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Knowledge and Perceptions of HIV Prevention and Transmission Among Healthcare Professionals in Bahrain: A Cross-Sectional Survey

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Abstract

Background

Advances in antiretroviral therapy have transformed HIV into a chronic, manageable condition. Contemporary prevention strategies, including pre-exposure prophylaxis (PrEP), post-exposure prophylaxis (PEP) and the principle that undetectable equals untransmittable (U=U), depend on clinicians' accurate understanding for effective implementation. Data assessing healthcare professionals' knowledge of modern HIV prevention concepts in the Gulf region remain limited.

Methodology

A national cross-sectional survey was conducted in the Kingdom of Bahrain between January and December 2025 among healthcare professionals and clinical students engaged in patient care across public primary healthcare centres and secondary and tertiary governmental hospitals. The questionnaire assessed demographic and professional characteristics, self-reported confidence in discussing HIV, eight evidence-based knowledge items and the perceived need for further HIV education. Knowledge scores ranged from 0 to 8 and were categorised as low (0-3), moderate (4-6) or high (7-8). Non-parametric tests were used for group comparisons.

Results

A total of 395 participants were included; 306 (77.5%) were female and 198 (50.1%) were nurses. The mean knowledge score was 3.83 ± 2.15 . Overall, 189 participants (47.8%) demonstrated low knowledge, 153 (38.7%) demonstrated moderate knowledge and 53 (13.4%) demonstrated high knowledge. Correct identification of PEP as the appropriate intervention following occupational exposure was reported by 255 participants (64.6%), while 230 (58.2%) recognised that HIV transmission would not occur following a needlestick injury involving a patient with an undetectable viral load. In contrast, only 129 participants (32.7%) correctly identified that individuals with sustained viral suppression do not transmit HIV sexually, and 148 (37.5%) were aware of the U=U concept. Physicians demonstrated significantly higher knowledge scores than nurses and other professionals ($P < 0.001$). No significant differences were observed across healthcare settings, specialties, age groups or gender. Confidence in discussing HIV was not significantly associated with knowledge score ($P = 0.105$). A majority of participants (362, 91.6%) expressed a desire for additional HIV-related education.

Conclusions

HIV-related knowledge among healthcare professionals in Bahrain was modest, with substantial gaps in contemporary biomedical prevention concepts, particularly U=U and PrEP. Professional disparities were evident, although deficits were observed across all care settings. The near-universal demand for further training identifies a modifiable, systems-level opportunity for competency-based HIV education.

Categories: HIV/AIDS, Infectious Disease

Keywords: bahrain, continuing medical education, cross-sectional survey, healthcare workers, hiv knowledge, hiv stigma, occupational exposure, post-exposure prophylaxis, pre-exposure prophylaxis, undetectable equals untransmittable

Introduction

The epidemiology of human immunodeficiency virus (HIV) infection has evolved substantially over the past

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three decades, largely because of the widespread implementation of combination antiretroviral therapy (ART). With sustained viral suppression, HIV is now considered a chronic, manageable condition, fundamentally transforming prognosis and life expectancy for people living with HIV (PLHIV) [1,2]. Globally, approximately 39 million individuals were living with HIV in 2023, with continued emphasis not only on expanding treatment access but also on optimising quality of care and addressing HIV-related stigma within healthcare systems [3].

Healthcare professionals play a pivotal role in HIV prevention, early diagnosis, therapeutic monitoring and patient counselling. Their knowledge and perceptions directly influence adherence to evidence-based prevention strategies, occupational safety practices and patient-provider communication. Contemporary HIV care requires an accurate understanding of occupational transmission risk, post-exposure prophylaxis (PEP), pre-exposure prophylaxis (PrEP) and the principle that undetectable equals untransmittable (U=U) [4]. Landmark clinical trials have demonstrated the preventive effect of viral suppression: the HIV Prevention Trials Network (HPTN) 052 trial showed a 96% reduction in linked HIV transmission with early ART initiation [5]. At the same time, the PARTNER studies reported zero genetically linked transmissions among sero-different couples when the HIV-positive partner maintained sustained viral suppression [6,7]. These findings form the scientific basis for the U=U paradigm, which has been endorsed by major public health authorities [8].

Despite the robustness of this evidence, awareness and acceptance of contemporary biomedical prevention concepts among healthcare professionals remain variable. A large multicounty survey across Europe and Central Asia reported incomplete knowledge of U=U, PEP and PrEP among healthcare workers, with substantial heterogeneity across professional roles [9]. Similar knowledge gaps have been documented in the Middle East; a study among healthcare workers in Oman demonstrated variable understanding of HIV transmission routes and persistent misconceptions regarding occupational risk [10]. Differences in HIV-related knowledge have also been observed among professional cadres, with physicians typically demonstrating higher knowledge scores than nurses and allied health professionals [9,11].

Persistent misconceptions regarding HIV transmission may contribute to exaggerated fear of occupational exposure, unnecessary infection-control practices, and stigmatising attitudes towards PLHIV. Evidence indicates that inadequate HIV knowledge among healthcare providers is associated with increased stigma and reduced confidence in delivering HIV-related care [12,13]. Addressing knowledge gaps is therefore central not only to clinical competence but also to fostering equitable and stigma-free healthcare environments.

In the Gulf region, data on healthcare professionals' knowledge of contemporary HIV prevention science are scarce. Although Bahrain has established structured HIV treatment services, no systematic evaluation has compared HIV-related knowledge across primary and secondary or tertiary care settings. Variations between care levels may reflect differences in clinical exposure, continuing professional development and familiarity with evolving prevention guidelines. Examining differences between medical and surgical specialties may further clarify whether routine practice patterns influence HIV literacy.

This study evaluated knowledge and perceptions regarding HIV prevention and transmission among healthcare professionals in Bahrain. The primary objective was to assess knowledge of HIV transmission and prevention among healthcare professionals and clinical students engaged in patient care in Bahrain. The secondary objectives were to describe self-reported awareness of PEP, PrEP and U=U; perceived occupational risk of HIV acquisition; confidence in discussing HIV status with patients; and perceived need for further HIV-related education. Additional secondary objectives were to explore differences in the original composite questionnaire score across demographic and professional groups, including healthcare settings and physician specialties, and its associations with self-reported confidence and perceived educational need.

Materials And Methods

Study design and participants

A cross-sectional survey was conducted in the Kingdom of Bahrain, with participant recruitment and data collection taking place from 31 July to 23 November 2025. The recruitment setting comprised Bahrain's public primary healthcare sector, encompassing 27 primary healthcare centres, and secondary/tertiary care at Salmaniya Medical Complex, the principal tertiary referral hospital within Government Hospitals.

Healthcare professionals and clinical students actively engaged in patient care during the study period were eligible for participation. This included physicians, nurses, pharmacists, physiotherapists, respiratory therapists, medical students and nursing students practising within public healthcare institutions in Bahrain. Individuals without direct patient contact, including purely administrative personnel, were excluded. Questionnaires with substantial missing data, defined as more than 20% incomplete responses across all questionnaire items, and duplicate entries, identified on the basis of demographic and professional characteristics, were removed prior to analysis.

Sampling strategy and sample size

A non-probability convenience sampling approach, supplemented by peer referral (snowball sampling), was employed. The questionnaire was administered electronically via Google Forms, and the research team distributed the survey link via WhatsApp through professional networks, including healthcare professional groups and departmental contacts. Participants were invited to share the link with eligible colleagues within their institutions. Participation was voluntary and anonymous. Because the survey used an open, shareable link, we could not determine the number of individuals invited or calculate a response rate.

The target sample size was estimated using the single-proportion formula, $n = Z^2 p(1 - p)/d^2$. The calculation assumed a 95% confidence level ($Z = 1.96$), an anticipated proportion of 0.50 and an absolute precision of 0.05. A proportion of 0.50 was selected to maximise the required sample size in the absence of a reliable local estimate. This yielded $n = (1.96^2 \times 0.50 \times 0.50)/0.05^2 = 384.16$, rounded up to 385 participants. The final analytical sample comprised 395 participants. Because recruitment used non-probability sampling, this calculation was treated as a sample-size planning benchmark; the nominal precision assumes simple random sampling and does not account for selection or non-response bias.

Questionnaire development and structure

The questionnaire was developed specifically for this study by a multidisciplinary team comprising specialists in infectious diseases, clinical pharmacy, and infection prevention and control, with input from a biostatistician. Item domains were informed by published studies of healthcare workers' HIV-related knowledge and stigma [9–13]. The study team reviewed the questionnaire for content relevance, scientific accuracy and clarity. The first 20 participants formed an initial pilot sample in which comprehension and completion time were assessed. No modifications were required following this assessment, and these responses were retained in the final analysis. This developmental review and pilot assessment did not constitute formal psychometric validation, which was not undertaken. The questionnaire was designed by the authors specifically for this study and is not a previously published or copyrighted instrument; no adaptation of, or permission for, an existing scale was required. The questionnaire was administered in English. The full questionnaire is reproduced in Appendix A.

The instrument comprised four sections. The first section collected demographic and professional characteristics, including age group, gender, professional category, specialty for physicians, and healthcare setting (primary versus secondary or tertiary care). The second section assessed self-reported confidence in discussing HIV status with patients.

The third section comprised eight items addressing perceived occupational risk, isolation practices, needlestick exposure, PEP and PrEP, U=U, sexual transmission and reproductive outcomes. Responses were scored using the original investigator-defined answer key, with one point assigned to each designated response and zero points to other responses, including “I don’t know”. The resulting composite score ranged from 0 to 8 and was categorised as low (0–3), moderate (4–6) or high (7–8). However, the instrument combined factual knowledge with self-reported awareness and perceived risk, and the occupational-exposure items contained contextual ambiguity. Consequently, this score should be interpreted as an exploratory composite rather than a validated measure of factual HIV knowledge. The fourth section assessed perceptions of the importance of HIV education. The original scoring key, supporting evidence and item-specific qualifications are presented in Appendix B.

The final section assessed perceived educational need by asking participants whether they desired additional training or information regarding HIV.

The inclusion of the educational need component was intended to contextualise knowledge findings and to identify potential demand for structured training interventions.

Variables

The primary outcome variable was HIV-related knowledge score, calculated from eight knowledge-based items. Secondary outcome variables included self-reported confidence in discussing HIV status with patients and perceived need for additional HIV-related education or training. Independent variables included demographic and professional characteristics: age group, gender, professional category, specialty for physicians, and healthcare setting, categorised as primary care or secondary/tertiary care. The knowledge score was analysed both as a continuous variable (0–8) and as a categorical variable using predefined knowledge levels: low, moderate, and high. These study-specific categories were used to facilitate descriptive presentation and comparisons. The thresholds have not been validated for this instrument and should not be interpreted as established levels of clinical competence.

Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows, Version 26 (released 2019; IBM Corp., Armonk, NY). Categorical variables were summarised as frequencies and percentages. Continuous variables were

presented as means and standard deviations. Knowledge scores are additionally reported as medians (Q1–Q3), where Q1 and Q3 are the 25th and 75th percentiles, calculated by linear interpolation, given their non-normal distribution. The distribution of knowledge scores was assessed for normality using the Kolmogorov–Smirnov test and visual inspection of histograms and quantile–quantile plots. As the distribution did not meet parametric assumptions, non-parametric statistical tests were employed.

The Kruskal–Wallis test was used to compare knowledge scores across more than two groups, while the Mann–Whitney U test was applied for two-group comparisons. Associations between categorical variables were evaluated using the chi-square test or Fisher’s exact test, as appropriate. The uncategorised composite questionnaire score was used for the principal score analyses; the study-specific categories were retained as secondary descriptive groupings. Age was summarised descriptively in five categories: 18–29, 30–39, 40–49, 50–59 and ≥60 years. For comparisons of knowledge scores, the 50–59-year and ≥60-year categories were combined because the latter included only two participants. The resulting analytical categories were 18–29, 30–39, 40–49 and ≥50 years, with 28 participants in the ≥50-year group. For the principal comparison of composite questionnaire scores, participants were grouped as physicians, nurses, and other healthcare professionals or clinical students. The third group comprised pharmacists, physiotherapists, respiratory therapists, medical students, nursing students, and respondents reporting another occupation. A two-sided P-value of less than 0.05 was considered statistically significant.

Ethical considerations

The study was approved by the Research Ethics Committee of the Government Hospitals in Bahrain (approval date: 31 July 2025; research approval serial number 74-310725). Participation was voluntary, and submission of the completed questionnaire was considered informed consent. No personally identifiable information was collected, and all data were analysed anonymously.

Results

Participant characteristics

A total of 395 healthcare professionals were included in the final analysis. The cohort was predominantly female (306, 77.5%), and the largest age group was 30–39 years (144, 36.5%), followed by 18–29 years (119, 30.1%). Nurses constituted the largest professional group (198, 50.1%), followed by physicians (134, 33.9%), while 63 (15.9%) represented other healthcare professions. Among physicians who reported their specialty ($n = 117$), 90 (76.9%) practised in medical specialties and 27 (23.1%) practised in surgical disciplines. The demographic and professional characteristics of participants are summarised in Table 1.

Study variables	n (%)
Age group	
18-29 years	119 (30.1%)
30-39 years	144 (36.5%)
40-49 years	104 (26.3%)
50-59 years	26 (06.6%)
≥60 years	02 (0.50%)
Gender	
Male	89 (22.5%)
Female	306 (77.5%)
Professional job	
Doctor	134 (33.9%)
Nurse	198 (50.1%)
Others	63 (15.9%)
If you're a doctor, what specialty? (n = 117)	
Medical	90 (76.9%)
Surgical	27 (23.1%)

TABLE 1: Demographic and professional characteristics of study participants (n = 395).

The total knowledge score ranged from 0 to 8, with a mean of 3.83 ± 2.15 . Based on predefined categorisation, 189 (47.8%) participants demonstrated low knowledge (scores 0-3), 153 (38.7%) demonstrated moderate knowledge (scores 4-6), and 53 (13.4%) achieved high knowledge (scores 7-8).

Performance across individual knowledge items demonstrated substantial variability. Correct identification of PEP as the appropriate intervention following occupational exposure was reported by 255 (64.6%) participants, while 230 (58.2%) correctly responded that HIV transmission would not occur following a needlestick injury from a patient with an undetectable viral load. Awareness of PEP and PrEP was reported by 206 (52.2%) respondents. In contrast, only 129 (32.7%) correctly identified that individuals with an undetectable viral load do not transmit HIV sexually, and 148 (37.5%) reported awareness of the U=U concept. Correct responses regarding reproductive outcomes were observed in 219 (55.4%) participants, while 209 (52.9%) correctly disagreed that automatic side-room isolation is required for PLHIV. The detailed distribution of knowledge scores and item-level responses is presented in Table 2.

Knowledge items	n (%)
I feel at risk of HIV transmission when treating people living with HIV.	
Disagree*	117 (29.6%)
Agree	240 (60.8%)
I don't know	38 (09.6%)
Should a person living with HIV automatically be put in a side room?	
Disagree*	209 (52.9%)
Agree	121 (30.6%)
I don't know	65 (16.5%)
If you get a needle stick injury from an HIV patient whose viral load is undetectable. Will you get HIV?	

Yes	165 (41.8%)
No*	230 (58.2%)
Would you need:	
PreEP	140 (35.4%)
PEP*	255 (64.6%)
Have you heard about PEP and PreEP?	
Yes *	206 (52.2%)
No	189 (47.8%)
Can a person living with HIV who has an undetectable Viral Load pass HIV to their negative partner through sex?	
Yes	151 (38.2%)
No*	129 (32.7%)
I don't know	115 (29.1%)
Do you know about U=U?	
Yes *	148 (37.5%)
No	247 (62.5%)
Can a person living with HIV still conceive and have children who are negative?	
Yes*	219 (55.4%)
No	60 (15.2%)
I don't know	116 (29.4%)
Total knowledge score (mean ± SD)	3.83 ± 2.15
Level of knowledge	
Low (score 0-3)	189 (47.8%)
Moderate (score 4-6)	153 (38.7%)
High (score 7-8)	53 (13.4%)

TABLE 2: Distribution of HIV-related knowledge scores and responses to individual knowledge items (n = 395).

*A response was awarded one point according to the original investigator-defined scoring key. Items 1, 5 and 7 assess perceived risk or self-reported awareness, while items 3 and 4 require contextual qualification regarding occupational exposure and PEP indications. See Appendix B for the scientific interpretation of each item.

HIV, human immunodeficiency virus; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; U=U, undetectable equals untransmittable; SD, standard deviation

Knowledge scores differed significantly across professional categories ($P < 0.001$). Physicians demonstrated the highest mean score (4.96 ± 1.95), compared with nurses (3.25 ± 2.04) and other professional groups (3.24 ± 1.97). When stratified by knowledge level, 34 (64.2%) participants in the high-knowledge category were physicians, whereas 114 (60.3%) of those in the low-knowledge category were nurses.

Subgroup analysis did not demonstrate statistically significant differences in knowledge scores between physicians working in secondary care and those in primary healthcare centres ($P = 0.270$), nor between medical and surgical specialists within secondary care ($P = 0.538$). Similarly, knowledge scores did not differ significantly across age groups ($P = 0.322$) or by gender ($P = 0.076$). Associations between knowledge score and demographic and professional characteristics are shown in Table 3.

Factor	Knowledge score (Mean ± SD)	Median (Q1-Q3)	Test statistic	P-value

Age group ^a				
18-29 years	3.99 ± 2.20	4 (2-6)	<i>H</i> (3) = 3.489	0.322
30-39 years	3.58 ± 2.21	3 (2-5)		
40-49 years	3.92 ± 1.99	4 (2.75-5)		
≥50 years	4.11 ± 2.17	4 (2.75-6)		
Gender ^b				
Male	4.18 ± 2.11	5 (2-6)	<i>U</i> = 11,950	0.076
Female	3.73 ± 2.16	3 (2-5)		
Professional job ^a				
Doctor	4.96 ± 1.95	5 (3-6.75)	<i>H</i> (2) = 56.068	<0.001**
Nurse	3.25 ± 2.04	3 (2-5)		
Others	3.24 ± 1.97	3 (2-4)		
Subgroup analysis				
Doctors ^b				
Secondary	5.04 ± 1.91	5 (3.75-7)	<i>U</i> = 877	0.270
PHC	4.44 ± 2.18	4 (3-6)		
Nurses ^b				
Secondary	3.34 ± 2.04	3 (2-5)	<i>U</i> = 1,320	0.056
PHC	2.50 ± 1.91	2 (1-3)		
Secondary doctor ^b				
Medical	5.06 ± 1.94	5 (3.25-7)	<i>U</i> = 1,121	0.538
Surgical	4.85 ± 1.81	5 (3.5-6)		
How confident do you feel discussing HIV status with your patient ^a				
Not confident	3.52 ± 2.09	3 (2-5)	<i>H</i> (2) = 4.502	0.105
Somewhat confident	3.92 ± 2.20	4 (2-6)		
Confident	4.08 ± 2.14	4 (2-6)		
Would you like more information and training about HIV ^b				
Yes	3.76 ± 2.12	4 (2-5)	<i>U</i> = 4,798	0.059
No	4.58 ± 2.38	5 (3-6)		

TABLE 3: Association between knowledge score and demographic and professional characteristics (n = 395).

^aKruskal-Wallis test; H is reported with degrees of freedom in parentheses.

^bTwo-sided Mann-Whitney U test; the smaller U is reported, with tie correction and no continuity correction.

**Statistically significant at *P* < 0.05.

HIV, human immunodeficiency virus; SD, standard deviation; IQR, interquartile range; PHC, primary healthcare

Self-reported confidence in discussing HIV status was not significantly associated with knowledge score (*P* = 0.105), although mean scores increased progressively from participants who were not confident (3.52 ± 2.09)

to those who were confident (4.08 ± 2.14). The distribution of confidence levels is illustrated in Figure 1.

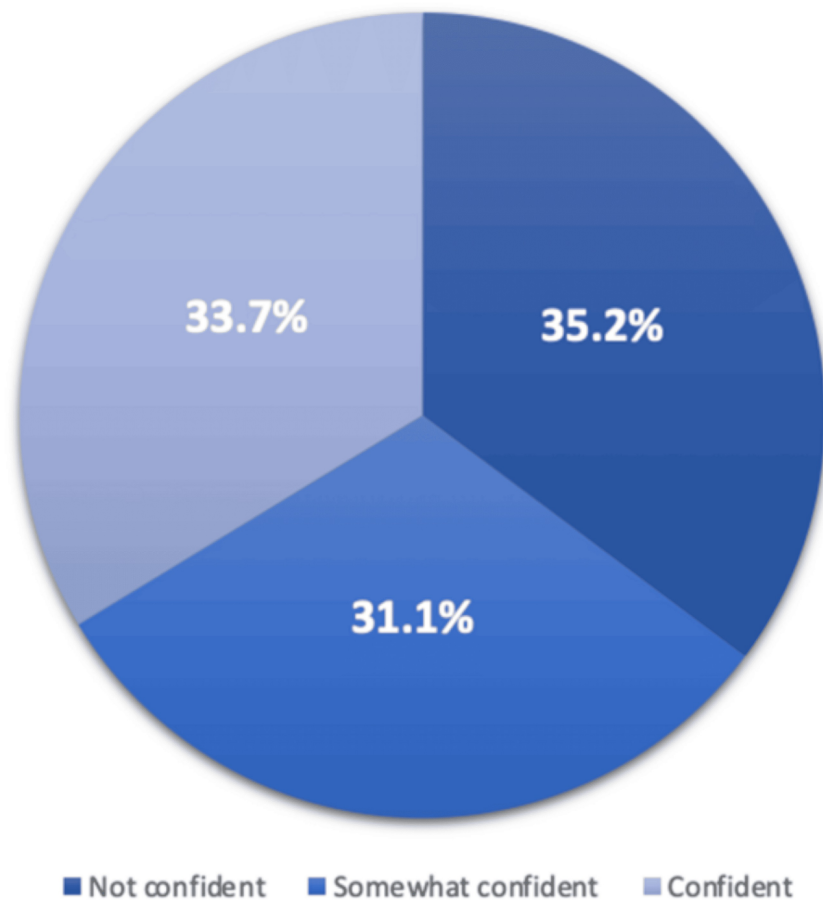


FIGURE 1: Self-reported confidence in discussing HIV status with patients (n = 395).

A large majority of participants (362, 91.6%) expressed a desire for additional HIV-related education. The need for further training did not differ significantly across professional groups ($P = 0.646$) or knowledge categories ($P = 0.155$). Participants' interest in additional HIV-related education is illustrated in Figure 2, and its association with professional group and knowledge level is detailed in Table 4.

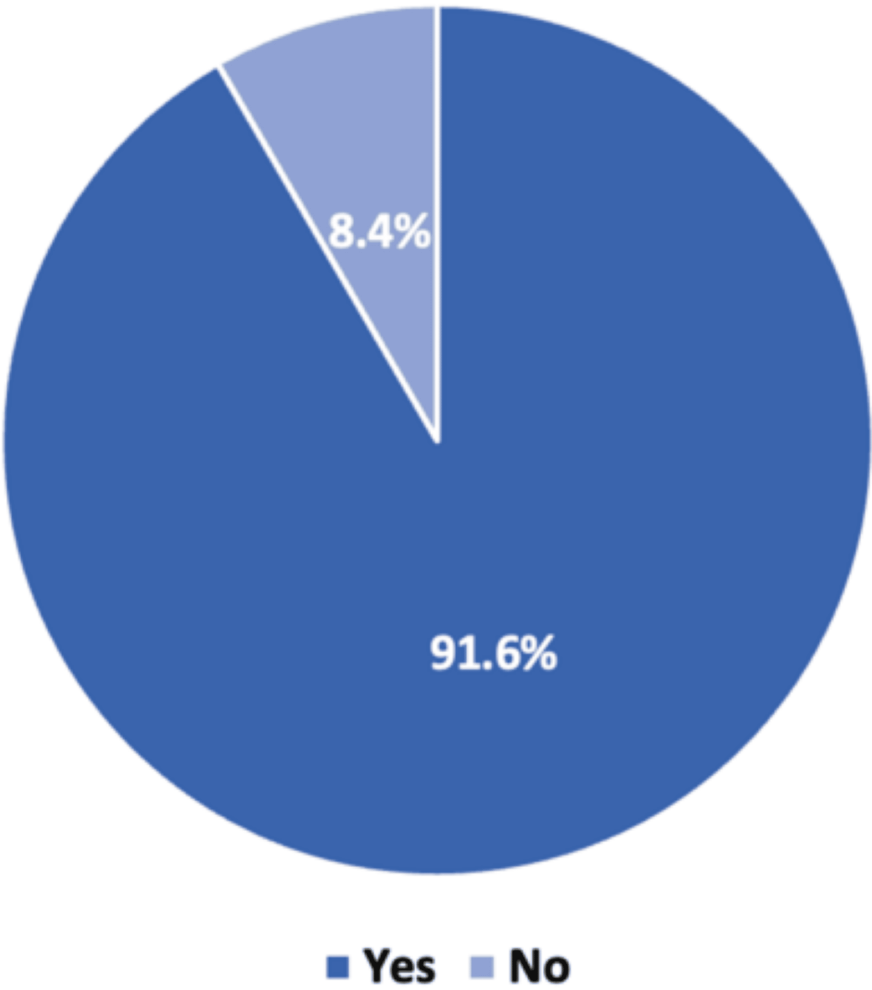


FIGURE 2: Participants' interest in additional HIV-related education (n = 395).

Factor	Need more HIV information		Test statistic	P-value
	Yes, <i>n</i> (%) (<i>n</i> = 362)	No, <i>n</i> (%) (<i>n</i> = 33)		
Professional job				
Doctor	120 (33.1%)	14 (42.4%)	$\chi^2(7) = 5.099\ddagger$	0.646‡
Nurse	184 (50.8%)	14 (42.4%)		
Pharmacy	04 (01.1%)	0		
Pysiotherapy	09 (02.5%)	02 (06.1%)		
Respiratory therapist	12 (03.3%)	02 (06.1%)		
Medical student	21 (05.8%)	01 (03.0%)		
Nursing student	06 (01.7%)	0		
Others	06 (01.7%)	0		
Level of knowledge				
Low	176 (48.6%)	13 (39.4%)	$\chi^2(2) = 3.735$	0.155
Moderate	141 (39.0%)	12 (36.4%)		
High	45 (12.4%)	08 (24.2%)		

TABLE 4: Relationship between professional group, knowledge level, and desire for additional HIV training (n = 395).

χ^2 denotes the Pearson chi-square statistic, with degrees of freedom given in parentheses.

‡ For professional group, χ^2 is provided as a descriptive measure of association; the *P*-value is from the two-sided Fisher-Freeman-Halton exact test, rather than the asymptotic chi-square distribution, because of sparse cells.

HIV, human immunodeficiency virus

Further analysis examining the distribution of knowledge levels across professional categories demonstrated a statistically significant association between professional group and knowledge level ($P < 0.001$). Physicians accounted for 34 (64.2%) participants in the high-knowledge category, whereas nurses accounted for 114 (60.3%) participants in the low-knowledge category. The detailed distribution of knowledge levels across professional groups is presented in Table 5.

Factor	Knowledge score (Mean ± SD)	Level of knowledge			Test statistic	P-value
		Low, n (%) (n = 189)	Moderate, n (%) (n = 153)	High, n (%) (n = 53)		
Professional group						
Doctor	4.97 ± 1.95	37 (19.6%)	63 (41.2%)	34 (64.2%)	χ ² (14) = 57.274‡	<0.001**‡
Nurse	3.25 ± 2.04	114 (60.3%)	68 (44.4%)	16 (30.2%)		
Pharmacy	3.50 ± 2.08	02 (01.1%)	02 (01.3%)	0		
Pysiotherapy	3.27 ± 1.85	07 (03.7%)	03 (02.0%)	01 (01.9%)		
Respiratory therapist	1.93 ± 1.27	13 (06.9%)	01 (0.70%)	0		
Medical student	3.95 ± 1.76	09 (04.8%)	13 (08.5%)	0		
Nursing student	3.67 ± 2.50	03 (01.6%)	02 (01.3%)	01 (01.9%)		
Others	3.00 ± 2.83	4 (02.1%)	01 (0.70%)	01 (01.9%)		

TABLE 5: Distribution of knowledge levels across professional groups (n = 395).

‡χ² is the Pearson chi-square statistic, with 14 degrees of freedom, provided as a descriptive measure of association. The P-value is from the Fisher-Freeman-Halton exact test for the 8 × 3 table, rather than the asymptotic chi-square distribution.

**Statistically significant at P < 0.05. Percentages are calculated within each knowledge-level column.

SD, standard deviation

Discussion

In this cross-sectional survey of 395 healthcare professionals in Bahrain, nearly half (189, 47.8%) demonstrated low HIV knowledge, and only 53 (13.4%) achieved high knowledge scores, with an overall mean score of 3.83 ± 2.15 out of 8. This modest performance is consistent with international findings showing incomplete HIV prevention literacy among healthcare workers. In a multicountry survey across Europe and Central Asia involving 18,348 healthcare workers, Mendez-Lopez et al. reported that only 31.3% of respondents achieved comprehensive knowledge across biomedical HIV prevention domains, despite higher overall awareness of HIV management principles [9]. Similarly, Shah et al. documented significant variability in HIV knowledge among healthcare workers in Oman, with substantial misconceptions regarding transmission risk persisting despite structured national HIV services [10]. Compared with these data, the proportion of high-knowledge respondents in our cohort (53, 13.4%) appears lower, suggesting that integration of contemporary HIV prevention science into routine clinical literacy remains incomplete in the regional context.

In the post-exposure item, 255 (64.6%) participants selected PEP rather than PrEP. This proportion is comparable to findings from Tanzania, where 62.1% of healthcare workers identified PEP indications [14]. The 2024 WHO guidelines recommend initiating PEP as soon as possible when indicated, ideally within 24 hours and no later than 72 hours after exposure, and providing a 28-day prescription; three-drug regimens are preferred [15]. In contrast, awareness of PrEP and U=U was substantially lower in our cohort. Only 206 (52.2%) participants reported awareness of PEP and PrEP, and only 129 (32.7%) correctly identified that individuals with a sustained undetectable viral load do not transmit HIV sexually. In the European multicountry survey, correct knowledge of PrEP was reported in 40.7% and correct U=U knowledge in 61.2% of healthcare workers [9], indicating that while knowledge gaps are global, U=U literacy in our cohort was markedly lower. Given the definitive evidence from HPTN 052 and the PARTNER studies demonstrating zero linked transmissions among virally suppressed individuals [5-7], this deficit likely reflects a lag in disseminating evolving evidence into routine continuing medical education rather than a lack of scientific clarity.

Reproductive knowledge was correct in 219 (55.4%) participants, while 209 (52.9%) correctly disagreed that automatic side-room isolation is required. These figures indicate that misconceptions regarding transmission risk remain prevalent. Nyblade et al. have shown that exaggerated perceptions of transmission risk among healthcare providers are closely associated with stigmatising practices and unnecessary isolation measures in clinical settings [12]. Inadequate knowledge has repeatedly been linked to stigma expression in

healthcare environments [13]. The persistence of perceived occupational risk in our cohort, with 240 (60.8%) participants reporting feeling at risk when treating PLHIV, aligns with findings from multiple regions where fear of transmission remains disproportionate to actual risk under standard precautions [12]. This suggests that, despite universal precaution training, misconceptions persist when biomedical prevention concepts are not sufficiently internalised.

A professional role was associated with the knowledge score in our study ($P < 0.001$). Physicians demonstrated a mean score of 4.96 ± 1.95 , compared with 3.25 ± 2.04 among nurses, and 34 (64.2%) of the high-knowledge group were physicians. Similar professional gradients have been documented internationally. Mekonnen et al. reported that physicians were significantly more likely than nurses and other cadres to demonstrate adequate PrEP knowledge (adjusted odds ratio 2.18) [11]. Mendez-Lopez et al. likewise identified physician status as independently associated with higher biomedical prevention literacy across 54 countries [9]. Differences in curriculum depth, clinical exposure to HIV and access to continuing education are possible explanations for the observed professional-group differences; however, these factors were not measured. The findings arise from unadjusted comparisons and do not establish professional role as an independent predictor or identify the factors underlying the observed differences.

Notably, knowledge scores did not differ significantly between primary healthcare and secondary or tertiary physicians ($P = 0.270$), nor between medical and surgical specialties ($P = 0.538$). This finding suggests that knowledge gaps are not confined to specific institutional levels or clinical disciplines. A similar absence of setting-based superiority has been observed in European healthcare surveys, where knowledge variability was distributed across care levels rather than concentrated within tertiary institutions [9]. The lack of difference in our cohort may reflect centralised dissemination of national guidelines and similar baseline professional training across institutions.

Although self-reported confidence was not statistically associated with knowledge score ($P = 0.105$), a progressive increase in mean knowledge score was observed across confidence levels, from 3.52 to 4.08. Previous research has demonstrated that knowledge deficits correlate with reduced comfort in discussing HIV prevention and transmission [13]. The absence of statistical significance in our cohort may reflect limited power to detect modest associations, yet the directional trend remains consistent with published evidence linking HIV literacy to provider communication confidence.

A particularly striking finding was the overwhelming demand for further education, expressed by 362 (91.6%) participants, with no significant variation across professional groups or knowledge categories. This uniform training need mirrors findings from systematic reviews, which identify insufficient provider training as a key barrier to effective PrEP implementation globally [16]. Zhang et al., in a qualitative meta-synthesis across low- and middle-income countries, reported that healthcare workers frequently expressed uncertainty regarding evolving HIV prevention guidelines and requested structured educational support [17]. The convergence of these findings suggests that training gaps are recognised by providers themselves and represent a modifiable, systems-level opportunity.

Taken together, our findings indicate that while foundational occupational HIV safety knowledge is moderately established, contemporary biomedical prevention literacy, particularly regarding U=U and PrEP, remains suboptimal. The pattern observed in Bahrain parallels international data but with comparatively lower U=U awareness, underscoring the need for targeted, competency-based continuing education. Bridging this knowledge gap is critical not only for improving clinical practice but also for reducing stigma, enhancing patient communication and aligning healthcare delivery with modern HIV prevention science.

Limitations

This study has several limitations. The cross-sectional design precludes causal inference between knowledge level, confidence and educational need. Convenience and snowball sampling may have introduced selection bias and limited the representativeness and generalisability of the findings. The unknown invitation denominator prevented calculation of a response rate, and potential non-response bias could not be assessed. Self-reported responses are subject to social desirability bias, particularly for items related to stigma and perceived risk. Additionally, self-reported awareness of U=U and responses to the sexual-transmission item represent distinct outcomes. Familiarity with the term does not necessarily demonstrate understanding of its implications, while respondents may understand the principle without recognising the abbreviation. Neither measure alone establishes clinical counselling competence. Although the questionnaire addressed core HIV prevention domains, it was not a formally validated standardised instrument, which may affect cross-study comparability.

Conclusions

In this convenience sample of healthcare professionals and clinical students in Bahrain, questionnaire responses indicated gaps in selected HIV prevention concepts, variable awareness of contemporary prevention approaches and substantial demand for further education. Composite questionnaire scores differed across professional groups, although their interpretation is limited by the instrument's measurement properties and study-specific classification thresholds. These exploratory findings may inform

the content of future educational initiatives, but their effectiveness and any effects on stigma or patient care require separate evaluation. Future studies should evaluate structured training using knowledge assessments before and after the intervention and, where feasible, a comparison group and follow-up assessment of retention. Effects on clinical behaviour, stigma and patient outcomes would require separate measurement.

Appendices

Appendix A: Study questionnaire

Knowledge and Perceptions of HIV Prevention and Transmission Among Healthcare Professionals in Bahrain: A Cross-Sectional Survey

This questionnaire was designed by the authors for this study. It is not adapted from any previously published or copyrighted instrument, and no permission for use of an existing scale was required. It was administered electronically as a self-completed online form. Question wording and response options below are reproduced verbatim as they appeared to participants.

Administered between 31 July 2025 and 23 November 2025. A total of 395 responses were analysed.

Consent

1. Do you agree to participate at this survey?

☐ Yes

☐ No

Affirmative response constituted informed consent; respondents answering "No" did not proceed.

Section 1: Demographic and professional characteristics

2. Age group

☐ 18-29

☐ 30-39

☐ 40-49

☐ 50-60

☐ Over 60's

3. Gender

☐ Male

☐ Female

4. What's your job?

☐ Doctor

☐ Doctor-PHC

☐ Nurse

☐ Nurse-PHC

☐ Pharmacist

☐ Physiotherapy

☐ Respiratory Therapist

- ☐ Medical student
- ☐ Nursing student
- ☐ Others

The "-PHC" options identified respondents based in primary healthcare centres. Healthcare setting was derived from this item rather than asked separately.

5. Others

- ☐ Free-text response

Shown only to respondents selecting "Others" at question 4. Responses received: medical support assistant, psychologist, laboratory technician.

6. If you're a Doctor, which specialty?

- ☐ Medical
- ☐ Surgical

Section 2: Confidence

7. How Confident do you feel discussing HIV status with your patient

- ☐ Confident
- ☐ Somewhat confident
- ☐ Not Somewhat confident at all
- ☐ Not my responsibility

Four response options were offered. For analysis, "Not Somewhat confident at all" and "Not my responsibility" were combined into a single "Not confident" category, giving the three levels reported in the manuscript.

Section 3: Knowledge items

The evidence-based correct response for each item is marked with an asterisk. Correct responses scored one point; incorrect responses and "I don't know" scored zero. Total score range 0-8. Asterisks did not appear on the questionnaire as administered.

8. I Feel at risk of HIV transmission when treating people living with HIV?

- ☐ Agree
- ☐ Disagree *
- ☐ I don't Know

9. A person living with HIV, should automatically be put on a side room?

- ☐ Agree
- ☐ Disagree *
- ☐ I don't Know

10. If you get a needle stick injury from an HIV patient who's viral load is undetectable. Will you get HIV?

- ☐ Yes
- ☐ No *

11. a) Would you need:

- ☐ PEP (Post-exposure prophylactic) *
- ☐ PreEP (Pre-exposure prophylactic)

12. b) Have you heard about PEP and PreEP?

- ☐ Yes *
- ☐ No

13. Can a person living with HIV who has an undetectable Viral Load pass the HIV virus to their negative partner through sex?

- ☐ Yes
- ☐ No *
- ☐ I don't know

14. Do you know about U=U (Undetectable = untransmissible)?

- ☐ Yes *
- ☐ No

15. Can a person living with HIV still conceive and have children who are negative?

- ☐ Yes *
- ☐ No
- ☐ I don't know

Section 4: Perceived educational need

16. Would you like more information and training about HIV?

- ☐ Yes
- ☐ No

Appendix B: Interpretation of the questionnaire scoring key

Questionnaire item	Original answer awarded one point	Scientific basis and necessary qualification
1. Feeling at risk when treating people living with HIV	Disagree	This measures perceived risk, not a factual proposition with one universally correct answer. Standard precautions reduce occupational risk, but the item does not specify the procedure or exposure. "Agree" should not automatically be interpreted as deficient knowledge [18].
2. Automatic placement in a side room	Disagree	HIV infection alone does not require isolation: standard precautions apply. Additional precautions may be needed for a coexisting transmissible infection [19].
3. Acquiring HIV after a needlestick from a patient with an undetectable viral load	No	Risk under sustained suppression is considered likely negligible, but direct occupational evidence is limited. The binary wording omits relevant clinical details and cannot establish knowledge of a definitive zero-risk rule. Occupational assessment remains appropriate [20,21].
4. Whether PrEP or PEP is needed following that exposure	PEP	PEP is the intervention used after exposure when indicated. However, because this question refers to the preceding suppressed-source scenario, neither offered option captures a decision that prophylaxis may be unnecessary after assessment [19-21].
5. Having heard of PEP and PrEP	Yes	This measures self-reported awareness. A "Yes" response does not establish understanding of indications, timing or use. WHO guidance supports the clinical relevance of PEP but cannot validate an individual's reported awareness as factual knowledge [19].
6. Sexual transmission from a person with an undetectable viral load	No	Supported when viral suppression is maintained through effective ART. WHO states that people with an undetectable viral load who continue treatment as prescribed do not transmit HIV sexually. The item's interpretation should explicitly include sustained suppression [22].
7. Knowing about U=U	Yes	This measures self-reported awareness of U=U, rather than demonstrated understanding. The underlying principle concerns prevention of sexual transmission through maintained viral suppression [22].
8. Whether a person living with HIV can conceive and have children without HIV	Yes	Supported: effective ART and appropriate reproductive and perinatal care enable people living with HIV to have children without HIV. This describes a possibility, not a guarantee of zero transmission throughout pregnancy, delivery and breastfeeding [23].

TABLE 6: Original Scoring Key, Supporting Evidence and Interpretative Limitations for Each Questionnaire Item.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Rawan Alagha, Abdulrahman Sharaf , Athraa Naser

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Supervision: Rawan Alagha

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Research Committee for Government Hospitals issued approval 74-310725. The study was approved by the Research Ethics Committee of the Government Hospitals in Bahrain (Approval date: 31-07-2025; Research approval serial no.: 74-310725). Participation was voluntary, and submission of the completed questionnaire was considered informed consent. No personally identifiable information was

collected, and all data were analyzed anonymously. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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