaking healthcare workers, 25.8% and 32.8% showed vaccine hesitancy for those residing in Arabic countries and those living outside Arabic countries, respectively.²³ In the study done in Italy among pregnant women, respondents with no college degree were more likely to be vaccine hesitant.¹⁹ Another study in California on pregnant women found that individuals living in less urban environments and essential workers were vaccine hesitant.¹⁷

A review examining factors that may predict vaccine acceptance, a higher level of education, previous history of COVID-19 infection, male gender, having chronic illnesses, and favorable attitudes toward the vaccine were predictors of vaccine acceptance.²⁴ However, the educational level, gender and history of COVID-19 infection did not show significant associations with vaccine acceptance in our study.

A review evaluating COVID-19 vaccine acceptance showed that global rates were 60.23%, while it was 54.07% in lower-income countries.²⁴ Another systemic review evaluating 33 countries showed varying degrees of COVID-19 acceptance ranging from 23.6% to 97%.²⁵ This highlights the degree of variations among countries, and when making health policy, one should take into account the population, culture, beliefs, and attitudes when devising public health policy.²⁶

Although the acceptance rate of COVID-19 in our study was 57.2%, we need to be cautious when interpreting these results. What matters is whether this perception can be translated into behavior. Currently, only 34% of Libyans have received the vaccine, 18% completed their series, according to the WHO.⁹ Enhancing confidence in the vaccine and ensuring participation would help the Libyan population reach the acceptable level of herd immunity for the SARS-CoV-2 virus, which is estimated to be between 55% and 82%.²⁷

There was unpreparedness and a lack of resources, or training in Libya during the COVID-19 pandemic.^{28,29} The country continues to heal from the aftermath of the armed conflict,

which has negatively impacted its healthcare system.³⁰ There is a huge gap in COVID-19 vaccination coverage between low-income and high-income countries.³¹ Countries with higher income in the Middle East, such as Saudi Arabia, the United Arab Emirates, Kuwait, and Qatar, had higher rates of vaccination of 78%, 100%, 99%, and 81%, respectively.⁹ Maybe the availability of resources and funding, along with their advanced healthcare systems, contributed to more effective vaccination messaging and campaigns, playing a major role in the success of their COVID-19 vaccination efforts.

New strategies could be introduced to enhance awareness and to support vaccination efforts in challenging and low resources settings. An example worth mentioning is the 2021 polio outbreak in certain cities in Yemen. During this outbreak, the Yemeni Health Ministry, WHO, UNICEF, and local partners launched a massive vaccination campaign, ultimately reaching over 90% of the campaign's target.³² Several actions were taken to enhance communication, education, social mobilization, and health promotion. These actions included meetings with local representatives and religious leaders. Health promotion sessions held in mosques, women's gatherings, and school events. Additionally, a massive media campaign was implemented through posters, banners, radio, and TV stations. A dedicated telephone helpline to connect the public with healthcare professionals for inquiries about the vaccine and related health topics. This comprehensive approach ensured strong grassroots community mobilization, ultimately boosting the campaign's efforts to achieve wider coverage, which led to its success. These lessons we suggest may be useful in COVID-19 vaccination efforts, especially when working in low-resource settings.

The COVID-19 pandemic has presented new challenges for the healthcare system. Policymakers and healthcare leaders need to develop new strategies and innovations to enhance preparedness and effectiveness for any future pandemics. The COVID-19 vaccination trends and the root causes of vaccine hesitancy still need to be examined and addressed to draw conclusions and lessons that can inform policymakers in the development of public health policies.³³

Each public health authority needs to take into account its population, culture, beliefs, and attitudes when devising public health policy. Thoughtful and targeted messaging based on these factors needs to be delivered and tested with the aim of reaching evidence-based policies that work within the community. This will help create a comprehensive health policy that leads to more successful outcomes.

Limitations

Since this is a cross-sectional study, we cannot establish any causal relationships based on our findings. Therefore, interpreting the results should be done with caution. Since this survey was voluntary, the results might be less representative due to lack of participation. There is a disproportionately high number of respondents in the 18–30 age group, as this online survey may not reach individuals in older age groups, which

could potentially skew our results. We may not reach people from low socioeconomic backgrounds, underserved communities, or rural areas, as participation requires a smart device and internet access. Their perception of the COVID-19 vaccine may be underrepresented in our study. We were unable to calculate our survey response rate as it was posted on online public platforms, so we were unable to assess sampling or nonresponse bias.

Conclusions

There is a gap between the perception of the COVID-19 vaccine and other vaccines among Libyans, with less favorable views toward the COVID-19 vaccine. Additionally, our study revealed that 57.2% of Libyans accept the COVID-19 vaccine. However, only 34% of Libyans have received at least one dose, and 18% completed their vaccination series, which is below the estimated number needed to achieve herd immunity against the SARS-CoV-2 virus.

A comprehensive health policy that takes into account population, culture, beliefs, and attitudes is needed, with the aim of increasing vaccine uptake among the population.

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Notes on contributor

Mohammed S. Beshr has graduated with an MBBS (Bachelor of Medicine, Bachelor of Surgery) degree from Sana'a University in Sana'a, Yemen, and is currently working as a researcher at the university. Interested in global health, and raising awareness about preventable diseases.

ORCID

Rana H. Shembesh  <http://orcid.org/0000-0002-6287-6791>

Mohammed S. Beshr  <http://orcid.org/0009-0007-0113-5117>

Mariam M. ALTarhouni  <http://orcid.org/0000-0002-7162-0149>

Authors biographies

Rana and Maryam completed their BSc (Bachelor of Science) in Applied Immunology at the Libyan International Medical University in Benghazi, Libya. They are currently in their final year of the MBBS (Bachelor of Medicine, Bachelor of Surgery) program at the same university. Both interested in and currently working on projects related to global health and underrepresented communities. Mohammed graduated with an MBBS (Bachelor of Medicine, Bachelor of Surgery) degree from Sana'a University in Sana'a, Yemen, and is currently working as a researcher at the university. Interested in global health, and raising awareness about preventable diseases.

Authors contributions

All authors participated in the conceptualization and design. MSB and RHS conducted the analysis, interpreted the results, designed the tables, and wrote the full manuscript. RHS and MMA submitted the proposal for approval, designed the questionnaire, and participated in its distribution. All authors have proofread and refined the paper. All authors approved the manuscript for publication.

AI declaration

During the preparation of this work, the authors used AI solely to enhance grammar and structure, to minimize grammatical errors of the first draft, without any application to the methodology or results. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

Consent for publication

The authors declare consent for publication.

Data availability statement

Data is available upon reasonable request from the authors.

List of Abbreviations

WHO	World Health Organization
NCDC	National Center of Disease Control
COVID-19	coronavirus disease-19
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2

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