

Beyond the Numbers, Unpacking the Challenges: Adherence and Retention among Young Adults Living with HIV in Eswatini

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Abstract

This study investigates adherence to Antiretroviral Therapy (ART) and retention in care among HIV-positive young adults aged 18–24 years in Eswatini, a country with one of the highest HIV prevalence rates globally. Using a mixed-methods approach, quantitative data were collected from 161 participants and complemented with qualitative interviews to explore personal and contextual experiences. The quantitative findings revealed that mean adherence to ART was 96.3% (± 6.1 SD), with 77.6% of participants maintaining high adherence levels of 95–100%. Viral suppression below 50 copies/mL was achieved in 85.7% of the study population, while retention in care was 82.6%. Although these results are encouraging, they fall short of UNAIDS 95-95-95 targets, highlighting persistent gaps. The qualitative findings provided deeper insights into lived realities. Motivators of adherence included family support, encouragement from healthcare providers, personal motivation to remain healthy, and peer encouragement. Barriers included stigma, fear of disclosure, financial constraints, treatment fatigue, and negative experiences with healthcare staff. Benefits of adherence included improved health, strength to perform daily tasks, and reduced risk of HIV transmission. Integrating the findings underscores the multifaceted nature of ART adherence, influenced by individual, social, economic, and systemic factors. The study concludes that addressing adherence challenges requires youth-centered interventions, stigma reduction, economic empowerment, and healthcare system strengthening. These results provide evidence to guide Eswatini's HIV response and contribute to the global goal of achieving sustained epidemic control.

Keywords: Adherence, Eswatini, HIV, Retention, Young Adult.

Introduction

HIV/AIDS continues to be a profound global health challenge, with a particularly significant impact on young adults aged 15-24 years. Effective Antiretroviral Therapy (ART) is crucial for viral suppression, improving health, and prolonging the lives of adolescents and youths living with HIV/AIDS, thereby decreasing related morbidity and mortality [1, 13]. Globally, substantial progress has been made in HIV prevention and care, with approximately 76% of people living with HIV (PLHIV) receiving ART in 2022, and 71% achieving viral suppression. This access to

ART has prevented about 21 million HIV and AIDS-related deaths over the past three decades [2, 16, 17].

Despite this progress, a considerable number of new HIV infections continue to be a concern, especially among adolescents and young people (AYP) [3]. In 2022, approximately 27% of the 1.3 million new HIV cases worldwide occurred in individuals aged 15 to 24 years [2]. Adolescent girls and young women (AGYW) accounted for sixty-six percent of all new infections among adults aged 15 years and older [2].

In sub-Saharan Africa (SSA), AYP are disproportionately affected by HIV due to a combination of biological, socioeconomic, and cultural factors. These factors include economic marginalization leading to transactional or concurrent sexual relationships, engagement in illicit drug use, and barriers to accessing HIV prevention and treatment services due to discrimination and negative attitudes from healthcare workers [4, 12]. Furthermore, HIV infection among AYP carries significant societal implications, including the potential for transmission to older sexual partners and vertical transmission to unborn babies if pregnant or breastfeeding [4].

Eswatini, a country in Southern Africa with a population of 1.2 million, has one of the highest HIV prevalence rates in the region. While the prevalence was 29.7% in 2017, it decreased to 25.9% by 2022 due to effective HIV management, which necessitates strict adherence to ART and consistent engagement in healthcare services [2]. However, the implementation of ART among adolescents and youths aged 10–24 years faces significant challenges in resource-limited settings [2]. Despite an ART coverage rate of 91%, viral suppression remains at 73.1%, reflecting challenges in sustaining optimal adherence and retention in care [21].

A critical challenge in managing HIV among young adults is the need to achieve and maintain high levels of medication adherence to fully realize the benefits of ART. Poor adherence leads to viral replication, disease progression, and the development of drug resistance, negatively impacting health outcomes [1]. The Ministry of Health in Eswatini, in its 2022 Integrated HIV Management Guidelines, recognizes the parallels between the maturation of adolescents into adults and the transition from pediatric to adult HIV programs [5]. As adolescents living with HIV mature, they are required to transfer to adult care settings and assume greater responsibility for their health and HIV

management. This population is diverse, comprising both perinatally and horizontally infected adolescents [5, 20].

Transition, defined as the purposeful, planned movement of adolescents and young adults with chronic medical conditions from child-centered to adult-oriented care systems, and typically occurs between 18 and 24 years of age, though early preparation is continuous from ages 10–19 years with multidisciplinary support. Adolescents living with HIV encounter unique challenges during this transition, including stigma, the need to disclose their HIV status to friends, family, and adult care providers, and potential neurocognitive impairments and mental health problems associated with HIV [11, 15]. Unsuccessful transition can manifest as poor ART adherence, viral rebound, increased rates of loss to follow-up (LTFU), lower retention in care, and detectable viral loads. These outcomes subsequently lead to weakened immune systems, increased morbidity and mortality, and the potential for developing drug resistance [5].

Adolescents and Youth Living with HIV (AYLHIV) experience significant disparities across the HIV care continuum, with higher rates of attrition from care and increased HIV-related mortality compared to other age groups. HIV/AIDS remains among the top five leading causes of death for adolescents in Africa [9]. Barriers to quality health services for AYLHIV include inadequate access to health care teams trained in adolescent- and youth-friendly services, non-tailored health information, difficulties navigating adult-oriented health systems, legal requirements for parental or caregiver consent, and challenges with service costs. While a successful transition is vital for optimal health outcomes, facilities often lack the necessary infrastructure, human resources (with appropriate knowledge and skills), and supportive environments [6]. Existing research in Eswatini has already identified poor ART outcomes, including low viral load suppression and suboptimal adherence, among adolescents

[8]. While these studies often focus on 10-19, the transition into young adulthood (18-24) presents unique challenges that may differ or intensify.

Near perfect adherence to ART, maintained throughout one's lifetime, is essential for its long-term success. ART adherence is defined as the extent to which an individual takes medication as prescribed regarding timing, dosing, and consistency. A strict adherence level of $\geq 95\%$ is suggested for ART to be effective and prevent the emergence of resistant strains. Failure to achieve this level results in accelerated progression of HIV to AIDS, increased morbidity and mortality, and resistance to ART. Non-adherence can lead to regimen failure, immune suppression, and emergence of resistant viral strains, limited future treatment options, and higher treatment costs. Health behaviors such as poor retention in HIV medical care and non-adherence to ART pose major challenges to reducing new HIV infections, addressing health disparities, and improving health outcomes. Therefore, understanding the barriers and facilitators to these behaviors is critical for developing effective strategies to improve retention and adherence [6, 14, 18].

Objectives

The overall aim of this study was to investigate the variables that affect HIV-positive young adults in Eswatini, aged 18 to 24 years, in terms of their adherence to antiretroviral therapy (ART) and retention in care. The study seeks to comprehend the difficulties this population encounters in adhering to their treatment plans and continuing to utilize healthcare services. The research examined various social, psychological, and structural factors to improve treatment adherence and retention in care, ultimately enhancing health outcomes for young adults living with HIV.

The primary research objectives are to:

1. Identify the socio-demographic characteristics of HIV-positive young adults aged 18-24 years in all four regions of Eswatini.
2. Assess the level of adherence to antiretroviral therapy (ART) among this young population.
3. Explore the factors that influence adherence to ART among HIV-positive young adults in all the regions.
4. Investigate the challenges faced by HIV-positive young adults in remaining engaged in healthcare services in all the regions.
5. Investigate the social, psychological, and structural factors that impact retention in care in all the regions.

The secondary research objective is to:

Propose recommendations and strategies to improve treatment adherence and retention in care for HIV-positive young adults to policymakers, managers, and other key stakeholders.

Materials and Methods

Study Design

This study employed a mixed-methods approach to provide a comprehensive understanding of ART adherence and retention in care among HIV-positive young adults aged 18-24 years in Eswatini. This design integrates both quantitative and qualitative research methods, allowing for the triangulation of numerical data and in-depth insights from participants [7]. The quantitative component assessed the level of adherence and identify socio-demographic characteristics, while the qualitative component explored the factors influencing adherence, challenges faced in healthcare engagement, and social, psychological, and structural impacts on retention in care.

Study Setting

The study was strategically conducted in the ART departments of four hospitals, ensuring representation from each of Eswatini's four

regions: Mbabane Government Hospital, Raleigh Fitkin Memorial Hospital, Hlathikhulu Government Hospital, and Good Shepherd Mission Hospital. This selection included both government-owned (Mbabane and Hlathikhulu) and mission-owned (Raleigh Fitkin Memorial and Good Shepherd Mission) facilities, situated in urban and semi-urban settings. This diverse geographical and institutional representation aimed to capture a broad range of experiences from populations encompassing rural, peri-urban, and urban backgrounds.

Study Population

The study population comprised HIV-positive young adults aged 18-24 years who had been receiving ART for a minimum period of 12 months. Specific inclusion criteria ensured participant eligibility: individuals had to be HIV positive and on ART, aged between 18 and 24 years, have been on ART for 12 months or more, and be residing in Eswatini. The criteria also included both those who had never been lost to follow-up (LTFU) on ART and those who had been previously LTFU but were registered in the ART back-to-care register. Exclusion criteria encompassed individuals who were HIV negative, HIV positive but not on ART, those on ART for less than 12 months, individuals under 18 years of age, or those unwilling to participate or unable to provide informed consent.

Sample Size Calculation

The sample size target was determined using a mathematical formula to achieve a desired level of statistical accuracy and precision. Based on the Eswatini SHIMS3 report, the estimated proportions of young adults aged 18-24 years living with HIV in the four regions are: Hhohho 21.6%, Manzini 26%, Lubombo 25.3%, and Shiselweni 26% [10].

Taking the average prevalence ($p \approx 0.247$), the formula applied was:

$$n = \frac{Z^2 \times p \times (1 - p)}{E^2}$$

Where n is the required sample size, Z is the Z-score corresponding to the chosen confidence level, p is the estimated average prevalence (in this case, the mean of the four regions), and E is the desired margin of error. For this study, a 95% confidence level was selected (corresponding to a Z-score of 1.96), with a 5% margin of error. Based on these parameters, the minimum sample size required was calculated to be approximately 288 participants.

Data Collection

Quantitative data was collected through medical record abstraction from sources such as chronic care files (CCFs), appointment registers, and the back-to-care register. This allowed for the collection of objective information related to ART adherence and retention. Qualitative data was collected through face-to-face interviews with ART patients and healthcare workers. Interviews were conducted in a private space to ensure confidentiality and minimize disturbances. Audio recording devices were used to capture the interviews, with explicit permission sought from participants through written informed consent. The researcher also took notes on a notepad during the interviews, observing and jotting down non-verbal cues such as frowning, smiling, or signs of worry. Each interview lasted approximately 45 minutes.

Data Management and Handling

Completed data collection tools were checked for completeness and stored securely in a folder. Audio transcripts from the interviews were transcribed verbatim by the researcher. Interviews conducted in SiSwati were translated verbatim into English. Verbal notes and observations on non-verbal cues were also typed up, with each interview transcribed separately. All information was saved in password-protected files to ensure confidentiality.

Statistical Analysis

Quantitative data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize socio-demographic characteristics and adherence levels. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations. Bivariate analysis was conducted to examine associations between variables using chi-square tests and t-tests as appropriate. A p-value of <0.05 was considered statistically significant.

Qualitative data were analyzed using thematic analysis. Transcripts were read repeatedly to achieve familiarity with the data. Initial codes were generated and then organized into potential themes. These themes were reviewed, refined, and named to ensure they accurately represented the data. The Socio-Ecological Model was used as a framework to organize the themes at individual, interpersonal, community, and societal levels.

Ethical Considerations

Ethical approval was obtained from the Texila American University Ethics Review Board (Reference No: TAU/IRB2024/BC/2895) and the Eswatini Health and Human Research Review Board (Reference No: EHHRRB 063/2024). Written informed consent was obtained from all participants before data collection. Participants were informed of their right to withdraw from the study at any time without any negative consequences to their healthcare. All data were anonymized to protect participant confidentiality.

Results

Socio-Demographic Characteristics

A total of 161 HIV-positive young adults aged 18-24 years participated in the quantitative component of the study.

The socio-demographic characteristics of the participants are presented in Table 1.

Table 1. Socio-Demographic Characteristics of ART Patients (n=161)

Characteristic		Frequency (n)	Percentage (%)
Gender	Female	98	60.9
	Male	63	39.1
Age Group (years)	18-20	67	41.6
	21-24	94	58.4
Region	Hhohho	35	21.7
	Manzini	42	26.1
	Lubombo	40	24.8
	Shiselweni	44	27.3
Education Level	Primary	23	14.3
	Secondary	112	69.6
	Tertiary	26	16.1
Employment Status	Employed	48	29.8
	Unemployed	113	70.2
Living Arrangement	With parents	89	55.3
	With partner	35	21.7
	Alone	25	15.5
	Other	12	7.5

The mean age of participants was 21.3 years (± 1.9 SD). The majority of participants were female (60.9%), had secondary education (69.6%), and were unemployed (70.2%). More than half (55.3%) lived with their parents. The distribution across the four regions of Eswatini was relatively even, with slightly higher

representation from Shiselweni (27.3%) and Manzini (26.1%).

ART Adherence and Clinical Outcomes

The quantitative findings on ART adherence and clinical outcomes are presented in Table 2.

Table 2. Clinical and ART Adherence Outcomes (n=161)

Variable		Frequency (n)	Percentage (%)	Mean (SD)
ART Adherence Level	Good Adherence ($\geq 95\%$)	125	77.6	96.3% (± 6.1)
	Poor Adherence ($< 95\%$)	36	22.4	
Viral Load Status	Undetectable (< 50 copies/mL)	138	85.7	
	Detectable (≥ 50 copies/mL)	23	14.3	
Retention in Care	Retained	133	82.6	
	Not Retained	28	17.4	
Self-Reported Missed Doses	Never missed	75	46.6	
	Rarely missed	55	34.2	
	Occasionally missed	21	13	
	Frequently missed	10	6.2	
Missed Clinic Visits (past 6 months)	No missed visits	118	73.3	
	At least one missed visit	43	26.7	

The study revealed a mean ART adherence of 96.3% (± 6.1 SD), with 77.6% of participants demonstrating 95-100% adherence based on clinical records. The cohort achieved an undetectable viral load (< 50 copies/mL) of 85.7%. Retention in care was at 82.6%, which is lower than the desired 95% target. While self-reported missed doses were low, with 46.6% reporting never missing a dose, a significant proportion admitted to rare (34.2%) or occasional (13.0%) lapses. Clinic attendance was 77.0%, though 26.7% reported at least one missed visit in the past six months.

Factors Influencing Adherence and Retention

The qualitative arm of the study identified key motivators, challenges, and benefits of ART adherence and retention as reported by participants. Verbatim responses reflected the lived realities of young adults:

Motivators included: “My family supports me to take my treatment,” “I want to live long and be healthy,” and “The nurse always encourages me not to miss my doses.”

Challenges included: “Sometimes I feel tired of taking pills every day,” “I don’t tell others because they may laugh at me,” and “I don’t have money for transport to come to the clinic.” Benefits mentioned were: “I don’t get sick often now,” “I feel strong to do my work,” and “I know I won’t pass HIV to my baby.”

These narratives illustrate the multi-level influences on adherence and retention, confirming the statistical findings and deepening understanding of participant experiences.

The qualitative arm of the study identified key motivators, challenges, and benefits of ART adherence and retention.

The Factors Influencing Adherence and Retention are presented in Table 3.

Table 3. Factors Influencing Adherence and Retention

Category	Factors	Frequency (n)	Percentage (%)
Motivators	Social support (family, peers)	142	88.2
	Personal desire for health	138	85.7
	Need to prevent HIV transmission	125	77.6
	Supportive healthcare workers	119	73.9
Challenges	Treatment fatigue	98	60.9
	Side effects	87	54
	Stigma and non-disclosure	113	70.2
	Financial constraints	105	65.2
	Suboptimal healthcare worker attitudes	76	47.2
Benefits	Enhanced immunity	151	93.8
	Prolonged life	147	91.3
	Viral suppression	139	86.3
	Improved quality of life	132	82

Motivators for ART adherence and retention included social support from family and peer groups, a personal desire for health, the need to prevent HIV transmission, and supportive healthcare worker practices. Challenges included treatment fatigue, burdensome side effects, and fear of stigma leading to non-disclosure, financial constraints, and suboptimal healthcare worker attitudes. The

benefits of consistent adherence were enhanced immunity, prolonged life, viral suppression, and an improved quality of life.

Association between Variables

The Bivariate analysis between Selected Variables and ART Adherence are presented in Table 4.

Table 4. Association between Selected Variables and ART Adherence

Variable		Good Adherence N (%)	Poor Adherence N (%)	χ^2/t -value	p-value
Gender	Female	79 (63.2)	19 (52.8)	1.58	0.21
	Male	46 (36.8)	17 (47.2)		
Age Group	18-20 years	48 (38.4)	19 (52.8)	2.74	0.1
	21-24 years	77 (61.6)	17 (47.2)		
Employment Status	Employed	42 (33.6)	6 (16.7)	4.21	0.04
	Unemployed	83 (66.4)	30 (83.3)		
Living Arrangement	With parents	75 (60.0)	14 (38.9)	5.31	0.02
	Other	50 (40.0)	22 (61.1)		
Duration on ART	1-2 years	32 (25.6)	15 (41.7)	3.87	0.05
	>2 years	93 (74.4)	21 (58.3)		

Employment status was significantly associated with ART adherence ($\chi^2 = 4.21$, $p = 0.04$), with employed participants more likely to have good adherence. Living arrangement also showed a significant association ($\chi^2 = 5.31$, $p = 0.02$), with those living with parents more likely to have good adherence. Duration on

ART was marginally significant ($\chi^2 = 3.87$, $p = 0.05$), with those on ART for more than two years more likely to have good adherence.

The Socio-Ecological Model illustrating multi-level factors influencing ART adherence and retention among young adults in Eswatini is shown in Figure 1

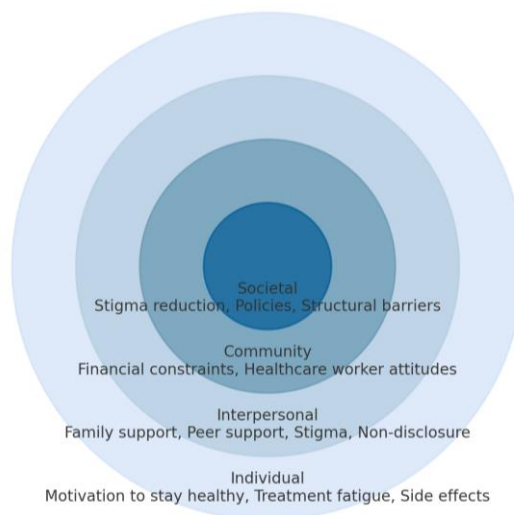


Figure 1. Socio-Ecological Model illustrating multi-level factors influencing ART adherence and retention among young adults in Eswatini.

Discussion

This study provides a comprehensive understanding of ART adherence and retention in care among HIV-positive young adults aged 18-24 years in Eswatini. The mixed-methods approach allowed for the triangulation of quantitative data on adherence levels and clinical outcomes with qualitative insights into the factors influencing these outcomes.

Adherence Levels and Clinical Outcomes

The quantitative findings revealed a mean ART adherence of 96.3% (± 6.1 SD), with 77.6% of participants demonstrating 95-100% adherence based on clinical records. This is higher than adherence rates reported in some previous studies among adolescents and young adults in sub-Saharan Africa, which have ranged from 60% to 85%. The higher adherence rate in our study may be attributed to Eswatini's

robust national ART program and the implementation of differentiated service delivery models, including multi-month dispensing.

The viral suppression rate of 85.7% in our study is consistent with Eswatini's overall progress towards the UNAIDS 95-95-95 targets. However, it is lower than the national average of 96.2% for adults, highlighting the "young adult gap" in HIV outcomes. This disparity underscores the need for targeted interventions for this age group.

Retention in care was at 82.6%, which is lower than the desired 95% target but higher than rates reported in some other studies among young adults in sub-Saharan Africa. This suggests that while Eswatini's healthcare system has made progress in retaining young adults in care, there is still room for improvement.

Factors Influencing Adherence and Retention

The qualitative findings identified multiple factors influencing ART adherence and retention, which can be understood through the lens of the Socio-Ecological Model. At the individual level, personal motivation and the desire for health were key motivators, while treatment fatigue and side effects were significant challenges. These findings are consistent with previous research on ART adherence among young adults.

At the interpersonal level, social support from family and peers emerged as a critical motivator, while stigma and non-disclosure were major barriers. This aligns with studies highlighting the importance of social support for ART adherence and the detrimental impact of stigma. The fear of disclosure leading to non-adherence is particularly concerning given the high levels of stigma in Eswatini [19].

At the community and organizational levels, financial constraints and suboptimal healthcare worker attitudes were significant challenges. These findings echo previous research highlighting the impact of economic barriers and healthcare provider attitudes on ART adherence.

Our findings resonate with the findings that highlighted that barriers to ART adherence emerge early in the treatment continuum and often persist without intervention [21]. Both studies demonstrate that stigma, limited disclosure, and unfavorable healthcare interactions remain dominant deterrents, while supportive family dynamics and personal motivation significantly enhance adherence.

Moreover, [21] reported that perceived discrimination and fear of social rejection particularly affected adherence intentions among newly diagnosed individuals. This insight reinforces the importance of stigma-reduction interventions, social support networks, and trust-building with healthcare providers. Addressing these behavioral and emotional barriers early can help sustain long-

term adherence and retention among Eswatini's youth population.

Implications for Practice and Policy

The findings from this study have several implications for practice and policy. First, there is a need for comprehensive, tailored interventions that address the personal, sociocultural, economic, and systemic factors influencing adherence and retention. Such interventions should include:

1. Strengthening social support systems through peer support groups and family engagement programs.
2. Addressing stigma through community education and anti-discrimination campaigns.
3. Providing economic support to mitigate financial barriers to adherence.
4. Training healthcare workers on youth-friendly service provision and positive attitudes.
5. Expanding differentiated service delivery models to better meet the needs of young adults.

Secondly, there is a need for policy reforms to address the structural barriers identified in this study. These may include:

1. Integrating mental health and sexual and reproductive health services within HIV care.
2. Extending clinic hours and improving accessibility of healthcare facilities.
3. Increasing funding for transport and other support services for young adults living with HIV.
4. Developing policies to protect the rights of young adults living with HIV and reduce stigma.

Limitations

Several limitations were encountered during the execution of this study. A primary constraint was the reliance on routinely collected medical data, which often suffered from incomplete recording by health providers

and inherent inaccuracies in the records. This could affect the precision of quantitative measures and the comprehensive understanding of patient histories.

Furthermore, a methodological challenge arose in reaching certain segments of the study population. Specifically, it proved exceptionally difficult to engage patients who were habitual defaulters on ART treatment, as these individuals were actively avoiding contact with health workers. This means that the qualitative data gathered may not fully capture the most severe and entrenched barriers faced by those who are chronically lost to follow-up.

An additional practical limitation was the inability to meet the calculated sample size target. Despite a mathematical formula indicating a need for approximately 288 participants, only 161 participants were enrolled. This shortfall was directly attributable to the success of the multi-month dispensing program, which significantly reduced patients' frequency of hospital visits. This reduction in the achieved sample size implies a potential reduction in the statistical power of quantitative analyses.

Finally, the data collection period was extended from the initially planned 3 months to 6 months in an effort to mitigate the recruitment challenges, though the target sample size was ultimately not met.

Conclusion

This study provides valuable insights into ART adherence and retention in care among HIV-positive young adults aged 18-24 years in Eswatini. The findings reveal both successes and challenges in HIV care for this population. While adherence rates and viral suppression are approaching target levels, retention in care remains below the desired 95%. The study identifies multiple factors influencing adherence and retention at individual, interpersonal, community, and societal levels.

The integrated findings from both quantitative and qualitative data underscore the necessity of comprehensive, tailored interventions that address the personal, sociocultural, economic, and systemic factors influencing adherence and retention. Such interventions are critical for enhancing the well-being and health outcomes for young adults living with HIV in Eswatini and for achieving the UNAIDS 95-95-95 targets.

Addressing ART adherence among young adults requires both structural and psychosocial interventions. Understanding adherence beliefs early before behavioral patterns are entrenched may enhance long-term retention and viral suppression outcomes in Eswatini [21].

Future research should focus on developing and evaluating targeted interventions for this age group, with particular attention to addressing stigma, strengthening social support, and mitigating economic barriers. Additionally, longitudinal studies are needed to better understand the transition from adolescent to adult care and its impact on long-term health outcomes.

Data Availability

The datasets generated and analyzed during the current study are not publicly available due to the need to protect the confidentiality and privacy of the study participants, particularly given the sensitive nature of HIV status and the small population size of Eswatini. The original data, including clinical records and structured questionnaire responses, contain identifiable or potentially re-identifiable information which could compromise participant anonymity. However, anonymized and de-identified data may be made available from the corresponding author upon reasonable request and with permission from the Eswatini Health and Human Research Review Board (EHHRRB) and the Eswatini Ministry of Health, provided that data sharing is in accordance with the ethical approval granted for the study.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

Ethical approval was obtained from the Texila American University Ethics Review Board and the Eswatini Health and Human Research Review Board.

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Author Contributions

Author 1: Conceptualization, Methodology, Writing – Original Draft Preparation, Supervision.

Author 2: Data Curation, Formal Analysis, Visualization, Writing – Original Draft Preparation.

Author 3: Validation, Investigation, Writing – Review & Editing.

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