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Original Article

Knowledge, Attitude and the Acceptance of the COVID-19 Vaccine Among Undergraduate Students of Air University Islamabad

Nadia Iqbal[1], Muhammad Farhan Chattha[2], Zoila Shah[3]

[1,2,3] Medical Officer, PAF Hospital, Islamabad, Pakistan

***Corresponding author: Nadia Iqbal, nadiaaiqball@gmail.com**

ABSTRACT

Background: COVID-19 vaccination remains an important public health measure for reducing severe disease and supporting community protection; however, vaccine uptake is influenced by knowledge, safety perceptions, trust, misinformation, affordability, and accessibility. University students are a relevant group for vaccine-confidence research because they are highly exposed to digital information and may influence family and peer health decisions. **Objective:** To assess knowledge, attitudes, and acceptance of COVID-19 vaccination among undergraduate students of Air University Islamabad. **Methods:** A descriptive cross-sectional study was conducted among 302 undergraduate students from different departments of Air University Islamabad, including Fazaia Medical College. Data were collected using an online structured questionnaire covering socio-demographic characteristics, COVID-19 information exposure, vaccine-related knowledge, attitudes, and acceptance factors. Data were analyzed using SPSS and summarized as frequencies, percentages, means, and standard deviations. **Results:** The mean age of participants was 21.04 ± 1.70 years; 161 students (53.3%) were female and 141 (46.7%) were male. Social media was the leading source of COVID-19 information (60.3%). The mean knowledge score was 5.11 ± 1.64, with 55.0% classified as having good knowledge. Most participants believed that COVID-19 vaccines were effective in preventing infection (90.4%) and that vaccination was necessary for Pakistan's population (87.4%). Overall, 79.8% had a positive attitude, 88.1% would encourage family and friends to be vaccinated, and 91.7% would accept vaccination if recommended by doctors. Free provision (96.0%), convenience (85.1%), and price (64.6%) were important decision factors. **Conclusion:** Undergraduate students demonstrated good knowledge, positive attitudes, and high conditional acceptance of COVID-19 vaccination, especially under doctor recommendation. Physician-led education, transparent safety communication, social media-based myth correction, and free, convenient vaccination services may strengthen vaccine confidence among university students. **Keywords:** COVID-19; vaccine acceptance; vaccine attitude; vaccine knowledge; undergraduate students; Pakistan; university students.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2, created a major global public health emergency after its emergence in late 2019. The pandemic disrupted healthcare systems, education, travel, economies, and routine social activity, while its rapid transmission through both symptomatic and asymptomatic individuals made sustained control difficult through non-pharmaceutical interventions alone. Vaccination therefore became one of the most important public health strategies for reducing severe disease, limiting transmission, protecting vulnerable populations, and supporting the gradual restoration of educational and social activities (1,2).

The availability of effective COVID-19 vaccines did not automatically translate into universal vaccine uptake. Vaccine acceptance is influenced by multiple interacting factors, including knowledge about disease and vaccine benefits, perceived risk of infection, confidence in vaccine safety and effectiveness,

trust in healthcare professionals and public institutions, social norms, affordability, accessibility, and exposure to misinformation (3). During the pandemic, concerns about rapid vaccine development, possible adverse effects, vaccine origin, commercial motives, and conspiracy narratives circulated widely, particularly through digital platforms. These concerns contributed to vaccine hesitancy in several populations and showed that acceptance depends not only on vaccine supply but also on public confidence and informed decision-making (4,5).

University students represent an important population for studying COVID-19 vaccine knowledge, attitudes, and acceptance. They are generally active users of social media and digital information channels, interact closely with peers in classrooms and campus environments, and may influence vaccine-related beliefs within their families and social networks. Although young adults are often at lower risk of severe COVID-19 than older adults, they can contribute to community transmission and may expose household members with greater clinical vulnerability. In university settings, vaccine confidence is therefore relevant not only for individual protection but also for campus safety, continuity of learning, and broader community health behavior (6,7).

Previous international studies have reported wide variation in COVID-19 vaccine acceptance across countries and populations. High willingness to accept vaccination has been reported in some Chinese populations, whereas studies from the United States, Europe, Saudi Arabia, Bangladesh, Indonesia, and other settings have identified concerns related to vaccine safety, effectiveness, side effects, misinformation, trust, income, gender, and healthcare recommendation as important determinants of acceptance (8). These findings suggest that vaccine acceptance is context-specific and shaped by both individual perceptions and the wider social and health communication environment.

In Pakistan, vaccine acceptance has been affected by a combination of public health need, previous immunization experiences, misinformation, access barriers, and trust in healthcare advice. Misleading narratives about COVID-19 vaccination have been recognized as a potential threat to vaccine uptake, while studies among Pakistani populations have shown that knowledge, attitudes, perceived barriers, and preventive practices vary across educational and professional groups (9,10). However, evidence specifically focused on undergraduate students in institutional university settings remains limited, particularly regarding how knowledge, attitudes, information sources, safety perceptions, affordability, convenience, and doctor recommendation collectively shape acceptance.

The present study was designed to address this gap by assessing knowledge, attitudes, and acceptance of COVID-19 vaccination among undergraduate students of Air University Islamabad. Using a PICO-based framing, the population comprised undergraduate students enrolled at Air University Islamabad; the exposure or area of interest was students' knowledge, attitudes, information sources, and perceptions related to COVID-19 vaccination; the comparison involved differences in response patterns across selected demographic and informational characteristics; and the outcome was acceptance of COVID-19 vaccination, particularly willingness under conditions such as doctor recommendation, family or peer influence, perceived safety, convenience, and cost. The study therefore aimed to determine the level of knowledge, describe attitudes, assess vaccine acceptance, and identify descriptive patterns that may inform university-based vaccine education and future public health communication strategies.

MATERIALS AND METHODS

This descriptive cross-sectional observational study was conducted to assess knowledge, attitudes, and acceptance of COVID-19 vaccination among undergraduate students of Air University Islamabad, Pakistan. The study setting was Air University Islamabad, located in PAF Complex, Sector E-9, Islamabad, and included students from Fazaia Medical College, engineering, basic and applied sciences, computer and artificial intelligence, school of management, social sciences, avionics, and aeronautics. A cross-sectional design was selected because the objective was to measure vaccine-related knowledge, attitudes, and acceptance at a single point in time among a defined university student population.

The target population comprised undergraduate students enrolled at Air University Islamabad during the study period. Students were eligible for participation if they were between 18 and 25 years of age, enrolled in an undergraduate program, had access to the internet, and provided informed consent before completing the questionnaire. Students younger than 18 years or older than 25 years, those who did not provide consent, and those who were mentally or seriously ill at the time of data collection were excluded. Participants were recruited from different departments of the university to obtain representation across academic disciplines. The planned sampling approach was simple random sampling from student groups and departmental lists, and data collection was performed through an online questionnaire circulated using university email IDs and relevant student contact channels.

The sample size was calculated using a 95% confidence level, 5% margin of error, an estimated population size of 5000 undergraduate students, and an expected response proportion of 50%, which yielded an initial sample size of 364. To compensate for potential non-response and incomplete submissions, the target sample was increased to 400 students. After screening submitted responses for eligibility and completeness, 302 valid responses were included in the final analysis. Informed consent was obtained electronically before participants accessed the main questionnaire, and participation was voluntary.

Data were collected using a structured self-administered questionnaire developed in English, as English is the primary academic language used in the university setting. The questionnaire was distributed through Google Forms and required approximately six minutes to complete. It contained 58 items covering socio-demographic characteristics, information exposure, knowledge regarding COVID-19 and COVID-19 vaccination, attitudes toward vaccination, and vaccine acceptance. The introductory section explained the purpose of the study, voluntary participation, anonymity, and confidentiality. The questionnaire was reviewed by an expert panel, and items were revised according to expert comments before data collection.

The socio-demographic section collected information on age, gender, marital status, religion, department, number of people living at home, monthly household income, hometown or residential background, and current health status. Information exposure variables included whether participants had heard about novel coronavirus, their self-rated knowledge of the pandemic, previous receipt of necessary vaccines, and their main source of COVID-19 information, including social media, television, healthcare providers, friends and family, newspapers, and radio.

Knowledge-related items assessed awareness and beliefs about COVID-19 vaccination, including perceived eligibility of infants, children and adolescents, pregnant and lactating women, and patients with chronic diseases; perceived vaccine effectiveness; beliefs about whether vaccination reduces symptoms; misconceptions related to disease causation and DNA modification; need for continued preventive measures after vaccination; views on population-wide vaccination; mandatory vaccination; and herd immunity. Knowledge was summarized using a score ranging from 1 to 11 and categorized into fair, good, and excellent knowledge levels according to the study scoring criteria (11).

Attitude variables assessed participants' willingness to encourage family members, friends, and relatives to receive COVID-19 vaccination; belief that vaccination was important for reducing COVID-19 incidence; support for fair vaccine distribution; and concerns about vaccine availability, immediate serious side effects, fake or faulty vaccines, rapid development and approval, unforeseen future effects, and commercial promotion by pharmaceutical companies. Overall attitude was classified as positive or otherwise according to responses across attitude-related items.

Acceptance variables assessed willingness to receive COVID-19 vaccination under different conditions and perceptions influencing vaccine decision-making. These included trust in vaccine development and testing, willingness to receive vaccination if recommended by doctors, influence of family and friends, belief that the vaccine could cause COVID-19, belief that the vaccine could cause more harm than good,

importance of convenience such as method, frequency, and distance to vaccination site, influence of vaccine price, affordability if not provided free by the government, preference for free vaccination in Pakistan, priority groups for vaccination, perceived vaccine safety, perceived vaccine essentiality, and trust in vaccines according to country or origin.

To reduce information bias, all participants received the same structured questionnaire in the same format, with fixed response options for quantitative analysis. The online format minimized interviewer-related influence, and the consent page informed participants that responses would remain anonymous and confidential to reduce social desirability pressure. Eligibility criteria were applied before final inclusion in the analysis, and only complete valid responses were analyzed. Potential confounding variables considered for descriptive comparison included gender, residence, department, knowledge category, and source of COVID-19 information.

Data were entered and analyzed using SPSS. Continuous variables, including age and knowledge score, were summarized using mean and standard deviation. Categorical variables, including gender, department, residence, income category, information source, knowledge category, attitude responses, and acceptance indicators, were summarized using frequencies and percentages. Cross-tabulations were used to describe response patterns across selected demographic and informational characteristics, including gender, residence, knowledge category, and source of information. The analysis was primarily descriptive, and findings were presented using tabulated frequencies, percentages, means, and standard deviations.

Data integrity was maintained by using a structured electronic form, restricting responses to eligible participants, reviewing submissions for completeness, and entering only valid responses into the final dataset. The use of predefined variables, standardized response categories, and a consistent scoring approach supported reproducibility of the analysis. Ethical approval was obtained from the Institutional Review Board of Fazaia Medical College, Air University Islamabad. Participation was voluntary, informed consent was obtained before questionnaire completion, no personal identifiers were included in the analysis, and confidentiality and anonymity of participants were maintained throughout the study.

RESULTS

A total of 302 undergraduate students were included in the final analysis. The mean age of participants was 21.04 ± 1.70 years, indicating a young adult university population. Females represented 161 participants (53.3%), while males represented 141 participants (46.7%). All participants were single and Muslim. The largest academic subgroup was Fazaia Medical College, comprising 98 students (32.5%), followed by engineering with 73 students (24.2%). Most participants were from urban areas, with 215 students (71.2%), while 87 students (28.8%) were from rural areas. Nearly half of the participants, 136 students (45.0%), reported a monthly household income above PKR 100,000. Most students reported good or excellent current health status, including 148 students (49.0%) with good health and 86 students (28.5%) with excellent health.

Table 1. Socio-Demographic and Baseline Characteristics of Participants (n = 302)

Variable	Category	Frequency	Percentage
Age	Mean ± SD	21.04 ± 1.70	—
Gender	Male	141	46.7
	Female	161	53.3
Marital status	Single	302	100.0
Religion	Islam	302	100.0
Department	Fazaia Medical College	98	32.5
	Engineering	73	24.2
	Basic and Applied Sciences	36	11.9
	Computer and Artificial Intelligence	33	10.9
	School of Management	32	10.6
	Social Sciences	21	7.0
	Avionics and Aeronautics	9	3.0
People living at home	1–3	38	12.6

Variable	Category	Frequency	Percentage
	4–5	156	51.7
	5–10	102	33.8
	>10	6	2.0
Monthly household income	< PKR 50,000	28	9.3
	PKR 50,000–70,000	67	22.2
	PKR 70,000–100,000	71	23.5
	> PKR 100,000	136	45.0
Hometown/residence	Rural	87	28.8
	Urban	215	71.2
Current health status	Excellent	86	28.5
	Good	148	49.0
	Fair	56	18.5
	Poor	12	4.0

Most participants had prior exposure to COVID-19-related information. A total of 244 students (80.8%) had heard about novel coronavirus, while 58 students (19.2%) had not. When participants rated their own knowledge of the pandemic, 159 students (52.7%) described it as good, 98 (32.5%) as moderate, 34 (11.3%) as excellent, and 11 (3.6%) as poor. Social media was the most frequently reported information source, used by 182 students (60.3%), followed by television among 56 students (18.5%) and healthcare providers among 37 students (12.3%). A high proportion of participants, 290 students (96.0%), reported receiving all necessary vaccines during their lifetime.

Knowledge regarding COVID-19 vaccination was generally favorable. The mean knowledge score was 5.11 ± 1.64 on a scale of 1 to 11. Based on knowledge classification, 166 participants (55.0%) had good knowledge, 110 (36.4%) had fair knowledge, and 26 (8.6%) had excellent knowledge. Most students believed that COVID-19 vaccines were effective in preventing infection, with 273 participants (90.4%) endorsing this view. A large majority also believed that the Pakistani population needed vaccination, reported by 264 participants (87.4%), and that vaccinated individuals should not abandon preventive measures such as mask use, reported by 249 participants (82.5%).

Table 2. Information Exposure and Knowledge-Related Findings Among Participants (n = 302)

Variable	Category / Response	Frequency	Percentage
Heard about novel coronavirus	Yes	244	80.8
	No	58	19.2
Self-rated pandemic knowledge	Excellent	34	11.3
	Good	159	52.7
	Moderate	98	32.5
	Poor	11	3.6
Main source of COVID-19 information	Social media	182	60.3
	Television	56	18.5
	Healthcare providers	37	12.3
	Friends and family	20	6.6
	Newspapers	5	1.7
	Radio	2	0.7
Received all necessary vaccines during lifetime	Yes	290	96.0
Overall knowledge score	Mean ± SD	5.11 ± 1.64	—
Knowledge category	Fair	110	36.4
	Good	166	55.0
	Excellent	26	8.6
COVID-19 vaccines are effective in preventing infection	Yes	273	90.4
Vaccinated people should continue preventive measures	Yes	249	82.5
All Pakistani population needs vaccination	Yes	264	87.4
COVID-19 vaccination should be mandatory	Yes	254	84.1
COVID-19 vaccines do not modify DNA	Yes	213	70.5
COVID-19 vaccines do not cause disease to trigger immunity	Yes	159	52.7

Attitudes toward COVID-19 vaccination were largely positive. Overall, 79.8% of participants were classified as having a positive attitude toward COVID-19 vaccination. Most participants were willing to encourage vaccination among family members, friends, and relatives, with 266 students (88.1%) agreeing with this statement. Support for fair vaccine distribution was also high, reported by 280 students (92.7%). A total of 200 participants (66.2%) agreed that the incidence of COVID-19 could not be reduced without vaccination. Concerns were present but did not dominate most attitude responses. Half of the participants, 151 students (50.0%), agreed that rapid vaccine development and approval influenced or

could influence their decision. In contrast, most students disagreed that vaccine availability, fake or faulty vaccines, immediate serious side effects, unforeseen future effects, or commercial promotion were major concerns.

Table 3. Attitude Toward COVID-19 Vaccination Among Participants (n = 302)

Attitude Indicator	Response / Category	Frequency	Percentage
Overall attitude toward COVID-19 vaccination	Positive	241	79.8
Will encourage family, friends, and relatives to get vaccinated	Agree	266	88.1
Supports fair vaccine distribution for all people	Agree	280	92.7
COVID-19 incidence cannot be reduced without vaccination	Agree	200	66.2
Vaccine availability would be a concern	Disagree	272	90.0
Immediate serious side effects would be a concern	Disagree	233	77.0
Vaccine might be fake or faulty	Disagree	254	84.0
Rapid development and approval influenced/could influence decision	Agree	151	50.0
Vaccine may have unforeseen future effects	Disagree	214	71.0
Vaccination is promoted for commercial gain	Disagree	245	81.0

Acceptance of COVID-19 vaccination was high, especially under conditions involving medical recommendation. A total of 277 participants (91.7%) agreed that they would receive a COVID-19 vaccine if doctors recommended it, while 25 participants (8.3%) disagreed. Trust in vaccine development and testing was also high, with 250 participants (82.8%) agreeing or strongly agreeing. Most participants rejected major safety-related misconceptions: 254 students (84.1%) disagreed or strongly disagreed that COVID-19 vaccination causes a person to get COVID-19, and 261 students (86.2%) disagreed or strongly disagreed that the vaccine would cause more harm than good.

Practical access-related factors were also important. Convenience of vaccination, including method, frequency, and distance to vaccination site, was considered important by 257 participants (85.1%). Vaccine price influenced decision-making among 195 participants (64.6%), while 290 participants (96.0%) agreed or strongly agreed that COVID-19 vaccination should be provided free of charge in Pakistan. If the vaccine was not provided free by the government, 177 participants (58.6%) reported that they could afford it, 67 (22.2%) were undecided, and 58 (19.2%) reported that they could not afford it. Regarding perceived safety, 154 participants (51.0%) agreed that the newly discovered COVID-19 vaccine was safe, while 142 participants (47.0%) were undecided and 6 participants (2.0%) disagreed.

Table 4. Acceptance and Practical Decision Factors Related to COVID-19 Vaccination (n = 302)

Acceptance / Decision Indicator	Response / Category	Frequency	Percentage
Would receive vaccine if doctors recommended it	Agree	277	91.7
	Disagree	25	8.3
Trusts vaccine development/testing process	Agree/strongly agree	250	82.8
Would receive vaccine if family/friends received it	Agree	215	71.2
Rejects belief that vaccine causes COVID-19	Disagree/strongly disagree	254	84.1
Rejects belief that vaccine causes more harm than good	Disagree/strongly disagree	261	86.2
Convenience important in decision-making	Agree	257	85.1
Price important in decision-making	Agree	195	64.6
Vaccine should be free in Pakistan	Agree/strongly agree	290	96.0
Could afford vaccine if not provided free	Yes	177	58.6
	Undecided	67	22.2
	No	58	19.2
Newly discovered COVID-19 vaccine is safe	Agree	154	51.0
	Undecided	142	47.0
	Disagree	6	2.0
COVID-19 vaccine is essential	Agree	252	83.4
Priority group for vaccination	Health workers	227	75.2

Cross-tabulated analysis showed high vaccine acceptance across selected participant characteristics. Female students had a slightly higher frequency of willingness to receive vaccination if family and friends were vaccinated, with 119 of 161 females (73.9%) agreeing compared with 96 of 141 males (68.1%). The difference was not statistically significant, with an odds ratio of 1.33 and 95% CI of 0.81–2.19. Urban students showed higher agreement with vaccination on doctor recommendation, with 200 of 215 urban participants (93.0%) agreeing compared with 77 of 87 rural participants (88.5%), but this difference was also not statistically significant, with an odds ratio of 1.73 and 95% CI of 0.75–4.02.

Acceptance on doctor recommendation remained consistently high across information sources, ranging from 90.6% among social media users to 100.0% among participants who reported friends/family, newspapers, or radio as their main information source.

Table 5. Cross-Tabulated Acceptance Patterns by Selected Participant Characteristics

Comparison Variable	Group	Accepted / Agreed, n (%)	Did Not Accept / Disagreed, n (%)	Effect Size / Test Statistic	p-value
Willing to vaccinate if family/friends vaccinated	Female	119/161 (73.9)	42/161 (26.1)	OR 1.33; 95% CI 0.81–2.19	0.265
	Male	96/141 (68.1)	45/141 (31.9)	Reference	
Would vaccinate if doctors recommended it	Urban residence	200/215 (93.0)	15/215 (7.0)	OR 1.73; 95% CI 0.75–4.02	0.197
	Rural residence	77/87 (88.5)	10/87 (11.5)	Reference	
Would vaccinate if doctors recommended it	Social media	165/182 (90.6)	17/182 (9.4)	$\chi^2 = 2.74$	0.740
	Television	51/56 (91.1)	5/56 (8.9)		
	Healthcare providers	34/37 (91.9)	3/37 (8.1)		
	Friends and family	20/20 (100.0)	0/20 (0.0)		
	Newspapers	5/5 (100.0)	0/5 (0.0)		
	Radio	2/2 (100.0)	0/2 (0.0)		

Overall, the results demonstrate good knowledge, largely positive attitudes, and high conditional acceptance of COVID-19 vaccination among undergraduate students. The highest acceptance indicator was willingness to receive vaccination if recommended by doctors, reported by 277 participants (91.7%). Social media was the leading information source, used by 182 students (60.3%), but acceptance on doctor recommendation remained high across all information-source categories. Safety confidence was more moderate than general acceptance: while 252 participants (83.4%) agreed that COVID-19 vaccination was essential, only 154 participants (51.0%) agreed that the newly discovered vaccine was safe, and 142 participants (47.0%) remained undecided. Practical considerations were also prominent, especially free provision of vaccination, supported by 290 participants (96.0%), and convenience of access, reported as important by 257 participants (85.1%).

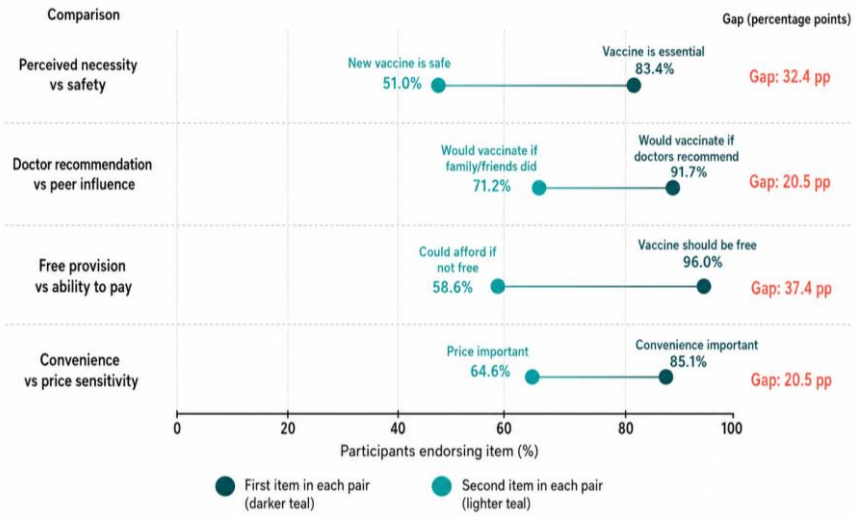

Figure 1. Conditional COVID-19 Vaccine Acceptance, Confidence, and Access Gaps Among Undergraduate Students

Figure Description: The figure presents paired percentage differences in key COVID-19 vaccination perceptions among 302 undergraduate students. The largest gap was observed between support for free vaccination and ability to pay if vaccination was not free, with 96.0% agreeing that the vaccine should be provided free of charge compared with 58.6% reporting affordability, yielding a 37.4 percentage-point gap. A substantial confidence gap was also seen between perceived vaccine necessity and safety, as 83.4% considered COVID-19 vaccination essential, whereas only 51.0% agreed that the newly discovered vaccine was safe, producing a 32.4 percentage-point gap. Acceptance was highest when vaccination was recommended by doctors (91.7%) compared with acceptance influenced by family or friends (71.2%),

showing a 20.5 percentage-point difference. Convenience was considered important by 85.1% of participants, compared with 64.6% who reported vaccine price as important, indicating another 20.5 percentage-point gap. Overall, the figure highlights that students showed high conditional acceptance and perceived necessity of vaccination, but important gaps remained in safety confidence and affordability.

DISCUSSION

The present study found that undergraduate students of Air University Islamabad demonstrated generally good knowledge, largely positive attitudes, and high conditional acceptance of COVID-19 vaccination. The findings are important because university students represent a socially connected young adult population that receives information from multiple channels and can influence health-related decisions within peer and family networks. Although most participants reported favorable views toward COVID-19 vaccination, the results also showed that acceptance was shaped by trust, perceived safety, professional recommendation, affordability, and convenience rather than by knowledge alone.

A major finding was that willingness to receive COVID-19 vaccination was highest when vaccination was recommended by doctors, with 91.7% of participants agreeing that they would be vaccinated under medical recommendation. This finding emphasizes the central role of healthcare professionals as trusted communicators, even in a student population where social media was the most common source of COVID-19 information. Previous studies have similarly shown that vaccine acceptance is influenced by trust in scientific evidence, confidence in health professionals, and perceived credibility of vaccine-related information (3–5). In this study, the high level of acceptance under doctor recommendation suggests that medical endorsement may help bridge the gap between general awareness and actual willingness to vaccinate.

Social media was the leading source of COVID-19 information, reported by 60.3% of participants. This finding is consistent with the digital information behavior expected among undergraduate students, but it also has important implications for vaccine communication. Social media can rapidly spread accurate public health messages, but it can also amplify misinformation, rumors, and conspiracy narratives. In Pakistan, misleading narratives about COVID-19 vaccination have been identified as a threat to vaccine confidence, particularly when uncertainty exists about vaccine safety, side effects, and development processes (12). The present findings suggest that social media should not be viewed only as a source of misinformation; rather, it may serve as an effective platform for delivering verified, physician-supported, and youth-oriented vaccination messages.

The knowledge profile of participants was generally favorable. More than half of the students had good knowledge, and most believed that COVID-19 vaccines were effective in preventing infection, that vaccinated individuals should continue preventive measures, and that the Pakistani population needed vaccination. These findings are consistent with studies showing that higher knowledge and preventive awareness are commonly associated with more favorable vaccine attitudes and health-protective behaviors (13,14). However, knowledge was not uniformly strong across all domains. Some participants remained uncertain or misinformed about issues such as vaccine-related disease causation, DNA modification, eligibility of special groups, and herd immunity. This pattern indicates that broad awareness of vaccination does not necessarily mean accurate understanding of vaccine science.

The attitude findings were largely positive, with 79.8% of participants classified as having a positive overall attitude toward COVID-19 vaccination. Most students agreed that they would encourage family members, friends, and relatives to get vaccinated, and a large majority supported fair vaccine distribution. These findings show that participants were not only personally receptive to vaccination but also socially supportive of vaccine uptake. This is particularly relevant in Pakistan, where health decisions are often influenced by family discussion, social norms, and trust in community networks.

Students who are willing to encourage others may function as informal health communicators, especially when their views are supported by credible medical information (15).

Despite these positive attitudes, safety confidence remained incomplete. Although 83.4% of participants agreed that COVID-19 vaccination was essential, only 51.0% agreed that the newly discovered vaccine was safe, while 47.0% were undecided. This difference shows a clear confidence gap: many students recognized the importance of vaccination but were not fully reassured about vaccine safety. Similar concerns have been reported in other populations, where fear of adverse effects, rapid vaccine development, and uncertainty about long-term safety reduced willingness to vaccinate (4,16). In the present study, rapid development and approval was the most prominent concern, reported by 50.0% of participants, suggesting that transparent explanation of vaccine testing, regulatory approval, and safety monitoring is essential for strengthening confidence.

Acceptance was also influenced by social factors. A total of 71.2% of participants agreed that they would receive vaccination if their family and friends were vaccinated. This finding supports the idea that vaccine decisions are relational and shaped by perceived behavior of trusted people. Although doctor recommendation produced higher acceptance than family or peer influence, the role of family and friends remained substantial. Similar patterns have been observed in vaccine acceptance literature, where social norms and perceived approval from trusted groups contribute to vaccination intention (17). For university populations, this means that vaccine communication should address both individual beliefs and the social environment in which students make health decisions.

Affordability and convenience were also important determinants of acceptance. Nearly all participants, 96.0%, agreed that COVID-19 vaccination should be provided free of charge in Pakistan, while only 58.6% reported that they could afford the vaccine if it was not provided free by the government. This 37.4 percentage-point gap indicates that financial considerations remained relevant even among university students, many of whom belonged to relatively higher-income households. Price influenced vaccination decisions among 64.6% of participants, while convenience was important for 85.1%. These findings are consistent with broader evidence that vaccine uptake depends not only on confidence but also on access, cost, and service delivery conditions (18). Free vaccination, accessible vaccination sites, and simple scheduling may therefore increase uptake by reducing practical barriers.

The study also showed that acceptance was high across selected demographic and informational subgroups. Female students showed slightly greater agreement than male students with vaccination if family and friends were vaccinated, and urban students showed slightly higher willingness than rural students to vaccinate if doctors recommended it. However, these differences were descriptive and should be interpreted cautiously. The consistently high acceptance across information-source groups suggests that professional recommendation may be influential regardless of whether students primarily receive information from social media, television, healthcare providers, or interpersonal sources.

Compared with international studies, the level of conditional acceptance in this study appears relatively high. Studies from China have reported high willingness to receive COVID-19 vaccination, whereas studies from several other countries have shown lower or more variable acceptance due to concerns about safety, effectiveness, side effects, and trust (6,13). The high acceptance observed in this university sample may reflect the young educated population, high previous vaccine exposure, perceived need for campus safety, and strong trust in doctor recommendation. At the same time, the moderate safety confidence indicates that acceptance should not be interpreted as complete absence of hesitancy. Many students appeared willing to accept vaccination under trusted conditions while still requiring reassurance about safety and development processes.

The findings have practical implications for university-based public health communication. Vaccination campaigns for students should combine evidence-based education with visible involvement of doctors, university health services, and trained healthcare professionals. Messages should directly address

specific misconceptions, including DNA modification, vaccine-induced disease, eligibility of special populations, and the need for continued preventive measures after vaccination. Because social media was the dominant information source, digital campaigns should use concise, visually clear, medically endorsed content that can be shared through student networks. In addition, vaccination services should be affordable, preferably free, and conveniently accessible within or near university settings.

The study has several limitations that should be considered when interpreting the findings. The study was conducted at a single university in Islamabad, which limits generalizability to all undergraduate students in Pakistan. Data were collected through an online questionnaire, so students with limited internet access or lower engagement with digital platforms may have been underrepresented. Responses were self-reported and may have been influenced by social desirability, particularly for questions about encouraging others or accepting vaccination. The cross-sectional design measured knowledge, attitudes, and acceptance at one point in time and therefore cannot establish temporal relationships or causality. In addition, the analysis was mainly descriptive, so observed subgroup patterns should be interpreted as exploratory rather than confirmatory.

Overall, the study indicates that undergraduate students of Air University Islamabad were broadly supportive of COVID-19 vaccination, especially when vaccination was recommended by doctors. The findings show that vaccine acceptance among students is not determined by one factor alone; instead, it reflects the combined influence of knowledge, professional trust, social influence, safety confidence, affordability, and convenience. The most important interpretation is that students were not strongly resistant to vaccination, but a sizeable proportion remained uncertain about vaccine safety. Addressing this uncertainty through transparent, physician-led, digitally delivered, and access-sensitive communication may strengthen vaccine confidence among university students and improve preparedness for future vaccination campaigns.

CONCLUSION

Undergraduate students of Air University Islamabad demonstrated good overall knowledge, largely positive attitudes, and high conditional acceptance of COVID-19 vaccination, particularly when vaccination was recommended by doctors. Although most participants recognized the importance of vaccination, supported fair distribution, and agreed that vaccines should be provided free of charge, confidence in vaccine safety was comparatively lower, with a substantial proportion remaining undecided about the safety of newly developed COVID-19 vaccines. Social media was the dominant source of information, but professional medical recommendation remained the strongest acceptance-related factor, highlighting the importance of physician-led and evidence-based communication. Practical considerations, including vaccine affordability, free provision, convenience, and access to vaccination sites, also influenced willingness. These findings suggest that university-based vaccination strategies should combine accurate digital health education, visible healthcare professional endorsement, targeted correction of misconceptions, transparent safety communication, and cost-free or easily accessible vaccination services to strengthen vaccine confidence among young adults and support preparedness for future immunization campaigns.

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