Original Article

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Knowledge, Attitude, and Awareness towards Human Immunodeficiency Virus (HIV) Pre-Exposure Prophylaxis (PrEP) among Undergraduate Healthcare Students: A Cross-Sectional Study

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Abstract:

Objective: Healthcare providers play a pivotal role in facilitating the uptake of HIV pre-exposure prophylaxis (PrEP). One of the key barriers to PrEP implementation is insufficient provider knowledge, which may stem from inadequate coverage of PrEP in undergraduate healthcare curricula. This study aimed to assess the knowledge, attitude, and awareness toward PrEP among healthcare students.

Material and Methods: A cross-sectional study was conducted between March and June 2024 using an online self-administered questionnaire. The survey targeted undergraduate students in medicine, pharmacy, and nursing programs at a public university in Malaysia. Descriptive and inferential statistical analyses were performed to evaluate PrEP-related knowledge, attitudes, and awareness using IBM Statistical Package for the Social Sciences (SPSS) version 28.

Results: A total of 399 students completed the questionnaire. About two-fifths of students (40.9%) demonstrated poor knowledge of PrEP, and the majority (67.2%) exhibited a neutral attitude, suggesting uncertainty about PrEP's safety and clinical utility. The mean knowledge score was 5.67±2.26 (range: 0-10), and the mean attitude score was 21.31±3.13 (range: 6-30). Final-year students had higher knowledge levels compared to first-year students (p-value<0.001), while attitudes did not differ across sociodemographic variables. The majority of respondents were aware of the PrEP concept (70.4%), but less than half (44.9%) were aware of the local PrEP guidelines.

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Conclusion: The findings underscore the need for comprehensive and early integration of PrEP-related content into healthcare education. Addressing identified knowledge gaps through targeted curriculum enhancements may better prepare future healthcare providers to support PrEP implementation.

Keywords: attitude, awareness, healthcare students, HIV prevention, knowledge, pre-exposure prophylaxis

Introduction

Pre-exposure prophylaxis (PrEP) is a highly effective biomedical intervention for preventing human immunodeficiency virus (HIV) infection among populations at increased risk, as recommended by the World Health Organization[1]. PrEP involves the use of oral or injectable antiretroviral medications taken before potential exposure to HIV. It has been shown to reduce the risk of HIV acquisition by 86% among men who have sex with men (MSM) and by 75% among heterosexual partners[2]. More recently, a clinical trial demonstrated 100% efficacy in HIV prevention among cisgender women who received twice-yearly injections of lenacapavir[3]. Since its approval in the United States in 2012, PrEP has contributed to a steady decline in new HIV infections. This reduction has been attributed in part to increased PrEP coverage, which has been associated with lower HIV incidence[4]. These findings underscore the public health importance of expanding PrEP access and improving awareness of its use.

PrEP is delivered through diverse service models involving both healthcare and community-based providers. Traditionally, physicians are the main prescribers of PrEP. However, in the effort to expand access and uptake, pharmacist-led and nurse-led PrEP services have been implemented[5–7]. Additionally, innovative PrEP delivery models, such as community-based providers, are emerging in countries like Thailand through the key population-led healthcare services initiative[8]. These models provide stigma-free and client-centred environments that enhance accessibility, particularly among marginalised populations such as MSM and transgender women.

Despite its proven efficacy and safety, PrEP uptake remains suboptimal worldwide. This challenge is evident across both high-income and low- to middle-income countries[5]. Achieving the global target of ending the HIV epidemic by 2030 is particularly difficult in developing countries, where access to PrEP is limited and key populations such as MSM and transgender individuals are disproportionately affected[5]. From the healthcare provider's perspective, barriers to PrEP implementation include limited knowledge, negative attitudes, and stigma associated with PrEP use[9,10]. A systematic review identified several provider-related barriers, including misconceptions about efficacy, concerns about side effects, perceived risk compensation, fear of drug resistance, and uncertainty regarding the need for ongoing monitoring[11]. Notably, higher levels of PrEP knowledge among healthcare providers have been positively associated with both the willingness to prescribe and actual prescribing behavior[9]. Therefore, improving provider knowledge, attitudes, and awareness is essential to scaling up PrEP delivery and bridging the gap between availability and implementation.

In the United States, PrEP awareness among primary care clinicians was initially low, with only 24% aware of PrEP in 2009 and 29% in 2010. This figure rose substantially to 66 percent by 2015[4]. However, awareness alone does not guarantee clinical implementation. As of 2020, only 25% of eligible individuals in the United States were receiving PrEP[12]. This gap highlights the difficulty of translating awareness into practice. One contributing factor is the lack of formal training on PrEP in both undergraduate education and postgraduate clinical settings. In a study

involving 271 nurses, 60% reported no prior education or training related to PrEP[10]. Another study of 2,085 medical, pharmacy, and nursing students revealed that only 45.4% had received academic instruction on PrEP[13]. Encouragingly, many healthcare providers have expressed a willingness to prescribe PrEP if adequate training is provided[11], and those who have received more training report higher levels of PrEP-related competency[14].

Although numerous studies have examined PrEP-related knowledge, awareness, and attitudes among healthcare students in the United States, Spain, and Brazil[13,15–19], comparable data from Malaysia are lacking. International findings have been variable, with most reporting low levels of PrEP knowledge and awareness across pharmacy, medical, and nursing students. Attitudinal differences have also been observed across disciplines. For example, pharmacy students in the United States have demonstrated relatively positive attitudes toward PrEP[18] while nursing students in Spain and Brazil have exhibited more neutral or hesitant views[16,17].

To date, no published study has assessed the knowledge, attitudes, and awareness of PrEP among pharmacy, medical, and nursing students in Malaysia. As these students represent the next generation of healthcare providers, they will play a pivotal role in facilitating PrEP access and ensuring its appropriate use. It is therefore critical that academic curricula provide comprehensive and accurate information on PrEP. Understanding students' current knowledge and awareness can inform curriculum development and help address gaps in training. Furthermore, exploring student attitudes may reveal potential psychological or cultural barriers to PrEP implementation. Such insights are essential for preparing a competent and stigma-free healthcare workforce capable of advancing national and global HIV prevention goals. This study aimed to evaluate the level of knowledge, attitudes, and awareness related to PrEP among pharmacy, medical, and nursing students at a public university in Malaysia.

Material and Methods

Study design

A descriptive, cross-sectional study was conducted among a convenience sample of undergraduate healthcare students at Universiti Teknologi MARA (UiTM), Malaysia. Data were obtained via a validated, self-administered online questionnaire. The survey was administered between March 12 and June 12, 2024. Ethical approval was granted by the Universiti Teknologi MARA Research Ethics Committee, and informed consent was obtained from all participants before data collection.

Study population

The target population consisted of undergraduate healthcare students enrolled in pharmacy, medicine, and nursing programs at UiTM, encompassing students from all academic years within these disciplines. Inclusion criteria were as follows: students aged 18 years or older, currently enrolled in one of the specified programs, and able to read and understand English. Students who did not meet these criteria or submitted incomplete responses were excluded from the study.

The required sample size was determined using the Raosoft Sample Size Calculator[20], based on an estimated total population of 2,666 students, as reported by academic program coordinators from the respective disciplines. With a 95% confidence level, a 5% margin of error, and an assumed 50% response distribution, the minimum required sample size was calculated to be 336. To account for potential non-response or incomplete data, an additional 10% was added, yielding a final target sample size of 370 participants.

Study instrument

A structured, self-administered questionnaire was developed based on previously published instruments assessing healthcare students' knowledge, awareness, and

attitudes regarding PrEP[15,16,18,19]. The development of survey items was further guided by the Malaysian Consensus Guidelines on Antiretroviral Therapy (2022)[21] to ensure contextual and clinical relevance.

The questionnaire consisted of five sections: (1) sociodemographic profile (7 items), (2) educational experience (2 items), (3) awareness of PrEP (2 items), (4) knowledge of PrEP (10 items), and (5) attitudes toward PrEP (6 items). Sociodemographic variables included age, gender, academic program, year of study, CGPA, race, and religion. Items related to educational experience and awareness evaluated participants' prior exposure to PrEP-related content and their familiarity with national guidelines. The knowledge section assessed factual understanding of PrEP availability, efficacy, administration, and safety. The attitude section explored perceptions of PrEP, including concerns related to high-risk sexual behavior, cost-effectiveness, and government support.

Response formats varied by section: awareness items used categorical and dichotomous ("Yes/No") responses, knowledge items employed true/false and multiple-choice formats, and attitude items were rated using a five-point Likert scale (1=strongly disagree to 5=strongly agree).

Content and face validity were assessed by three clinical pharmacy lecturers and one infectious disease specialist. Reviewers were asked to rate each item's relevance using a four-point Likert-type scale (1=not relevant to 4=highly relevant). The content validity index (CVI) was calculated as the proportion of reviewers assigning a score of 3 or 4 to each item. All items achieved a CVI score of 1.0 and were retained. Minor revisions were made based on expert feedback to improve clarity and precision.

A pilot test was conducted with a sample of 10 students from each academic program (pharmacy, medicine, and nursing) to assess item comprehensibility. Based on their responses, minor adjustments were made; no further amendments were required at this stage. Data from the pilot test were excluded from the final analysis.

Reliability of the attitude section, which employed Likert-type items, was assessed using Cronbach's alpha. The scale demonstrated acceptable internal consistency with a Cronbach's alpha value of 0.70. Reliability analyses were not conducted for sections using categorical response formats (awareness and knowledge) due to the formative nature of these items.

For data analysis, negatively worded items were reverse-coded to ensure uniform interpretation. For the knowledge section, one point was awarded for each correct response (maximum score=10). For knowledge items with multiple correct answers (Items 2 and 6), one mark was awarded only if all correct options were selected. For the attitude section, the total score ranged from 6 to 30 based on responses to Likert-scale items. Both knowledge and attitude scores were converted to percentages and categorized using Bloom's cut-off points: high/positive (≥80%), moderate/neutral (60–79%), and low/negative (≤59%).

Data collection

Participants were recruited using a convenience sampling method. The questionnaire was disseminated online via email and WhatsApp using Google Forms, accompanied by an introductory section outlining the study's objectives, eligibility criteria, and an informed consent statement. Participation was entirely voluntary, and no incentives or compensation were offered. An initial screening question ensured that only eligible respondents could proceed with the survey.

Access to the questionnaire was provided through a secure Google Form link distributed via institutional email and messaging platforms such as WhatsApp. Participants were required to review the study information and indicate their informed consent before beginning the survey.

Measures were taken throughout the data collection process to ensure confidentiality and data integrity. Google Form settings were configured to allow only one submission per participant and to prevent duplicate responses. No personally identifiable information was collected. All responses were automatically recorded in a secure Google Sheet accessible only to the principal investigator and authorized members of the research team. The dataset was then exported to Microsoft Excel for data cleaning and verification, with strict data protection protocols applied throughout.

Data analysis

Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means and standard deviations. To examine the differences in knowledge and attitude scores across sociodemographic groups, independent t-tests and one-way analysis of variance (ANOVA) were performed, with Tukey's post hoc tests applied for pairwise comparisons where applicable. Pearson's correlation coefficient was used to assess the relationship between knowledge and attitude scores.

Results

Sociodemographic characteristics

The sociodemographic characteristics of the respondents are summarized in Table 1. A total of 399 undergraduate students completed the questionnaire, surpassing the minimum required sample size. The majority were enrolled in the pharmacy program (62.7%), followed by the medical (23.8%) and nursing (13.5%) programs. Most participants were female (75.9%), aged 21–23 years (66.9%), of Malay ethnicity (94.5%), and identified as Muslim (97.2%). Nearly half of the respondents (48.9%) were in their fourth year of study, and 46.4% reported a cumulative grade point average (CGPA) ranging from 3.00 to 3.49.

Educational experience and awareness of PrEP

As presented in Table 2, 58.4% of respondents reported exposure to PrEP-related content as part of their academic curriculum, whereas only 22.3% had prior experience interacting with HIV-positive patients in either clinical or non-clinical settings. In terms of awareness, 70.4% were familiar with the concept of HIV pre-exposure prophylaxis (PrEP); however, only 44.9% were aware of the Malaysian Consensus Guidelines on Antiretroviral Therapy (2022).

Knowledge and attitude towards PrEP

As detailed in Table 3, only 28.3% of students correctly identified the recommended frequency of PrEP administration, and just 26.1% recognized that PrEP does not prevent the transmission of other STIs. Additionally, only 40.9% knew which PrEP medications are approved in Malaysia. Nonetheless, the majority of respondents answered the remaining items correctly.

In terms of attitudes (Table 4), 67.2% expressed a neutral stance toward PrEP, while 22.8% held a positive attitude and 10.0% a negative one. Responses were mixed regarding whether PrEP indirectly promotes high-risk sexual behavior. Notably, 53.2% believed that its widespread use could significantly increase antiretroviral resistance. Conversely, most respondents supported its cost-effectiveness, government funding, and professional advocacy for use among at-risk populations.

The overall mean knowledge score was 5.67±2.26, and the mean attitude score was 21.31±3.13, with maximum possible scores of 10 and 30, respectively. Based on Bloom's cut-off criteria (Table 5), 40.9% of respondents demonstrated poor knowledge, 38.3% moderate knowledge, and 20.8% good knowledge.

Table 1 Sociodemographic characteristics (n=399) and differences in knowledge and attitude toward PrEP by sociodemographic characteristics

Variable	n (%)	Knowledge score*		Attitude score*	
		Mean±S.D.	(p-value)	Mean±S.D.	(p-value)
Gender					
Male	96 (24.1)	5.47±2.56	0.319†	21.35±3.29	0.876†
Female	303 (75.9)	5.73±2.15		21.30±3.09	
Age					
18–20	43 (10.8)	4.02±2.35[a]	<0.001‡	21.79±3.04	0.447‡
21–23	267 (66.9)	5.70±2.17[b]		21.13±3.24	
24–26	78 (19.5)	6.38±2.18[b]		21.59±2.75	
Above 26	11 (2.8)	6.09±1.51[b]		21.73±3.41	
Course					
Pharmacy	250 (62.7)	5.79±2.34	0.180‡	21.16±3.06	0.219‡
Medicine	95 (23.8)	5.29±2.27		21.80±3.34	
Nursing	54 (13.5)	5.78±1.72		21.15±3.04	
Year of study					
Year 1	42 (10.5)	4.10±2.12[a]	<0.001‡	22.07±3.04	0.371‡
Year 2	49 (12.3)	4.80±2.50[a]		21.06±3.07	
Year 3	104 (26.1)	4.91±2.21[a]		21.38±3.05	
Year 4	195 (48.9)	6.57±1.80[b]		21.13±3.20	
Year 5 (medical student)	9 (2.3)	7.00±2.06[b]		22.22±2.82	
CGPA					
2.00–2.19	5 (1.3)	4.40±3.58	0.114‡	21.00±3.00	0.392‡
2.20–2.99	71 (17.8)	5.49±2.01		21.63±2.79	
3.00–3.49	185 (46.4)	5.89±2.32		21.03±3.03	
3.50–4.00	45 (11.3)	5.10±2.02		21.08±3.55	
Pass (medical student)	93 (23.3)	5.28±2.28		21.73±3.35	
Race					
Malay	377 (94.5)	5.69±2.23	0.454†	21.28±3.12	0.477†
Non-Malay¶	22 (5.5)	5.32±2.70		21.77±3.41	
Religion					
Muslim	388 (97.2)	5.71±2.24	0.052†	21.27±3.10	0.128†
Non-Muslim§	11 (2.8)	4.36±2.66		22.73±4.13	

*Maximum scores for the knowledge and attitude sections were 10 and 30, respectively. S.D.=standard deviation. †Independent *t*-test. ‡One-way analysis of variance (ANOVA) with Tukey post hoc analysis. Superscript letters within the same column indicate statistically significant differences between groups. ¶Non-Malay includes respondents from Sabah, Sarawak, and other ethnicities. §Non-Muslim includes Christian and other non-Muslim respondents

Sociodemographic differences in knowledge and attitude

Statistical comparisons of knowledge and attitude scores across sociodemographic variables are also presented in Table 1. Respondents aged 18–20 years had lower knowledge scores (4.02±2.35, p-value<0.001) compared to older age groups. Meanwhile, fourth- and fifth-year students had higher scores (6.57±1.80 and 7.00±2.06, respectively) than students in earlier years. No other sociodemographic variables—including gender, academic program, CGPA, race, or religion—were associated with knowledge or attitude scores.

Furthermore, no notable differences in attitude scores were found across any sociodemographic subgroup.

Table 2 Educational experience and awareness related to HIV and PrEP

	Response, n (%)	
	Yes	**No**
Educational experience		
Have you learnt about PrEP in your course of study?	233 (58.4)	166 (41.6)
Have you interacted with HIV-positive patients in a clinical or non-clinical setting in the past?	89 (22.3)	310 (77.7)
Awareness		
Before this survey, were you aware of the concept of HIV PrEP, which is HIV medications taken by HIV-negative individuals prior to HIV exposure to prevent HIV infection?	281 (70.4)	118 (29.6)
Are you aware of the Malaysia consensus guidelines on antiretroviral therapy 2022?	179 (44.9)	220 (55.1)

PrEP=pre-exposure prophylaxis

Table 3 Knowledge of PrEP (n=399)

Items*	Response, n (%)	
	Correct	**Incorrect**
1. PrEP can prevent the transmission of other sexually transmitted diseases. (Answer: False)	104 (26.1)	295 (73.9)
2. The oral PrEP medications can be taken (Tick all that apply):† (Answer: in bold) ☐ Once daily ☐ Twice daily ☐ Two tablets before sex and one tablet after sex for two days ☐ Not sure	113 (28.3)	286 (71.7)
3. The PrEP medications approved in Malaysia are: (Answer: in bold) ☐ Zidovudine 300mg/Lamivudine 150mg ☐ Tenofovir/Emtricitabine 300mg/200mg ☐ Lopinavir 200mg/Ritonavir 50mg ☐ Not sure	163 (40.9)	236 (59.1)
4. At the moment, PrEP is available for free at some health facilities under the Ministry of Health Malaysia (Answer: True)	203 (50.9)	196 (49.1)
5. How often should individuals be tested for HIV while taking PrEP? (Answer: in bold) ☐ Once a month ☐ Once every 3 to 6 months ☐ Once a year ☐ Not sure	227 (56.9)	172 (43.1)
6. PrEP is recommended for (Tick all that apply):† (Answer: in bold) ☐ Men who have sex with men ☐ Individual who has an HIV-positive partner whose viral load or level is unknown ☐ Individual who is diagnosed with sexually transmitted diseases in the last 6 months ☐ Transgender individuals who consistently use condoms ☐ Not sure	242 (60.7)	157 (39.3)
7. PrEP has potential side effects that need regular monitoring. (Answer: True)	264 (66.2)	135 (33.8)
8. Before starting PrEP, an HIV test needs to be done to ensure the individual is HIV-negative (Answer: True)	292 (73.2)	107 (26.8)
9. Individuals who take PrEP are recommended to have regular follow-up with the doctor at least every 3 to 6 months. (Answer: True)	314 (78.7)	85 (21.3)
10. PrEP is effective in reducing the risk of getting HIV. (Answer: True)	340 (85.2)	59 (14.8)

*One mark was awarded for each item answered correctly. †For multiple-choice questions containing more than one correct answer, all correct options had to be selected to obtain one mark.
PrEP=pre-exposure prophylaxis

Table 4 Attitude towards PrEP (n=399)

Item	Response, n (%)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
PrEP indirectly promotes high-risk sexual behaviour.	47 (11.8)	82 (20.6)	125 (31.3)	96 (24.1)	49 (12.3)
Individuals who are at risk for HIV should be encouraged to take other preventative measures as well.	6 (1.5)	1 (0.3)	26 (6.5)	99 (24.8)	267 (66.9)
Providing PrEP for free at health facilities under the Ministry of Health Malaysia is cost-effective in the long term.	18 (4.5)	47 (11.8)	114 (28.6)	114 (28.6)	106 (26.6)
PrEP should be funded by the government for HIV prevention.	12 (3.0)	21 (5.3)	86 (21.6)	157 (39.3)	123 (30.8)
Widespread use of PrEP will likely significantly increase rates of antiretroviral resistance.	8 (2.0)	23 (5.8)	156 (39.1)	120 (30.1)	92 (23.1)
As a future healthcare provider, I will support the use of PrEP regardless of the individuals' risky behaviours.	7 (1.8)	22 (5.5)	84 (21.1)	153 (38.3)	133 (33.3)

PrEP=pre-exposure prophylaxis

Pearson's correlation analysis revealed no relationship between knowledge and attitude scores (r=–0.016, p-value=0.755).

Table 5 Knowledge and attitude score classifications (n=399)

	Classification*	n (%)
Knowledge	Good	83 (20.8)
	Moderate	153 (38.3)
	Poor	163 (40.9)
Attitude	Positive	91 (22.8)
	Neutral	268 (67.2)
	Negative	40 (10.0)

*Bloom's criteria: good/positive (≥80%), moderate/neutral (60–79%), and poor/negative (≤59%)

Discussion

This study revealed a gap between the general awareness and accurate clinical knowledge of PrEP among Malaysian undergraduate healthcare students. Although 70.4% of respondents reported being familiar with the concept of PrEP, only 20.8% demonstrated good knowledge. Older and more senior students had significantly higher knowledge scores. To the best of our knowledge, this is the first study in Malaysia to comprehensively assess PrEP-related knowledge, awareness, and attitudes among healthcare students.

In the present study, the mean PrEP knowledge score was moderate (5.67 out of 10), reflecting a partial understanding of PrEP concepts among healthcare students. In contrast, a study conducted in the United States involving 744 medical, nursing, and pharmacy students reported lower mean knowledge scores of 1.38, 1.53, and 1.93 out of 6, respectively[19]. This difference may be attributed to the variations in the number and content of items in the respective instruments. Nevertheless, both studies highlighted inadequate PrEP knowledge among healthcare students. Approximately two-fifths of respondents in this study demonstrated poor knowledge of PrEP, which is consistent with findings from a study involving 570 nursing students in Spain that similarly reported low knowledge levels[16]. Regarding attitudes, the findings of the present study align with those of López-Díaz et al.[16], who also observed generally neutral attitudes towards PrEP among nursing students and uncertainty in its clinical utility.

Item-level analysis highlighted several critical knowledge deficiencies. Fewer than one-third of respondents correctly identified that PrEP can be taken either daily or on an event-driven basis, and nearly half were unaware of the medications currently approved for PrEP use in Malaysia, despite their regulatory approval in 2022[21]. These findings indicate that PrEP has not yet been meaningfully integrated into Malaysian health science curricula. Since appropriate use of PrEP requires a clear understanding of dosing schedules, drug selection, and patient eligibility, such knowledge gaps are concerning and may hinder future prescribing competence.

A particularly widespread misconception, reported by nearly three-quarters of respondents, was the belief that PrEP protects against other STIs. This misunderstanding may result in the failure to provide appropriate counseling on condom use and other essential components of sexual health education, thereby compromising the effectiveness of comprehensive HIV prevention efforts. Educational programs must directly address such misconceptions and present PrEP as one component within a multifaceted prevention strategy, which should also include consistent condom use, routine STI screening, and behavioral counseling[22].

In addition to knowledge gaps, students' attitudes toward PrEP exhibited notable nuances. While 67.2% of respondents reported a neutral overall attitude, a closer analysis revealed strong support for public health measures. For example, 72.6% agreed that PrEP should receive government funding, and 83.3% supported its use in combination with other prevention strategies for individuals at high risk of HIV. This divergence between personal neutrality and policy-level endorsement suggests that students conceptually support systemic implementation of PrEP, even if they lack confidence in clinical application. This distinction provides a strategic entry point for educational interventions aimed at strengthening both clinical knowledge and advocacy skills.

Academic seniority was significantly associated with PrEP-related knowledge. Final-year students, particularly those in the fifth year of the medical program, achieved the highest knowledge scores. This trend is consistent with findings from the United States, where senior pharmacy and medical students consistently demonstrate greater PrEP knowledge than their junior counterparts[15]. These differences likely reflect cumulative exposure to HIV prevention content, clinical experiences, and public health training. Senior students have generally completed more advanced learning in pharmacotherapy and infectious diseases, which may incorporate PrEP-related content, and they are also more likely to encounter HIV-related cases during clinical placements. Nevertheless, this finding should be interpreted with caution, as other confounding factors may exist. Senior students may possess higher cognitive maturity and academic skills, in line with their educational experience, and their broader social exposure may further enhance awareness of PrEP. However, the persistence of basic misconceptions among senior students highlights the need to introduce PrEP education earlier and reinforce it across the academic continuum[15].

Despite these strengths among senior students, several key misconceptions persisted. For instance, 53.2% of respondents believed that PrEP use increases the risk of antiretroviral resistance. This proportion is higher than those reported in prior studies involving pharmacy (40%) and nursing (27%) students[16,18]. Although resistance is a legitimate clinical concern, it is rare and largely preventable through proper HIV testing and monitoring protocols.23 Clarifying this point is essential to ensure that unfounded fears do not deter future healthcare providers from prescribing PrEP when appropriate[11].

With regard to behavioral perceptions, 36% of students believed that PrEP promotes high-risk sexual

behavior. This belief is consistent with findings among nursing students but is higher than those reported for pharmacy students[16,18]. However, emerging evidence indicates that risk-taking behaviors typically precede, rather than follow, PrEP initiation.24 Educators must equip students with the skills to critically assess evolving research and avoid perpetuating stigmatizing or moralistic assumptions. This is especially important given that stigma among healthcare providers has been shown to limit PrEP access among marginalized populations[11]. Encouragingly, most respondents supported PrEP use regardless of individuals' sexual behaviors and endorsed its cost-effectiveness and public funding. These perspectives form a strong foundation for fostering more compassionate and evidence-informed attitudes through targeted educational efforts.

Although 58.4% of students reported having learned about PrEP during their academic program, only 44.9% were aware of the Malaysian Consensus Guidelines on Antiretroviral Therapy (2022). This reflects a critical gap in exposure to official clinical guidance, despite its centrality to safe and effective prescribing. Previous studies have found that guideline familiarity is associated with a greater likelihood of PrEP prescribing[19]. Accordingly, academic curricula should incorporate both national and international PrEP guidelines, such as those from the Ministry of Health Malaysia,[21,25] the Centers for Disease Control and Prevention[26], and the University of Washington[27], as part of structured HIV prevention instruction.

Only 22.3% of respondents reported prior engagement with people living with HIV. Existing research shows that direct interaction with individuals affected by HIV can reduce provider stigma and foster empathy[28]. Academic institutions should implement structured experiential learning opportunities, such as community outreach, patient panels, and placements in HIV care settings, to humanize PrEP-related care and strengthen professional identity. These experiences may enhance students' communication skills, cultural competence, and willingness to serve vulnerable populations[28,29].

Taken together, these findings underscore the urgent need for a more integrated, evidence-informed, and stigma-sensitive approach to PrEP education within Malaysian healthcare training programs. Bridging the gap between awareness and clinical competence, correcting misconceptions, and fostering student empathy are essential steps toward preparing future providers to contribute effectively to HIV prevention efforts.

This study has several limitations that should be acknowledged. First, the majority of respondents were Malay and Muslim, which may limit the generalizability of the findings to Malaysia's broader multi-ethnic and multi-faith healthcare population. As religious beliefs can influence attitudes and behaviors toward HIV prevention, the results may reflect perspectives specific to this demographic. Nevertheless, given the paucity of research on PrEP-related attitudes among Muslim healthcare students and providers, this study offers valuable insights into an underrepresented and culturally significant subgroup. Second, the study was conducted at a single public university, and the sample was disproportionately composed of pharmacy students. This disciplinary imbalance may limit the applicability of the findings to medical and nursing students, thereby reducing the overall generalizability across healthcare training programs. Third, the cross-sectional design captures a snapshot of knowledge, awareness, and attitudes at a single time point, without accounting for changes that may occur as students progress through their training. Additionally, the use of an online self-administered questionnaire may have introduced sampling bias. Individuals without consistent internet access or those less interested in the topic may have been underrepresented, while those with a greater interest in HIV prevention may have been more likely to

participate. Future research should consider recruiting a more diverse and representative sample across multiple academic institutions. Longitudinal and mixed-method studies, as well as investigations involving practicing healthcare professionals, are warranted to assess whether observed knowledge gaps and attitudinal patterns persist over time and translate into clinical practice.

Conclusion

This study offers valuable insights into the knowledge, attitudes, and awareness of HIV PrEP among pharmacy, medical, and nursing students at a Malaysian public university. Although general awareness of PrEP was relatively high, the findings revealed notable gaps in clinical knowledge. While students' overall attitudes were largely neutral, many respondents expressed strong support for public health implementation and government funding, suggesting conceptual endorsement despite limited personal confidence in the clinical application. Future research should aim to include multi-institutional samples with greater disciplinary diversity and adopt longitudinal methodologies to examine changes in knowledge and attitudes throughout students' academic progression.

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Conflict of interest

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