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Research paper

Enhancing Immunization Education for Future Pharmacists Amid The Evolving Global Community Pharmacy Landscape

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Abstract

In the past decade, the role of community pharmacists has significantly expanded, particularly in developed countries, to support public immunization due to their accessibility and widespread availability. Pharmacists are now actively involved in vaccination recommendation, counseling, and administration, having previously only been involved in vaccine procurement, storage, and dispensing. This change, backed by favorable public health results, has led legislators throughout the world to let pharmacists participate in vaccination campaigns. Pharmacists in some community pharmacies in Abu Dhabi and Dubai have begun giving COVID-19 and flu shots in the United Arab Emirates since August 2022. It is anticipated that this move will improve accessibility and vaccination coverage rates, and future regulatory developments will probably include a wider variety of vaccinations in community pharmacies. This research aims to assess pharmacy students' attitudes, immunization knowledge, and preparedness for vaccination tasks to identify potential curriculum gaps along with educational interventions required for their expanding responsibilities. A structured, anonymous survey was made with Google Forms and distributed via email to third-, fourth-, and fifth-year pharmacy students. The questionnaire's five primary themes were demographic data, vaccination knowledge, attitudes and beliefs, preparedness for vaccine-related skills, and recommendations for education. Vaccine knowledge was assessed using a scoring method, whereas attitudes, preparedness, and educational needs were assessed using a five-point Likert scale. The questionnaire underwent a pilot study and expert validation before full implementation. The information was gathered in March 2023 and analyzed using SPSS (version 23.0). The training of pharmacists must change to keep up with the ongoing worldwide evolution of pharmacy practice. Most students (94.9%) believed pharmacist-administered vaccines improve access, and 87.1% supported their role. While confidence in vaccine counseling (84.6%) and public health participation (84.5%) was high, only 61% felt prepared to explain vaccine mechanisms. This research will help identify current educational gaps and inform necessary curriculum modifications to better equip future pharmacists for immunization services. By integrating vaccine administration training into pharmacy education, students can develop the necessary skills and confidence to effectively promote, counsel, and administer vaccines in their communities.

Keywords: *Curriculum Development; Educational Interventions; Pharmacists' Role; Practical Training; Public Health; Vaccine Education.*

1. Introduction

Despite the significant rise in global immunization efforts, more than 1.5 million people worldwide continue to die annually from diseases that could have been prevented through vaccination. Furthermore, the economic burden of treating these vaccine-preventable diseases more strains an already overburdened healthcare system. According to the Centers for Disease Control and Prevention (CDC), a significant number of individuals do not have the needed vaccinations, making them susceptible to diseases that can be avoided. This not only compromises their health but also poses a larger risk to public health by increasing disease transmission within communities [1]. Over the past two years, the pharmacy occupation has undergone a significant transformation to better address patient and healthcare needs. Pharmacists now provide a variety of direct patient care services in addition to their traditional dispensing responsibilities, such as managing medication therapy, ordering and understanding lab outcomes, prescribing, managing parenteral pharmaceuticals, recognizing travel medication, carrying out therapeutic substitutions, and administering vaccinations [18]. [3]. Pharmacists now play a critical role in immunization, contributing to life-saving efforts on a broader scale.

Historically, the past two eras' vaccine management was limited to physicians and nurses. However, evolving policies and procedures have increasingly official trained pharmacists, pharmacy interns, and students with certified vaccination training to administer vaccines, thereby

improving patient access to immunization facilities [2]. Given their frontline role in healthcare, pharmacists improve vaccine accessibility due to the prolonged operating hours of pharmacies, their capacity to accept walk-in patients, and their general availability in communities [19], [5]. This not only maximizes the professional expertise of pharmacists but also improves the workload of physicians and nurses, allowing them to attention on other critical healthcare tasks [4]. Several global studies have evaluated pharmacists' vaccination competencies, showing that they can safely and effectively deliver various vaccines, including seasonal influenza, COVID-19, and travel immunizations [20]. Research shows that patients generally trust pharmacists as vaccinators and have a positive perception of receiving vaccines in community pharmacies. This growing acceptance has prompted policymakers and regulatory authorities worldwide to expand pharmacists' immunization responsibilities to keep pace with evolving healthcare needs and improve vaccination coverage [6].

To date, more than 40 countries have successfully measured and implemented pharmacy-based vaccination plans to enhance immunization awareness and coverage. The COVID-19 pandemic further accelerated this expansion, highlighting the urgent need for build immunization across entire populations. However, the extent of pharmacists' authority to administer vaccines differs globally [7]. While the UK, the US, Australia, New Zealand, and Canada have given pharmacists the power to distribute a wider variety of vaccinations, other nations continue to limit pharmacy-based immunization to influenza as well as COVID-19 vaccines. These include vaccinations against human papillomavirus (HPV), herpes zoster (shingles), varicella (chickenpox), hepatitis A and B, meningococcal infections, pneumococcal illness, along other diseases that can be avoided. In keeping with these initiatives, the "International Pharmaceutical Federation" (FIP) is still pushing for more pharmacist-led immunization programs across the globe [12]. FIP actively inspires regulatory bodies and policymakers to enhance vaccine accessibility and equity through pharmacy-based immunization programs.

FIP provides resources for countries looking to establish such services, offering best practices from nations with successful pharmacy vaccination models to facilitate knowledge-sharing and implementation across different healthcare systems. Pharmacy-based vaccination is still a relatively new practice in the Middle East and Gulf region, where most countries have yet to authorize pharmacists to administer vaccines [8]. However, to expand immunization coverage in the UAE, select pharmacies have recently begun offering influenza and COVID-19 vaccination services. It is anticipated that more pharmacies will participate in delivering vaccination services soon. Although there are several benefits associated with pharmacy-based vaccination, it has been noted in the literature that several obstacles exist to the implementation of this approach in community pharmacies [21]. The main difficulties are a lack of immunization education in pharmacy schools [15], the necessity of organized models of community pharmacy vaccination [19], and the knowledge and attitude gaps in the environment of students [16].

It is essential to provide pharmacists with the information and abilities they need to overcome these obstacles by utilizing extensive and ongoing professional development programs [14]. To improve pharmacists' immunization skills, regulatory bodies have implemented specialized educational and approved training programs [9]. The 2020 FIP Vaccination Reference Guide also highlights the importance of ensuring that pharmacy students graduate with vaccination capabilities, regardless of their country's regulations [10]. Pharmacy education should integrate both theoretical knowledge and hands-on experiential training to prepare students for future vaccination roles. Ensuring that pharmacy graduates are prepared to administer vaccines will allow them to seamlessly integrate into immunization efforts once regulatory outlines support their involvement [22]. [11]. The necessity of having trained healthcare personnel who can assume broader responsibilities through public health emergencies is a crucial lesson learned from the COVID-19 pandemic. The current study aims to estimate prospective pharmacists' vaccination-related knowledge, attitudes, and readiness in community pharmacy settings in the United Arab Emirates [23]. By recognizing potential gaps in education, this research can provide insights into necessary curriculum enhancements that will better equip future pharmacists to administer vaccines effectively in their professional practice.

1.1. Aim of the study

This study aimed to assess and explore in depth pharmacy students' knowledge, attitudes, and perceived preparedness regarding pharmacist-led vaccination as an emerging professional role.

1.2. Ethics approval

The study received ethical approval from the "Fatima College of Health Sciences" (FCHS) "Institutional Review Board" (IRB). Participation in the web-based survey was regarded as implicit permission for the cross-sectional survey because there were no intrusive procedures or medical treatments involved in the study.

1.3. Literature review

Educational recommendations based on immunization knowledge, attitudes, and preparedness of future pharmacists in the era of international expanded scope of community pharmacy Practice remain significant. Although the role of pharmacists in immunization administration is growing worldwide, there is limited research on how pharmacy education programs are adapting to this shift. Therefore, further studies are needed to explore the current level of immunization knowledge among pharmacy students, their attitudes toward vaccine administration, and their preparedness to handle immunization-related tasks in practice. Research is also needed to understand how cultural, regional, and policy differences across countries influence pharmacists' roles in immunization and how education systems can be tailored to meet the demands of international expanded pharmacy practices. Finally, exploring strategies for bridging the gap between theoretical knowledge and practical immunization skills could help ensure that pharmacists are fully equipped to contribute to global vaccination efforts.

[13] Examined the third- and fourth-year medical, dentistry, and pharmacy students' attitudes, knowledge, and practice (AKP) on hepatitis B (HB) infection at an independent medical institution in Malaysia. A prevalidated 34-item questionnaire was used to administer a cross-sectional survey to 482 pupils. Students usually had adequate education and experience along with a favorable attitude regarding HB infection, according to data analysis done with SPSS version 22. However, there were notable variations in KAP ratings amongst students studying medicine, dentistry, and pharmacy. Additionally, students' age and family income influenced their KAP scores. Despite their awareness, not all students participated in health education, screening, or vaccination programs, highlighting the need for regular HBV awareness initiatives to reduce occupational risk.

[8] Examined the attitudes, beliefs, and behaviors of parents with underimmunized children compared to those with fully immunized children. A case-control study was conducted using data from the National Immunization Survey, with a response rate of 52.1% (2315 of 4440 households). The results showed that families with numerous children, those with lower incomes, and those who used several healthcare providers were more likely to be unimmunized. In addition to refusing vaccinations for non-medical reasons and expressing

hesitation toward full immunization for newborns, parents of children who were under-immunized were more likely to believe that vaccines are dangerous. Interestingly, parental views and assumptions were associated with 14.8% of underimmunization. The study highlights the need for targeted efforts to address vaccine safety concerns and socioeconomic barriers to maintain high immunization rates.
[24] Examined the connection between regional vaccination coverage in Germany as well as the opinions of doctors on vaccination. A strong correlation between physician opinions and vaccination rates was found in a cross-sectional study of pediatricians along with general practitioners ($P < 0.0001$). Geographic differences were noted, with former Western German states having lower vaccination rates. Measles and pertussis vaccination rates varied significantly by region, with Berlin and Bavaria reporting the lowest coverage. The findings suggest that improving vaccination rates requires enhanced education and training for both healthcare providers and the general population.
[15] Discussed that 38% of U.S. pharmacy schools include immunization education and training in their core curricula, which may contribute to low vaccination rates, especially among hard-to-reach populations. This study calls on all pharmacy schools to make vaccination instruction a required course of study rather than an option. While recognizing the requirement for both time and money for curriculum modifications, it promotes implementing the Pharmacy-Based Immunization Delivery program of the American Pharmacists Association.
[16] The policymakers and autism agencies should implement educational programs to enhance pharmacists' understanding. With autism prevalence rising in the U.S., pharmacists are increasingly likely to interact with affected families. This study assessed pharmacists' awareness of autism symptoms, treatments, and misconceptions through an online survey in Mississippi. Results revealed knowledge gaps, with 23% unaware that autism is a developmental disorder, 32% doubting genetics as a major factor, and over 18% believing vaccines cause autism. Over 90% expressed interest in continuing education on autism.
[18] Examined vaccine knowledge and attitudes among medical, law, and engineering students at Belgrade University. A survey of 509 students found that medical students had significantly higher vaccine knowledge and more positive attitudes toward immunization than law or engineering students. Those with greater vaccine knowledge, more years in university, and no personal exposure to negative vaccine experiences were more likely to support vaccination. The study highlights the need for specialized vaccination curricula in medical education and suggests that medical students could play a key role in future public health campaigns.
Even though research in the US and Europe (e.g., [15]) has not been done on immunization education among pharmacy students, the research in the Middle East is limited. Vaccination through pharmacies is also still at its initial stage in the UAE and the Gulf more broadly, with the influenza vaccine and COVID-19 vaccine being the only options that are approved in a select few pharmacies now. Therefore, our research covers a significant gap, as the readiness of pharmacy students in a Middle Eastern setting is not studied extensively since the regulatory frameworks, cultural variables, and patient expectations vary significantly in the West.
All the above studies have certain limitations. While they have explored the immunization knowledge, attitudes, and practices (KAP) of healthcare students in fields such as medicine and dentistry, there is a lack of research specifically focused on pharmacy students. Additionally, the factors influencing their preparedness to participate in vaccination programs, particularly considering the expanding role of pharmacists in immunization efforts, remain underexplored. Research is needed to investigate the current state of immunization education within pharmacy curricula, as well as the barriers that students may face in acquiring and applying immunization knowledge and skills. Furthermore, there is a need for studies that explore the socio-economic and demographic factors affecting pharmacy students' immunization knowledge and participation in related health initiatives. With pharmacists increasingly playing a pivotal role in vaccination delivery, it is crucial to address these gaps to ensure that future pharmacists are well-prepared to contribute effectively to public health efforts.

2. Methodology

2.1. Design

The present cross-sectional study is a population-based survey conducted at FCHS-Al Ain and Abu Dhabi Campus, UAE, between March and April 2023. Self-reported data were gathered using a structured questionnaire comprising five sections: (A) demographic information of participants; (B) knowledge assessment on vaccines; (C) attitudes and beliefs regarding vaccination; (D) preparedness in terms of vaccination competencies; and (E) educational recommendations and interventions.
Questions in Section B, which evaluates knowledge of vaccines, have three possible answers: true, false, as well as don't know. Correct answers receive one point, "don't know" receives zero, and erroneous answers receive zero. A five-point Likert scale was used to evaluate attitudes, beliefs, readiness, and educational requirements. The goals of the study and a thorough literature evaluation served as the foundation for the questionnaire's design. A panel of professionals in pharmacy education evaluated the content validity, as well as a pilot test with four students was used to evaluate the face validity; the results from these students were not included in the final analysis. Responses to the online survey were gathered throughout April 2023 from students presently enrolled in Year 3 ($n = 30$), Year 4 ($n = 22$), and Year 5 ($n = 34$). The questionnaire took about 20 minutes to complete. The research did not include participants who did not finish the questionnaire. Using SPSS (version 23.0 for Windows), the gathered data were coded and examined using both statistical methods, inferential and descriptive.

2.2. Sample

All current FCHS pharmacy learners in Years 3 through 5 were eligible to participate in the study. Because the research population was so small, a universal sampling approach was employed. The study's target group consisted of freely participating pharmacy students in Years 3, 4, and 5, respectively. In all, 86 pupils met the requirements. The required sample size was determined using a computerized sample size calculator. Given a population percentage that was 50.00%, a 95.00% confidence level, a 10.00% margin of error, as well as a total population of 86, 49 participants were the recommended sample size.

2.3. Instrumentation

The study's goals and a thorough literature analysis served as the foundation for the questionnaire's development. The following three important sources on pharmacist participation in immunization were mostly used: FIP Vaccination Reference Guide (2022): Knowledge and Abilities to Support Professional Development along with Inform Pharmacy Education in Vaccination, distributed by the "International Pharmaceutical Federation" (FIP), Immunization Competencies for Health Professionals, and an Overview of The electrical current Pharmacy The effects on Immunization: A Global Report (2016). The formulation of the questionnaire was also guided by references to other pertinent research with comparable goals. There were five primary components of the questionnaire: (1) Demographic information about

participants, (2) questions based on knowledge of vaccinations, (3) attitudes and beliefs about vaccination, (4) readiness concerning vaccination skills, and (5) recommendations along with interventions for education. Three response options were available in the vaccination knowledge section: true, false, or don't know. Correct answers received one point, "don't know" received zero, and erroneous answers received zero. A five-point Likert scale was used to rate items on attitudes, beliefs, readiness, and educational requirements. A group of specialists in pharmacy education reviewed the questionnaire to guarantee its content validity. Four students participated in a pilot test to evaluate face validity; the results of the pilot were not included in the final analysis.

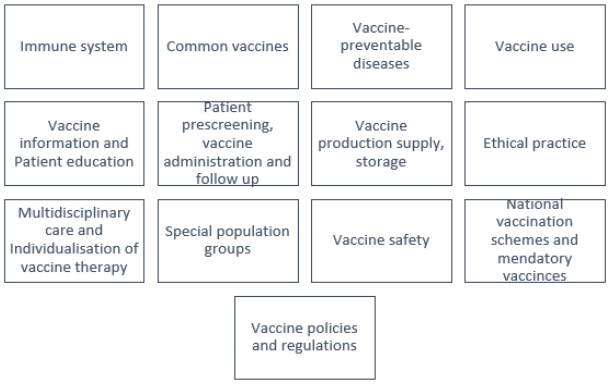

Fig. 1: Demonstrate the Questionnaire's Knowledge Domains Are Modified from the FIP Vaccination Reference Guide.

The questionnaire's knowledge domains were adapted from the FIP Vaccination Reference Guide (2022) to align with the study objectives and ensure relevance to pharmacy education. Modifications were made to tailor the content to the specific competencies required for pharmacists in vaccination services, as shown in Figure 1. The domains covered essential aspects such as vaccine types, mechanisms of action, safety and efficacy, immunization schedules, and regulatory guidelines. Additionally, emphasis was placed on pharmacists' roles in vaccine administration, patient counseling, and addressing vaccine hesitancy. These modifications aimed to enhance the questionnaire's applicability in assessing pharmacy students' knowledge and preparedness in vaccination, ensuring alignment with global standards set by the International Pharmaceutical Federation (FIP).

2.4. Data collection

An anonymous, self-administered survey was created using SurveyMonkey® (San Mateo, CA, USA) and distributed to students via email. The target participants included pharmacy students currently enrolled in Year 3 (n=30), Year 4 (n=22), and Year 5 (n=34). Responses were gathered throughout March 2023. The questionnaire required approximately 20 minutes to complete, and submission was considered as implied consent for participation in the study. Students who did not complete the questionnaire were excluded from the final analysis. Out of the 86 students invited to participate, 39 completed the questionnaire, resulting in a response rate of 45%. An analysis of the sociodemographic characteristics indicated that most respondents were UAE nationals, with an average age of 21.9 years (SD = 2.4; range: 19–31 years). When asked about their preferred career path after graduation, the majority (79.5%, n=31) expressed a preference for hospital pharmacy. Additional details are presented in Table 1. Academically, the respondents were fairly distributed across years 3, 4, and 5 of the pharmacy program, with the highest representation from year 3 (38.5%). Notably, a strong preference for hospital pharmacy as a career path was observed among students (79.5%), indicating a clear inclination toward a clinical and patient-focused role. This preference may be driven by factors such as job security, career growth opportunities, and personal interest in clinical practice.

Table 1: Demonstrate the Sociodemographic Profile of Participants

Characteristics	n (%)
Country of Origin	
UAE	32 (82.1%)
Syrian	2 (5.1%)
Other	5 (12.8%)
Age	
≤ 20	8 (20.5%)
> 20	31 (79.5%)
Year of Study	
Year 3	15 (38.5%)
Year 4	13 (33.3%)
Year 5	11 (28.2%)

Most participants (82.1%) are from the UAE, indicating strong domestic enrollment in the pharmacy program. Smaller representations from Syria (5.1%) and other countries (12.8%) suggest a degree of international diversity, though UAE nationals remain the dominant group. This demographic makeup implies that cultural and regional factors specific to the UAE likely shape students' educational experiences and expectations. Most participants are over 20 years old (79.5%), suggesting greater maturity and professional insight. The distribution across Year 3 (38.5%), Year 4 (33.3%), and Year 5 (28.2%) ensures diverse perspectives, while a strong preference for Hospital Pharmacy (79.5%) reflects the interest in clinical practice, possibly influenced by job market trends and career stability.

Table 2 presents the preferred career paths of pharmacy students upon graduation. Most participants indicated a strong inclination toward hospital pharmacy, reflecting its prominence as a career choice. Other fields such as community pharmacy, pharmaceutical industry, academia, and regulatory affairs were also considered, though to a lesser extent. These preferences highlight the diverse career opportunities available to pharmacy graduates and underscore the significance of hospital pharmacy as a primary professional aspiration.

Table 2: Demonstrate the Field of Preference After Completion of Your Pharmacy Degree

Hospital Pharmacy	31 (79.5%)
Pharmaceutical manufacturing	3 (7.7%)
Academia	2 (5.1%)
Enforcement	1 (2.6%)
Pharmaceutical marketing	1 (2.6%)
Others	1 (2.6%)

2.4.1. Students' knowledge of vaccinations

As illustrated in Table 3, the findings suggest that most respondents had limited knowledge of vaccines and vaccination. The average score recorded was 7.33 (SD = 0.38), with scores ranging from a minimum of 3 to a maximum of 14. However, the study revealed that a significant number of students were aware of the role of adjuvants in vaccine formulations. Additionally, respondents demonstrated an understanding of the importance of obtaining informed consent before administering a vaccine. Furthermore, students recognized that outpatient pharmacies must acquire a vaccine administration license before offering immunization services to patients.

Table 3: Demonstrate the Knowledge of Students Towards Vaccinations (N=39)

S. No.	Knowledge regarding vaccines	n (%)
1.	Students know passive immunity	10 (25.6%)
2.	Students know about inactivated vaccines	16 (41.0%)
3.	Answers regarding childhood vaccines (Hep B)	24 (61.5%)
4.	Answers regarding BCG indication	18 (46.2%)
5.	Students know about adjuvants	32 (82.1%)
6.	Students know about vaccine storage conditions	15 (38.5%)
7.	Students know about the risks of vaccines	24 (61.5%)
8.	Students should know about vaccines and informed consent	35 (89.7%)
9.	Students know about the vaccine technique	25 (64.1%)
10.	Students know about the ADR SOP	18 (46.2%)
11.	Students know about drug-drug interactions	8 (20.5%)
12.	Students know about contraindications	18 (46.2%)
13.	Answers regarding childhood vaccines (schedule)	13 (33.3%)
14.	Students know about vaccine licensure	30 (76.9%)

The findings reveal a significant knowledge gap among students regarding vaccinations, with an average knowledge score of 7.33 out of 14, emphasizing the need for enhanced education. While students demonstrated a strong awareness of topics like adjuvants (82.1%) and informed consent (89.7%), they showed limited understanding of passive immunity (25.6%), drug-drug interactions (20.5%), and vaccine storage conditions (38.5%). This suggests that while basic vaccine concepts are well understood, more specialized areas require greater focus in their training. The higher scores on informed consent and adjuvants may be due to their prominence in curricula and clinical practice.

2.5. Data analysis

To make statistical analysis easier, the gathered data were methodically coded and loaded into SPSS ('IBM SPSS® Statistics for Windows; IBM Corp, Armonk, New York, USA'). Students' replies were assessed using both descriptive and inferential statistical approaches, guaranteeing a comprehensive analysis of the dataset's trends, patterns, and linkages. Descriptive statistics provided summaries of key variables, while inferential methods enabled the identification of significant associations and differences among groups. This approach allowed for a deeper understanding of students' perspectives, highlighting critical insights that could inform future educational strategies and interventions related to the study's objectives.

3. Results and Discussion

According to the study's findings, participants tended to have favorable opinions about vaccinations and pharmacists' roles in immunization. According to Table 4, a sizable majority (94.9%) thought that enabling community pharmacists to give vaccinations would increase patient access to immunization. Furthermore, 87.1% of those surveyed agreed that community pharmacists should have a part in administering vaccines. Additionally, 84.7% of participants in the poll said that qualified vaccination pharmacists ought to be paid more than their non-certified colleagues. Furthermore, 84.6% of respondents expressed confidence in the ability of community pharmacists to counsel and educate patients about vaccines. Similarly, 84.5% indicated their willingness to participate in public health campaigns as immunizers if permitted by regulatory authorities.

Table 4: Attitudes and Beliefs About Vaccines and Pharmacists' Vaccination Role

Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	M	S.D.
I believe that WHO-approved vaccines are safe and effective.	0 (0.00%)	1 (2.6%)	6 (15.4%)	13 (33.3%)	14 (35.9%)	4.18	0.14
I am in favor of community pharmacists in the United Arab Emirates being able to do the tasks of providing vaccinations.	0 (0.00%)	1 (2.6%)	3 (7.7%)	13 (33.3%)	21 (53.8%)	4.42	0.12
I believe that community pharmacists can provide counseling and education on vaccines to patients.	0 (0.00%)	2 (5.1%)	4 (10.3%)	14 (35.9%)	19 (48.7%)	4.28	0.14
I support that certified immunization pharmacists should be paid more than non-certified pharmacists.	0 (0.00%)	2 (5.1%)	4 (10.3%)	15 (38.5%)	18 (46.2%)	4.26	0.14
I feel comfortable counseling patients on recommended vaccines during my community pharmacy placement.	0 (0.00%)	2 (5.1%)	11 (28.2%)	13 (33.3%)	13 (33.3%)	3.95	0.15
I would like to participate in public health campaigns as an immunizer if authorized by regulators.	0 (0.00%)	1 (2.6%)	5 (12.8%)	12 (30.8%)	21 (53.8%)	4.36	0.13
I feel uncomfortable with blood or other bodily fluids or secretions.	12 (30.8%)	11 (28.2%)	7 (17.9%)	6 (15.4%)	3 (7.7%)	2.41	0.21

I am concerned about needle stick injuries.	3	6	13	9	8	3.33	0.19
I would not be comfortable having to make physical contact with a patient of the opposite gender when vaccinating them	9 (23.1%)	10 (25.6%)	9 (23.1%)	6 (15.4%)	5 (12.8%)	2.69	0.22
I believe that I will not be comfortable giving vaccines to the pediatric population.	8 (20.5%)	8 (20.5%)	7 (17.9%)	10 (25.6%)	6 (15.4%)	2.95	0.22
I believe that I will not be comfortable giving vaccines to the geriatric population.	7 (17.9%)	10 (25.6%)	8 (20.5%)	7 (17.9%)	7 (17.9%)	2.92	0.22
I feel that I know the basis of pharmacy's emergency protocol if patients have an adverse reaction to a vaccine.	0 (0.00%)	3 (7.7%)	18 (46.2%)	11 (28.2%)	7 (17.9%)	3.56	0.14
I feel that vaccination by community pharmacists is likely to be accepted by patients.	2 (5.1%)	3 (7.7%)	10 (25.6%)	14 (35.9%)	10 (25.6%)	3.69	0.18
I believe that allowing community pharmacists to immunize will improve patient acceptability.	1 (2.6%)	0 (0.00%)	7 (17.9%)	20 (51.3%)	11 (28.2%)	4.03	0.14
I believe that allowing community pharmacists to immunize will improve patient access to vaccines.	0 (0.00%)	0 (0.00%)	2 (5.1%)	22 (56.4%)	15 (38.5%)	4.33	0.09
Other medical experts, in my opinion, are probably in favor of allowing pharmacists to legally provide vaccinations.	0 (0.00%)	1 (2.6%)	11 (28.2%)	17 (43.6%)	9 (23.1%)	3.89	0.13

3.1. Students' preparedness for vaccination

The assessment of students' preparedness for vaccination, categorized into 'Unprepared,' 'Somewhat unprepared,' 'Neutral,' 'Somewhat prepared,' and 'Prepared,' revealed an overall low level of perceived readiness (mean = 3.35; SD = 1.39; min = 1.5; max = 5.0). As shown in Table 5, 61% of respondents reported being well-prepared to explain vaccine mechanisms using basic immunology knowledge. Furthermore, 59. % of the participants felt sufficiently prepared to show that they understood the benefits and justifications of vaccination in their practice contexts. Similarly, 59.00% of respondents said they were confident in their capacity to follow UAE regulations regarding the handling, storage, and transportation of vaccines.

Table 5: Students' Preparedness for Vaccination

Item	U	SU	N	SP	P	M	S.D.
Using your fundamental understanding of the immune system, describe how vaccinations operate.	3 (7.7%)	2 (5.1%)	10 (25.6%)	13 (33.3%)	11 (28.2%)	3.69	0.19
Show that you comprehend the benefits and justifications of vaccinations as they relate to the practice environment.	2 (5.1%)	3 (7.7%)	11 (28.2%)	8 (20.5%)	15 (38.5%)	3.79	0.19
Integrate into practice knowledge about the main steps in vaccine development or evaluation.	3 (7.7%)	7 (17.9%)	15 (38.5%)	4 (10.3%)	10 (25.6%)	3.28	0.20
Utilize your understanding of the elements and characteristics of immunization agents as necessary for safe and efficient practice.	4 (10.3%)	4 (10.3%)	16 (41.0%)	6 (15.4%)	9 (23.1%)	3.31	0.20
Utilize pertinent public health concepts to raise vaccination rates.	3 (7.7%)	3 (7.7%)	19 (48.7%)	6 (15.4%)	8 (20.5%)	3.33	0.18
Effectively discuss vaccinations in the context of the practice setting or settings.	1 (2.6%)	4 (10.3%)	15 (38.5%)	9 (23.1%)	10 (25.6%)	3.59	0.17
Implement UAE guidelines when storing, handling, or transporting vaccines.	0 (0.00%)	4 (10.3%)	12 (30.8%)	12 (30.8%)	11 (28.2%)	3.77	0.16
Prepare and administer immunization agents correctly.	9 (23.1%)	5 (12.8%)	14 (35.9%)	5 (12.8%)	6 (15.4%)	2.85	0.22
Recognize, anticipate, manage, and prevent side effects after vaccination.	5 (12.8%)	3 (7.7%)	16 (41.0%)	9 (23.1%)	6 (15.4%)	3.21	0.19
Document pertinent information for every vaccination interaction following jurisdictional health-related procedures as well as national recommendations for vaccination practices.	2 (5.1%)	6 (15.4%)	17 (43.6%)	8 (20.5%)	6 (15.4%)	3.26	0.17
Acknowledge and address specific demographic groups' particular vaccination requirements.	6 (15.4%)	8 (20.5%)	12 (30.8%)	5 (12.8%)	8 (20.5%)	3.03	0.22
Show that you understand the UAE's vaccination program and how it affects your practice.	3 (7.7%)	6 (15.4%)	15 (38.5%)	8 (20.5%)	7 (17.9%)	3.26	0.19
Utilizes an evidence-based strategy to address vaccination-related concerns.	3 (7.7%)	7 (17.9%)	17 (43.6%)	5 (12.8%)	7 (17.9%)	3.15	0.19
Observing the law and upholding the highest moral standards in all facets of vaccination practice.	2 (5.1%)	3 (7.7%)	17 (43.6%)	8 (20.5%)	9 (23.1%)	3.49	0.18

With a mean score of 3.35 out of 5, pupils' self-assessed readiness for immunization activities was rated as moderate. Notably, 59% of respondents were confident in their comprehension of the advantages and justification for vaccinations pertinent to practice settings, as well as 61% felt equipped to describe how vaccines operate using fundamental immunological knowledge. Nevertheless, just 28.2% of respondents felt prepared to give vaccinations, which was a much lower level of preparation. This indicates a significant gap between theoretical knowledge and practical skills, emphasizing the need for more hands-on training. Implementing guidelines for storing and handling vaccines also showed moderate preparedness (59%), reflecting the importance of integrating practical guidelines into educational programs.

3.2. Students' educational recommendations on vaccines

Most pharmacy students (79.5%) strongly advocated for in-person vaccine administration training workshops, emphasizing their importance in learning proper vaccination techniques, as shown in Table 6. Additionally, 74.4% of students believed these workshops were essential for hands-on practice, allowing them to administer and receive intramuscular and subcutaneous sterile saline injections among classmates. Another highly recommended component was the integration of an educational module on vaccines as an assessed component within the pharmacy curriculum, supported by 74.3% of respondents. To enhance the practical skills, simulation-based immunization training may be beneficial to be incorporated into Objective Structured Clinical Examinations (OSCEs) and interprofessional workshops between the nursing and medical students. Such modules would enable students to practice in real-life settings, improve interaction with

different groups of patients, and gain confidence in the handling of adverse events. Internationally, such practices have been proven to enhance applied competency and preparedness.

Table 6: Educational Recommendation Regarding Vaccines

Item	SD	D	N	A	SA	M	S.D.
The scientific information I received so far regarding vaccines in the pharmacy program is enough for my future practice.	3 (7.7%)	5 (12.8%)	17 (43.6%)	8 (20.5%)	6 (15.4%)	3.23	0.18
An educational module on vaccines should be an assessed component of the pharmacy program.	0 (0.00%)	1 (2.6%)	9 (23.1%)	13 (33.3%)	16 (41.0%)	4.13	0.14
An educational module on vaccines should be an elective course, not a core course, in the pharmacy program.	7 (17.9%)	3 (7.7%)	10 (25.6%)	10 (25.6%)	9 (23.1%)	3.28	0.22
Attending an online lecture rather than an in-person lecture on vaccines will make me competent in counseling patients on vaccines.	8 (20.5%)	4 (10.3%)	11 (28.2%)	8 (20.5%)	8 (20.5%)	3.10	0.23
In-person vaccine administration training workshops are essential to teach pharmacy students how to administer vaccines.	0 (0.00%)	1 (2.6%)	7 (17.9%)	9 (23.1%)	22 (56.4%)	4.33	0.14
An in-person vaccine administration training workshop should allow me to give and receive intramuscular and subcutaneous sterile saline injections to and from classmates.	1 (2.6%)	2 (5.1%)	7 (17.9%)	9 (23.1%)	20 (51.3%)	4.15	0.17
OSCE stations should be designed to incorporate specific vaccine-related scenarios that pharmacists may face in practice.	2 (5.1%)	1 (2.6%)	8 (20.5%)	11 (28.2%)	17 (43.6%)	4.03	0.18
Attending a 2-hour clinical observation session within the Immunization Service Primary Healthcare Center will not improve my vaccine administration competency.	12 (30.8%)	5 (12.8%)	11 (28.2%)	6 (15.4%)	5 (12.8%)	2.67	0.22

3.3. Knowledge of vaccinations

Students display high awareness in certain critical areas such as adjuvants (82.1%), vaccine-informed consent (89.7%), and vaccine licensure (76.9%). This indicates strong foundational knowledge in these key areas, which are essential for ensuring safe and effective vaccination practices. However, moderate knowledge levels in areas like inactivated vaccines (41.0%), vaccine storage (38.5%), and BCG indication (46.2%) suggest gaps that need to be addressed to ensure a comprehensive understanding and competency in all aspects of vaccination.

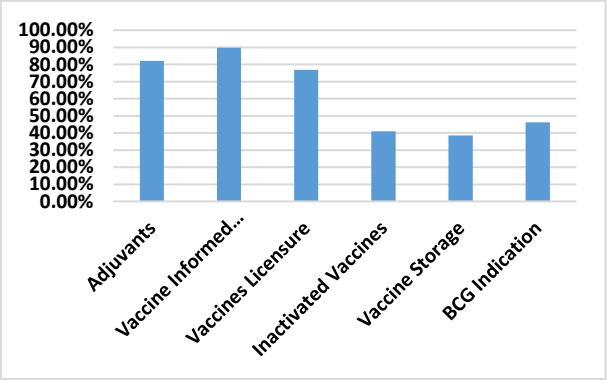

Fig. 2: Demonstrate that Students' Awareness is Different Vaccination.

3.4. Attitudes and beliefs regarding vaccination and the role of pharmacists

The results point to a generally favorable perception of vaccinations and the growing contribution of pharmacists to immunization. Most people are confident in the safety as well as efficiency of WHO-approved vaccination (4.18), and a sizable majority favor community pharmacists giving vaccinations (4.42). This optimistic outlook suggests that pharmacy students are prepared to take on more responsibility for immunization and public health initiatives. However, some concerns remain. Many students report discomfort with needle stick injuries (3.33) and physical contact with patients of the opposite gender (2.69). Additionally, administering vaccines to pediatric (2.95) and geriatric populations (2.92) is an area of unease. These findings highlight the need for additional training and support to ensure that students feel confident in handling all aspects of vaccination, particularly with vulnerable populations.

3.5. Vaccination preparedness

Students demonstrate moderate to high confidence in key areas such as understanding immunization principles (3.79), UAE vaccine handling guidelines (3.77), and effective communication about immunization (3.59). This suggests that the current educational framework provides a solid foundation in these aspects. However, gaps exist in hands-on skills, particularly in administering immunization agents (2.85) and recognizing the unique immunization needs of specific populations (3.03). These practical skills are essential for effective vaccine administration. Strengthening practical training through workshops and targeted educational interventions is crucial to ensuring students are well-prepared for their roles as vaccinators. Opinions are divided on whether the current curriculum provides sufficient vaccine education (3.23) and whether vaccine-related courses should be mandatory or elective (3.28). These findings suggest that ongoing curriculum reviews and potential expansions are necessary to meet student needs. Integrating more practical training and interactive learning experiences will help improve overall preparedness for vaccination responsibilities.

3.6. Study limitations

There are many restrictions on this study. Because of its cross-sectional form, it is impossible to track changes over time. Furthermore, self-reported answers might be skewed by ambient influences, honesty, as well as memory recall. The study focuses exclusively on Fatima

College pharmacy students, limiting generalizability to other health disciplines and universities. A low response rate (39 out of 49) also impacts the study's statistical reliability. Despite these constraints, the findings provide valuable insights into pharmacy students' vaccination knowledge, attitudes, and preparedness. The response rate (39 out of 49; 45) is rather low, which can decrease the representativeness of the findings. This can create bias in responses and decrease the applicability to other pharmacy programs in the UAE or the entire Middle East. To confirm these findings and increase the external validity, future research using larger and multi-institutional cohort studies is necessary.

4. Conclusion

The study indicates a predominantly positive outlook on vaccines and the expanding role of pharmacists in immunization. However, it also identifies notable knowledge gaps and differences in preparedness, especially in practical vaccination skills. The study found that participants held positive attitudes toward vaccines and pharmacists' involvement in immunization. A majority (94.9%) believed pharmacist-administered vaccines would improve access, and 87.1% supported their role in vaccination. Confidence in pharmacists' ability to counsel on vaccines was high (84.6%), and 84.5% were willing to join public health campaigns. However, students' preparedness for vaccination tasks was moderate, with 61% feeling confident in explaining vaccine mechanisms. These findings emphasize the need for improved educational strategies, prioritizing hands-on training and in-depth vaccine education to connect theory with practice. Students' suggestions for in-person workshops and structured educational modules provide valuable insights for curriculum enhancement, ensuring future pharmacists are well-equipped for their growing public health responsibilities.

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