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The Unseen Architecture of Trust: Seven-Year Mixed-Methods Evidence on Nurse-Led HIV Prevention and the Paradox of Stigma in Uzbekistan

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Abstract

Background: *Nurses constitute the largest healthcare workforce globally and serve as the primary point of contact for patients, positioning them as critical agents in HIV prevention. Yet the paradox that nurses may simultaneously educate communities about HIV while harboring stigmatizing attitudes toward people living with HIV (PLHIV) remains inadequately characterized. We investigated this dual role through a seven-year mixed-methods investigation in Uzbekistan.*

Methods: *We conducted a longitudinal educational intervention among 1,247 secondary school participants (students, teachers, parents) who received nurse-led HIV education in Tashkent, Uzbekistan (2019-2026), with follow-up at 6, 12, 24, and 36 months. Concurrently, we administered repeated cross-sectional surveys to 892 practicing nurses (2025) with comparative data from 2019-2023, and conducted semi-structured interviews with 42 nurses and 18 PLHIV. Primary outcomes were HIV knowledge (validated 25-item scale) and stigmatizing attitudes (Healthcare Provider HIV Stigma Scale, HPHSS). Multivariable logistic regression identified predictors of high stigma.*

Findings: *Among 1,247 school participants, nurse-led education produced substantial knowledge gains (22.4±3.8 to 74.6±5.2 points, $p<0.001$, Cohen's $d=1.82$), with 68.9% retention at 36 months. Stigmatizing attitudes toward HIV-positive peers declined from 86.4% to 9.2% ($p<0.001$). However, among 892 nurses surveyed in 2025, 29.7% reported fear or hostility toward PLHIV, 41.8% were unwilling to share a toilet with PLHIV, and 45.7% were unwilling to eat with PLHIV. Comprehensive HIV training was the strongest predictor of reduced stigma (adjusted OR=0.32; 95% CI: 0.24-0.43), while working in primary care (OR=2.34; 95% CI: 1.76-3.11) and perceived infection risk (OR=3.42; 95% CI: 2.54-4.61) predicted higher stigma. Qualitative analysis revealed a profound disjuncture: nurses effectively educated communities about HIV while privately expressing fear, avoidance, and discriminatory attitudes.*

Interpretation: *Nurses demonstrate remarkable capacity as HIV educators but simultaneously harbor stigmatizing attitudes that may undermine their effectiveness. We propose the **Unseen Architecture of Trust**—a conceptual framework comprising three pillars (Transformative Education, Empathic Care, Sustainable Systems) that must be systematically constructed to align nurses' professional roles with their personal attitudes. Without targeted interventions addressing the paradox of nurse stigma, the full potential of nursing as a prevention force will remain unrealized.*

Keywords: HIV Prevention, Nursing, Stigma, Healthcare Workers, Central Asia, Mixed-Methods, Longitudinal Study, Trust

1. Introduction

The global HIV response has achieved unprecedented biomedical progress. Antiretroviral therapy (ART) has transformed HIV into a manageable chronic condition, and pre-exposure prophylaxis (PrEP) offers near-complete protection when used consistently [1,2]. Yet despite these advances, 1.3 million new HIV infections occurred globally in 2023, with Central Asia experiencing one of the fastest-growing epidemics worldwide [3]. In Uzbekistan, registered HIV cases increased by 22.3% between 2020 and 2026, reaching 62,847 [4]. The persistence of HIV is not a biomedical failure but a social one: stigma, discrimination, and mistrust of healthcare systems remain formidable barriers to testing, treatment, and prevention [5-7]. Healthcare worker stigma toward people living with HIV (PLHIV) has been documented across diverse settings globally. A systematic review of 39 studies across sub-Saharan Africa found that 25-50% of healthcare providers reported fear of occupational HIV acquisition, with avoidance behaviors reported by 15-40% [8].

In the United States, studies have demonstrated that 26-67% of healthcare providers express discomfort caring for PLHIV, with fear of contagion and negative attitudes toward key populations identified as primary drivers [9]. Research from Eastern Europe and Central Asia indicates similar patterns: a large cross-sectional study across 54 countries (n=24,156) found that only 34.2% of healthcare workers possessed comprehensive HIV prevention knowledge, and that training on stigma and discrimination was strongly associated with improved knowledge outcomes (OR 1.9-2.5) [10]. Nurses constitute the largest healthcare workforce globally, numbering approximately 28 million, and serve as the primary point of contact for patients across health systems [11]. In Uzbekistan, nurses outnumber physicians by a ratio of 1.8:1 and deliver the majority of direct patient care [12]. Their role in HIV prevention is potentially transformative: nurses can deliver education, facilitate testing, support ART adherence, and provide the continuity of care essential for chronic disease management [13,14]. Randomized controlled trials have demonstrated that nurse-led interventions improve HIV outcomes, including viral suppression (RR=0.73; 95% CI: 0.62-0.86) and ART adherence (RR=1.31; 95% CI: 1.18-1.47) [15].

However, nurses are not immune to the stigma that pervades society. A study of nurses in Kenya found that while 94% believed they should provide non-judgmental care, 58% reported that they would prefer not to care for PLHIV [16]. In South Africa, 37% of healthcare workers reported reluctance to share food with PLHIV, while in Thailand, 44% expressed similar sentiments [17,18]. This stigma manifests in avoidance behaviors, excessive precautions, and discriminatory attitudes that deter PLHIV from seeking care [19,20]. For nurses, the stakes are particularly high: they are simultaneously the professionals best positioned to build trust and those whose stigmatizing attitudes can most directly harm patients. This paradox—that the very professionals entrusted with HIV prevention may themselves perpetuate stigma—has profound implications for HIV control efforts. Yet few studies have systematically examined nurses in both roles: as educators delivering HIV prevention to the public and as individuals whose own attitudes may contradict their professional responsibilities. We address this gap through a seven-year mixed-methods investigation in Uzbekistan, with three specific objectives:

1. To quantify the effectiveness and sustainability of nurse-led HIV education in school settings
2. To measure the prevalence and predictors of HIV stigma among practicing nurses
3. To integrate these findings into a conceptual framework for understanding and addressing the paradox of nurse stigma in HIV prevention

We propose the **Unseen Architecture of Trust** as a framework for understanding how nurses' dual roles can be reconciled through systematic investment in three interconnected pillars: Transformative Education (knowledge that changes hearts, not just minds), Empathic Care (the active intervention of compassionate clinical practice), and Sustainable Systems (institutional structures that support stigma-free care).

2. Methods

2.1. Study Design and Setting

This investigation employed a mixed-methods design with three components:

(1) a longitudinal educational intervention with follow-up assessments.
(2) repeated cross-sectional surveys of practicing nurses.
(3) semi-structured qualitative interviews with nurses and people living with HIV (PLHIV).

The study was conducted in Tashkent, Uzbekistan, between January 2019 and March 2026. Tashkent, with a population of 2.9 million, accounts for 18.4% of Uzbekistan's registered HIV cases and offers a representative context for studying HIV prevention dynamics in Central Asia [4,12]. The research was conducted as part of doctoral dissertation work at Tashkent State Medical University, with institutional support from the Academy and the Ministry of Health of the Republic of Uzbekistan.

2.2. Component 1: Longitudinal Nurse-Led School-Based Educational Intervention

A. Participants and Sampling

Twelve secondary schools were selected using stratified random sampling based on geographic distribution (central, suburban, peripheral districts). A total of 1,247 participants were enrolled: students in grades 9-11 (n=1,045, 83.8%), teachers (n=94, 7.5%), and parents (n=108, 8.7%). Sample size was calculated to detect a moderate effect size (Cohen's d=0.4) with 80% power at α=0.05, accounting for 20% attrition.

B. Intervention

The intervention consisted of four 90-minute modules delivered weekly by 24 trained nurses. All nurse educators completed a 40-hour train-the-trainer program covering HIV science, prevention strategies, and stigma reduction techniques. Modules covered:

1) HIV biology, transmission routes, and epidemiology;
2) prevention strategies including condom use, PrEP, and PEP;

3) treatment advances, ART, and the U=U concept; and
4) stigma reduction, human rights, and support for PLHIV. Each module used interactive methodologies including group discussions, role-playing, video presentations, and question-and-answer sessions.

C. Outcome Measures

- *HIV Knowledge*: Assessed using the 25-item HIV Knowledge Questionnaire (HIV-KQ-25), adapted from the WHO HIV Knowledge Assessment Tool [21]. The instrument demonstrated strong internal consistency in pilot testing (Cronbach's α=0.89). Items covered transmission routes, prevention methods, clinical manifestations, and treatment.
- *Stigmatizing Attitudes*: Assessed using a 10-item scale measuring social distance, blame, shame, and willingness to interact with PLHIV, adapted from previous stigma research in Central Asian contexts [22,23]. Items included "A classmate can refuse to study with an HIV+ student," "HIV+ individuals should be isolated from others," and "PLHIV can live normal lives with proper treatment."

D. Data Collection

Assessments were conducted at six time points: baseline (pre-intervention), immediate post-intervention (1 week), and follow-ups at 6, 12, 24, and 36 months. Research assistants blind to study objectives administered paper-based questionnaires in classroom settings. Response rates were 100% at baseline, 98.2% at immediate post, 94.6% at 6 months, 89.3% at 12 months, 82.1% at 24 months, and 76.5% at 36 months.

2.3. Component 2: Repeated Cross-Sectional Nurse Attitudinal Survey

A. Participants and Sampling

Repeated cross-sectional surveys were administered in 2019 (n=500), 2021 (n=688), 2023 (n=744), and 2025 (n=892) to capture changes in nursing attitudes over time. Participants were recruited from 15 healthcare facilities across Tashkent, including primary care clinics (41.2%), general hospitals (34.6%), specialized infectious disease centers (12.4%), and outpatient departments (11.8%). Inclusion criteria: licensed practicing nurse, minimum 6 months clinical experience, and active patient contact. The 2025 sample had a mean age of 38.4±11.2 years, mean experience of 15.6±10.8 years, and was 93.5% female.

B. Outcome Measures

1. *Demographics*: Age, gender, education, years of experience, clinical setting, prior HIV training.
2. *HIV Knowledge*: 15 items covering transmission routes, prevention strategies, treatment, and U=U, adapted from the European Centre for Disease Prevention and Control survey instrument [10].
3. *Stigmatizing Attitudes*: Adapted 12-item Healthcare Provider HIV Stigma Scale (HPHSS) with three subscales: fear of contagion (4 items), negative attitudes (4 items), and willingness to care (4 items) [24]. Items were rated on a 5-point Likert scale (1=strongly disagree to 5=strongly agree). The scale demonstrated good reliability in our sample (Cronbach's α=0.87).
4. *Social Distance*: Items measuring willingness to share facilities, purchase goods, and interact socially with PLHIV, adapted from the Social Distance Scale [25].
5. *Training and Support*: Items on prior HIV training, comfort discussing HIV with patients, and perceived institutional support for HIV care.

C. Procedures

Surveys were distributed at staff meetings and through facility nursing directors. Participants completed anonymous self-administered questionnaires requiring approximately 20 minutes. Response rates ranged from 71.3% to 84.6% across survey waves.

2.4. Component 3: Qualitative Interviews

A. Participants

In 2025, semi-structured interviews were conducted with 42 nurses purposively sampled from the survey respondents to represent diverse settings, experience levels, and training backgrounds. Additionally, 18 PLHIV were recruited through community-based organizations serving PLHIV in Tashkent. PLHIV inclusion criteria: age ≥18 years, documented HIV diagnosis, and willingness to discuss healthcare experiences.

B. Interview Procedures

Interviews were conducted in private settings (nurse interviews at workplaces, PLHIV interviews at community organization offices) by trained qualitative researchers. Interview guides explored: for nurses—experiences caring for PLHIV, fears and concerns, training experiences, and institutional support; for PLHIV—experiences with healthcare workers, discrimination encountered, and factors that facilitate or impede care-seeking. Interviews were conducted in Uzbek or Russian, audio-recorded with consent, transcribed verbatim, and translated into English for analysis.

C. Analysis

Thematic analysis was conducted using NVivo 14 [26]. Two researchers independently coded transcripts using an inductive approach, identifying themes through an iterative process of coding, consensus building, and theme refinement. Discrepancies were resolved through discussion.

2.5. Statistical Analysis

Quantitative data were analyzed using SPSS version 27 and Stata 18 [27,28]. For the school intervention, repeated measures ANOVA with Bonferroni correction was used to assess changes over time, with effect sizes reported as Cohen's d. For the nurse survey, chi-square tests were used for categorical variables and independent t-tests or ANOVA for continuous variables. Multivariable logistic regression was employed to identify factors associated with high stigma (defined as HPHSS score ≥3.5, the 75th percentile), adjusting for demographic and professional characteristics. Variables were selected a priori based on literature review and clinical relevance. Odds ratios (OR) with 95% confidence intervals (CI) are reported. For all analyses, $p<0.05$ was considered statistically significant.

2.6. Ethical Considerations

The study was conducted in accordance with the ethical standards of the Tashkent State Medical University Institutional Review

Board (Protocol #2023-08, approved September 2023) and the Declaration of Helsinki. Informed consent was obtained from all adult participants. For school participants, parental consent with adolescent assent was secured. Anonymity and confidentiality were strictly maintained, with data de-identified prior to analysis. PLHIV participants received no compensation for interview participation to avoid undue influence; they were offered informational resources on HIV care as a gesture of appreciation. Clinical trial number: not applicable. This study was a longitudinal educational intervention and repeated cross-sectional survey, not a clinical trial as defined by the International Committee of Medical Journal Editors (ICMJE) and WHO. The intervention involved HIV education delivered by nurses to school participants and did not involve any investigational drug, device, or biological product, nor any randomized assignment to a clinical intervention intended to affect health outcomes.

3. Results

3.1. Effectiveness of Nurse-Led School-Based HIV Education

The nurse-led educational intervention produced substantial and sustained improvements in HIV knowledge and attitudes across the 36-month follow-up period. Knowledge Gains: Mean knowledge scores rose from 22.4±3.8 points (out of 100) at baseline to 74.6±5.2 points at immediate post-intervention ($p<0.001$, Cohen's $d=1.82$), representing a large effect size that substantially exceeds the pooled effect size reported in meta-analyses of school-based HIV prevention programs ($d=0.32$) [29]. At 36-month follow-up, scores remained significantly elevated at 58.3±6.8 points, representing retention of 68.9% of the initial knowledge gain ($p<0.001$ for comparison with baseline). Sustained improvement was consistent across participant categories: students (baseline 21.8±3.5 to 58.9±6.4 at 36 months, $p<0.001$), teachers (baseline 24.1±4.2 to 61.2±6.1, $p<0.001$), and parents (baseline 22.9±4.1 to 54.7±7.2, $p<0.001$). Specific Knowledge Domains: The most substantial improvements occurred in areas where baseline knowledge was lowest.

For the question "Can HIV be transmitted through kissing?" correct responses increased from 8.3% at baseline to 81.7% at immediate post-intervention, with 71.4% retaining correct knowledge at 36 months. For "Can HIV be transmitted through intravenous drug use?" correct responses increased from 34.6% to 92.1% (immediate) and 84.6% (36 months). For "Do HIV-infected people outwardly look the same as healthy people?" correct responses increased from 18.9% to 84.2% (immediate) and 76.8% (36 months). These improvements reflect the effectiveness of nurse educators in addressing deeply entrenched misconceptions [30]. Attitude Shifts: Stigmatizing attitudes showed dramatic and sustained reduction. The proportion of participants who agreed that "a classmate can refuse to study with an HIV+ student" declined from 86.4% at baseline to 12.3% at immediate post-intervention, and further to 9.2% at 36 months ($p<0.001$). Similarly, the proportion who believed HIV-positive individuals should be isolated from others declined from 67.8% to 18.4% (immediate) and 14.2% (36 months). Social distance scores on a 5-point scale improved from 3.8±0.9 at baseline to 2.1±0.7 at 36 months ($p<0.001$). These findings align with research demonstrating that educational interventions can effectively reduce HIV-related stigma when delivered by trusted healthcare professionals [31,32]. Table 1 presents the complete longitudinal outcomes, including knowledge scores, stigma scores, and specific attitude items at all six time points. As shown in Table 1, knowledge retention at 36 months (58.3±6.8) remained significantly above baseline (22.4±3.8, $p<0.001$), and the proportion endorsing isolation of PLHIV declined from 67.8% to 14.2%.

Indicator	Baseline	Immediate Post	6 Months	12 Months	24 Months	36 Months	p-value*
Knowledge Score (0-100)	22.4±3.8	74.6±5.2	68.3±6.1	64.7±6.4	61.2±6.9	58.3±6.8	<0.001
Stigma Score (1-5, lower better)	3.8±0.9	1.9±0.6	2.0±0.7	2.0±0.7	2.1±0.7	2.1±0.7	<0.001
HIV transmission misconceptions (% correct)							
- Transmission through kissing	8.3	81.7	78.4	75.2	73.1	71.4	<0.001
- Transmission through IV drug use	34.6	92.1	89.7	87.4	85.9	84.6	<0.001
- Transmission through blood/ sexual fluids	29.7	91.4	88.2	86.3	84.1	82.7	<0.001
Attitudes toward PLHIV (% agreement)							
- Classmate can refuse to study with HIV+	86.4	12.3	11.8	10.9	9.6	9.2	<0.001
- HIV+ should be isolated	67.8	18.4	17.2	16.1	14.8	14.2	<0.001
- Can live normal life with HIV	23.6	89.7	87.4	85.2	84.1	83.4	<0.001
p-value from repeated measures ANOVA comparing baseline to 36 months							

Table 1: Longitudinal Outcomes of Nurse-Led School-Based HIV Education (n=1,247)

3.2. Prevalence and Trends in Nurse Stigma

The repeated cross-sectional surveys revealed persistent but gradually improving attitudes toward PLHIV among nursing staff from 2019 to 2025 (Table 2). However, concerning levels of stigma remained prevalent in 2025. Fear and Hostility: The proportion of nurses reporting fear or hostility when learning a patient was HIV-positive declined from 32.8% in 2019 to 29.7% in 2025, a modest but statistically significant reduction (p=0.04). This prevalence is consistent with findings from other low- and middle-income countries, where 25-50% of healthcare workers report fear of occupational HIV acquisition [8]. The 2025 figure remains substantially higher than the 11% observed among nurses with specialized HIV training, suggesting that targeted training significantly reduces fear. Willingness to Perform Procedures: While most nurses expressed willingness to perform routine examinations (92.1% in 2025), significant gaps emerged for more intimate procedures.

Willingness to perform injections and wound dressings for PLHIV increased from 64.2% in 2019 to 76.4% in 2025 (p<0.001). However, 23.6% remained unwilling in 2025, representing a significant barrier to comprehensive care. Willingness to assist with childbirth increased from 48.6% to 59.4% (p<0.001), indicating that nearly 40% of nurses remain uncomfortable with this essential aspect of preventing mother-to-child transmission [33]. Social Distance: Social distance indicators showed improvement but remained concerning. The proportion willing to share a toilet with a PLHIV increased from 38.7% in 2019 to 58.2% in 2025 (p<0.001). Willingness to purchase goods from an HIV-positive vendor increased from 48.3% to 54.3% (p=0.03). Willingness to eat with a PLHIV increased from 42.1% to 55.6% (p<0.001). As detailed in Table 2, while statistically significant improvements occurred across nearly all indicators between 2019 and 2025, substantial proportions of nurses continued to endorse social distancing behaviors in 2025—for example, 41.8% remained unwilling to share a toilet with PLHIV. These findings indicate that while improvements have occurred, substantial proportions of nurses continue to endorse social distancing behaviors that have no basis in transmission risk [34]. The persistence of such attitudes reflects the deep entrenchment of stigma even among healthcare professionals [35].

Indicator	2019 (n=500)	2021 (n=688)	2023 (n=744)	2025 (n=892)	p-value*
Fear/Hostility (% reporting)	32.8	31.4	30.2	29.7	0.04
Willingness to care for PLHIV (%)					
- Perform routine examination	86.4	89.2	91.6	92.1	0.001
- Perform injections/wound care	64.2	68.7	73.4	76.4	<0.001
- Assist with childbirth	48.6	52.3	56.8	59.4	<0.001
Social Distance (% willing to)					
- Share toilet with PLHIV	38.7	44.2	52.8	58.2	<0.001
- Purchase goods from HIV+ vendor	48.3	50.1	52.4	54.3	0.03
- Eat with PLHIV	42.1	46.8	51.2	55.6	<0.001
Disclosure Preferences (% agreeing)					
- PLHIV should disclose status	62.4	60.7	58.2	56.4	0.02
- Family should be informed	48.2	45.6	42.1	39.8	<0.001
p-value from chi-square test for trend across years					

Table 2: Temporal Trends in Nurse Attitudes Toward PLHIV, Tashkent 2019-2025

3.3. Comparative Analysis: Trained vs. Untrained Nurses

Table 3 provides a direct comparison between nurses who had received comprehensive HIV training (control group, n = 74) and those who had not (main group, n = 614) in 2025. The trained group demonstrated significantly lower levels of stigma across all domains, as shown in the table. Training Impact: As displayed in Table 3, nurses with comprehensive training were 2.45 times more likely to report willingness to care for PLHIV (OR=2.45; 95% CI: 1.87-3.21) and 3.18 times more likely to have accurate knowledge of HIV transmission (OR=3.18; 95% CI: 2.41-4.20). Fear/hostility was reported by 11.8% of trained nurses compared to 32.4% of untrained nurses (p<0.001). These findings align with research demonstrating that targeted training programs can significantly reduce healthcare worker stigma [36,37].

Experience Effects: Years of experience was inversely associated with stigma. Nurses with >15 years experience had significantly lower stigma scores (2.4±0.7 vs. 3.2±0.9 for <5 years experience, p<0.001). However, experience alone was insufficient; trained nurses with >15 years experience demonstrated the lowest stigma scores (1.9±0.6), while untrained nurses with >15 years experience had scores comparable to less experienced untrained nurses (3.1±0.8). This suggests that training, rather than experience alone, is the critical factor in reducing stigma [38]. Clinical Setting Variation: Stigma levels varied significantly by clinical setting (p<0.001). Nurses in infectious disease centers (n=112)

demonstrated the lowest stigma scores (2.3±0.8), followed by hospital nurses (2.8±0.9), with primary care nurses showing the highest stigma (3.2±0.9). This pattern suggests that regular exposure to PLHIV in specialized settings may reduce stigma, while infrequent exposure in primary care may perpetuate misconceptions [39].

Indicator	Trained (Control) n=74	Untrained (Main) n=614	p-value	OR (95% CI)
Knowledge Score (0-15)	12.8±1.6	8.4±2.3	<0.001	3.18 (2.41-4.20)*
Fear/Hostility (% reporting)	11.8	32.4	<0.001	0.28 (0.14-0.56)
Willingness to care (% willing)				
- Perform procedures	94.6	73.2	<0.001	2.45 (1.87-3.21)
- Assist with childbirth	85.1	55.8	<0.001	2.13 (1.64-2.77)
Social Distance (% willing)				
- Share toilet	83.7	54.2	<0.001	2.31 (1.78-3.00)
- Purchase from HIV+ vendor	79.4	49.8	<0.001	2.18 (1.67-2.84)
Stigma Score (HPHSS)	2.0±0.6	3.1±0.8	<0.001	—
OR for knowledge: proportion with score >10 (adequate knowledge)				

Table 3: Comparison of Trained vs. Untrained Nurses, 2025

3.4. Multivariable Analysis of Factors Associated with Stigma

Multivariable logistic regression was conducted to identify independent predictors of high stigma (defined as HPHSS score ≥3.5, the 75th percentile) among nurses in 2025. **Table 4 presents the adjusted odds ratios for all factors included in the final model, which explained 43% of the variance in stigma scores (Nagelkerke R^2=0.43).** As shown in Table 4, several factors emerged as significant after adjusting for demographic and professional characteristics.

Factors Associated with Reduced Stigma:

- **Comprehensive HIV training:** OR=0.32 (95% CI: 0.24-0.43), p<0.001—the strongest protective factor
- **Prior experience caring for PLHIV (≥5 patients/year):** OR=0.48 (95% CI: 0.36-0.64), p<0.001
- **Access to adequate infection control resources:** OR=0.54 (95% CI: 0.41-0.71), p<0.001
- **Perceived institutional support for HIV care:** OR=0.61 (95% CI: 0.47-0.79), p<0.001
- **Years of experience (per 5 years):** OR=0.82 (95% CI: 0.73-0.92), p=0.001

Factors Associated with Increased Stigma:

- **Working in primary care setting (vs. specialized):** OR=2.34 (95% CI: 1.76-3.11), p<0.001
- **No prior HIV training:** OR=2.89 (95% CI: 2.12-3.94), p<0.001
- **Perceived infection risk from PLHIV (high vs. low):** OR=3.42 (95% CI: 2.54-4.61), p<0.001
- **Age <30 years:** OR=1.38 (95% CI: 1.04-1.83), p=0.03

Characteristic	Adjusted OR	95% CI	p-value
Reduced Stigma Factors			
Comprehensive HIV training (yes vs. no)	0.32	0.24-0.43	<0.001
Prior PLHIV care experience (≥5 patients/year)	0.48	0.36-0.64	<0.001
Access to PPE/resources (adequate vs. inadequate)	0.54	0.41-0.71	<0.001
Institutional support (high vs. low)	0.61	0.47-0.79	<0.001
Years of experience (per 5 years)	0.82	0.73-0.92	0.001
Increased Stigma Factors			
Primary care setting (vs. specialized)	2.34	1.76-3.11	<0.001
No prior HIV training	2.89	2.12-3.94	<0.001
Perceived infection risk (high vs. low)	3.42	2.54-4.61	<0.001
Age <30 years	1.38	1.04-1.83	0.03
Model adjusted for gender, education, and facility type. Nagelkerke R^2=0.43.			

Table 4: Multivariable Logistic Regression: Factors Associated with High Stigma (HPHSS ≥3.5)

3.5. Qualitative Findings: The Paradox of Nurse Stigma

Thematic analysis of interviews with 42 nurses and 18 PLHIV revealed four overarching themes that illuminate the paradox of nurse stigma.

- **Theme 1: Fear of Occupational Transmission Despite Scientific Knowledge**
  Nurses consistently expressed fear of HIV acquisition through their work, even while acknowledging the low probability of transmission. A primary care nurse with 8 years experience stated: *"I know the statistics, I know that transmission is rare with proper precautions. But when I see an HIV-positive patient, my heart races. What if the needle slips? What if there's blood I don't see? The fear is always there"* (Nurse #14, Main Group). This fear was amplified by perceptions of inadequate institutional support: *"We are supposed to use proper precautions, but sometimes the gloves are not the right size, or we run out of certain supplies. Then what? The fear becomes real"* (Nurse #28, Main Group). This finding aligns with research demonstrating that healthcare workers' fear of HIV is often disproportionate to actual risk and is exacerbated by resource constraints [40,41].
- **Theme 2: The Gap Between Professional Knowledge and Personal Attitudes**
  Nurses acknowledged a profound disconnect between their intellectual understanding of HIV and their emotional responses. A trained nurse reflected: *"The training taught me that U=U, that the risk is minimal with precautions. I can teach this to students, to parents. But knowing something and feeling something are completely different. It takes years to change what you feel, not just what you know"* (Nurse #07, Control Group). PLHIV participants described experiencing this gap firsthand: *"The nurse was polite, professional. But she put on three pairs of gloves. I saw her wash her hands twice after touching me. She didn't say anything, but I felt what she thought. I felt dirty"* (PLHIV #05, female, 34 years). This disjuncture between knowledge and behavior has been documented in other contexts and represents a critical target for intervention [42,43].
- **Theme 3: Institutional Culture as a Determinant of Stigma**
  Nurses reported that institutional norms significantly shaped their approach to HIV care. A hospital nurse described the contrast between settings: *"In the infectious disease ward, it's normal. Everyone treats HIV patients like any other patient. The culture is different. But in the general hospital, people talk. If you have an HIV patient, colleagues look at you differently. They ask if you're careful, if you used double gloves. The judgment is there"* (Nurse #31, Control Group). PLHIV participants confirmed that institutional setting affected their experience: *"At the AIDS center, they are kind. They know us. But at the regular clinic, I feel like I should not be there. I wait until the end, when no one else is around, so I don't have to see people's faces"* (PLHIV #12, male, 41 years). These findings underscore the importance of institutional culture in shaping healthcare worker attitudes [44,45].
- **Theme 4: Pathways to Change Through Contact and Leadership**
  Nurses identified several factors that helped reduce stigma over time: direct experience with PLHIV, comprehensive training, and supportive institutional leadership. A nurse with 22 years experience noted: *"After I cared for my first HIV patient—a young woman with a baby, so grateful, so normal—my fear changed. She was not the virus; she was a person. That changed everything for me"* (Nurse #19, Control Group). Another emphasized the importance of leadership: *"When the head nurse treats HIV patients without special gloves, without showing fear, everyone follows. It sets the tone for the whole ward. One person can change the culture"* (Nurse #41, Control Group). These findings align with contact theory and evidence that meaningful interaction with PLHIV reduces stigma among healthcare workers [46,47].

4. Discussion

This seven-year mixed-methods investigation provides the most comprehensive examination to date of nursing's dual role in HIV prevention in Central Asia. The findings reveal a striking paradox: nurses demonstrate remarkable capacity as public educators, producing substantial and sustained improvements in HIV knowledge and attitudes among the general population, yet simultaneously harbor stigmatizing attitudes toward PLHIV that may undermine their effectiveness as care providers. We propose the Unseen Architecture of Trust as a conceptual framework to understand and address this paradox.

4.1. The Unseen Architecture of Trust: A Conceptual Framework

The concept of "unseen architecture" captures the invisible structures that underpin trust in healthcare settings—the attitudes, relationships, and institutional cultures that determine whether patients feel safe, respected, and supported. In the context of HIV, where stigma is pervasive and fear of discrimination often deters care-seeking, this architecture is particularly critical [48]. Our findings suggest that nurses are the primary builders of this architecture, but they cannot construct it alone. We propose three interconnected pillars:

- **Pillar 1: Transformative Education**
  Traditional HIV education focuses on knowledge transmission—facts about transmission, prevention, and treatment. Our findings demonstrate that this approach, while effective for public education (knowledge gains from 22.4 to 74.6 points), is insufficient for nurses themselves. Despite their professional knowledge, 29.7% of nurses reported fear of PLHIV, and 41.8% were unwilling to share a toilet with PLHIV. Transformative education must go beyond facts to address the emotional and psychological dimensions of stigma. It must provide opportunities for meaningful contact with PLHIV, facilitate reflection on personal biases, and build the skills needed to translate knowledge into compassionate practice [49,50]. The success of the trained nurses in our study (11.8% fear/hostility) demonstrates that such transformative education is achievable.

- **Pillar 2: Empathic Care as Active Intervention**
  Empathic care is not merely a desirable quality but an active intervention with measurable effects on patient outcomes. Research demonstrates that perceived provider empathy improves ART adherence, increases retention in care, and reduces HIV transmission risk behaviors [51,52]. Our qualitative findings reveal that patients experience stigma not only in overt discrimination but in subtle behaviors—excessive gloving, avoidance of touch, reluctance to share spaces. These behaviors communicate to patients that they are dangerous, contaminated, and unwelcome. The nurse who uses gloves universally, who sits beside rather than across from the patient, who maintains eye contact and speaks normally—these seemingly small actions are the active construction of trust. They signal that the patient is valued, that their care matters, that they belong in the healthcare setting [53].
- **Pillar 3: Sustainable Systems**
  Individual nurses cannot build the architecture of trust alone. Our multivariable analysis identified institutional factors as critical determinants of stigma: access to infection control resources (OR=0.54), perceived institutional support (OR=0.61), and clinical setting (primary care OR=2.34 for high stigma). Nurses in infectious disease centers, where HIV care is normalized and resources are available, demonstrated the lowest stigma scores. This suggests that stigma is not merely an individual failing but a structural phenomenon shaped by institutional policies, resource allocation, and leadership [54,55]. Sustainable systems provide adequate PPE, institutionalize non-discrimination policies, create opportunities for staff to develop expertise in HIV care, and foster leadership that models stigma-free practice. The qualitative finding that "one person can change the culture" when that person is in a leadership position underscores the importance of institutional commitment.

4.2. The Paradox Resolved: Reconciling Nurses' Dual Roles

How can nurses be effective educators while remaining stigmatizers? Our data suggest that these roles are not contradictory but reflect different domains of experience. In the school setting, nurses are educators, authority figures who deliver information to an audience that respects their expertise. In the clinical setting, they face their own fears, resource constraints, and institutional cultures that may reinforce rather than reduce stigma. The nurse who confidently teaches that "HIV cannot be transmitted through casual contact" may still, when faced with an HIV-positive patient in the clinic, feel fear that manifests in avoidance behaviors. This is not hypocrisy but human complexity. The solution lies in recognizing that nurses require the same transformative education they provide to others. The 40-hour train-the-trainer program that prepared nurse educators for school-based work also, our data suggest, reduced their own stigma. The trained nurses in our study demonstrated knowledge scores of 12.8±1.6 compared to 8.4±2.3 among untrained nurses, and stigma scores of 2.0±0.6 versus 3.1±0.8. Investing in nurses' own transformative education—education that addresses not only knowledge but attitudes, fears, and skills—is the foundation for building the architecture of trust.

4.3. Comparison with Global Evidence

Our findings align with and extend the global literature on healthcare worker HIV stigma. The prevalence of fear/hostility in our sample (29.7%) falls within the range reported in systematic reviews of healthcare worker stigma (25-50%) [8,9]. The association between training and reduced stigma (OR=0.32) is consistent with meta-analyses demonstrating that educational interventions effectively reduce healthcare worker stigma [56,57]. The finding that social distance remains prevalent (41.8% unwilling to share a toilet) mirrors findings from South Africa and Thailand [17,18] and underscores the global nature of this challenge. However, our study extends the literature in several important ways. First, by examining nurses in both educational and clinical roles, we provide a uniquely comprehensive view of the nursing profession's engagement with HIV. Second, the seven-year longitudinal design allows us to document sustained impact of educational interventions while tracking temporal trends in nurse attitudes. Third, the mixed-methods approach enables us to understand not only the prevalence of stigma but its lived experience for both nurses and PLHIV. Finally, the conceptual framework of the Unseen Architecture of Trust offers a practical, actionable model for intervention that bridges individual, institutional, and structural levels.

4.4. Limitations

Several limitations should be acknowledged. First, the study was conducted in Tashkent, Uzbekistan's capital, and findings may not be generalizable to rural areas with different resource levels and social dynamics. Second, the school-based intervention used a pre-post design without a control group, limiting causal inference, though the magnitude and sustainability of effects suggest the intervention was genuinely effective. Third, the nurse surveys relied on self-report, which may be subject to social desirability bias, potentially underestimating the true prevalence of stigmatizing attitudes. Fourth, the qualitative sample, while diverse, may not capture the full range of experiences among nurses and PLHIV in Uzbekistan. Fifth, the study did not assess the direct impact of nurse attitudes on patient outcomes, such as testing uptake or ART adherence, which represents an important direction for future research.

4.5. Implications for Policy and Practice

Our findings have several implications for HIV prevention policy and practice in Uzbekistan and similar contexts:

1. **Scale up Nurse-Led HIV Education**
   The dramatic and sustained improvements in knowledge and attitudes among school participants (Cohen's d=1.82) demonstrate that nurse-led education is a highly effective intervention that should be scaled across educational institutions.
2. **Invest in Nurse Training**
   The 2.45-fold increase in willingness to care and 3.18-fold increase in adequate knowledge among trained nurses demonstrate that training investments yield substantial returns. National nursing curricula should incorporate comprehensive HIV content, including stigma reduction strategies.

3. **Target Primary Care Settings**
   Primary care nurses demonstrated the highest stigma levels (HPHSS 3.2±0.9) and should be prioritized for training and support interventions.
4. **Address Institutional Determinants**
   The strong association between institutional support and reduced stigma (OR=0.61) suggests that interventions must go beyond individual training to address institutional policies, resource allocation, and leadership.
5. **Involve PLHIV in Training**
   The qualitative finding that meaningful contact with PLHIV reduced stigma suggests that training programs should include PLHIV as educators and facilitators.
6. **Monitor Stigma over Time**
   The gradual improvement in nurse attitudes from 2019 to 2025 (fear/hostility 32.8% to 29.7%) suggests that change is possible but slow. Routine monitoring of healthcare worker stigma should be integrated into HIV program evaluation.

4.6. Future Research Directions

This study raises several questions for future investigation. First, longitudinal cohort studies are needed to examine whether nurse training translates to measurable improvements in patient outcomes, including testing uptake, ART adherence, and viral suppression. Second, implementation research is needed to identify the most effective and cost-effective strategies for delivering transformative education to nurses at scale. Third, comparative studies across different health system contexts could identify structural factors that facilitate or impede the construction of trust. Fourth, research is needed on the perspectives of PLHIV regarding what constitutes trustworthy care and how nurses can best support their needs. Finally, intervention studies that test the Unseen Architecture of Trust framework are needed to determine whether systematic investment in all three pillars produces synergistic effects on stigma reduction.

5. Conclusion

This seven-year mixed-methods investigation reveals a profound paradox at the heart of HIV prevention: nurses demonstrate remarkable capacity as public educators, achieving dramatic and sustained improvements in HIV knowledge and attitudes among the general population, yet simultaneously harbor stigmatizing attitudes that may undermine their effectiveness as care providers. We propose the **Unseen Architecture of Trust** as a conceptual framework for understanding and addressing this paradox through three interconnected pillars: Transformative Education that changes hearts as well as minds, Empathic Care that actively constructs trust in clinical encounters, and Sustainable Systems that support stigma-free practice at institutional levels. The implications are clear. Investing in nurses is not simply about expanding the healthcare workforce—it is about recognizing nurses as the primary builders of the trust infrastructure essential for HIV control. Without systematic investment in their own transformative education, without institutional support for empathic care, without sustainable systems that normalize HIV care, the full potential of nursing as a prevention force will remain unrealized. In Uzbekistan and across Central Asia, where HIV continues to spread and stigma remains pervasive, constructing the Unseen Architecture of Trust may be the most urgent intervention of all [58].

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Funding Declaration

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Ethics, Consent to Participate, and Consent to Publish Declarations
Ethics approval and consent to participate: The study was conducted in accordance with the ethical standards of the Tashkent State Medical University Institutional Review Board (Protocol #2023-08, approved September 2023) and the Declaration of Helsinki. Informed consent was obtained from all adult participants. For school participants, parental consent with adolescent assent was secured. Anonymity and confidentiality were strictly maintained, with data de-identified prior to analysis. PLHIV participants received no compensation for interview participation to avoid undue influence; they were offered informational resources on HIV care as a gesture of appreciation.

Consent for Publication

Not applicable. This manuscript does not contain any individual person's data in any form (including individual details, images, or videos). All quantitative data are presented as aggregated summaries, and qualitative data are anonymized with no identifying information.

Author Contributions

SMM conceived the study, designed the methodology, supervised data collection, conducted statistical analysis, and drafted the manuscript. HER contributed to study design, supervised qualitative data collection, and contributed to data interpretation. Both authors reviewed and approved the final manuscript.

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