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COMPARATIVE EFFECTIVENESS OF A MULTI-ARM HEALTH EDUCATION INTERVENTION ON ADHERENCE BEHAVIOUR AND HEALTH OUTCOMES AMONG PLWHIV IN TARABA STATE, NIGERIA

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ABSTRACT: *Human Immunodeficiency Virus (HIV) continues to constitute a significant public health challenge, particularly in sub-Saharan Africa, where optimal adherence to antiretroviral therapy (ART) is essential for achieving favourable treatment outcomes. Given the paucity of comparative evidence on the effectiveness of health education strategies in improving adherence behaviour and health outcomes among people living with HIV (PLWHIV) in resource-constrained settings, this study compared four health education interventions among 60 PLWHIV in Nigeria. Data were collected using validated questionnaires and analysed using descriptive statistics and one-way analysis of variance (ANOVA) at a 0.05 level of significance. The combined intervention produced the greatest improvements: treatment behaviour increased in mean score from 7.67 to 16.27, medication adherence from 3.20 to 8.33, pill count from 66.16% to 98.98%, and appointment-keeping from 4.47 to 7.93 (all p = 0.00), indicating very large effects. Researcher-led intervention showed moderate significant gains (adherence: 2.24–3.17; pill count: 59.99%–97.99%), while peer-led intervention achieved smaller significant improvements (adherence: 2.76–3.36, p = 0.049; pill count: 61.00%–90.01%). Control changes were minimal and largely non-significant. The interventions demonstrated a hierarchical pattern of effectiveness, with the combined peer-led and researcher-led health education approach yielding the greatest impact, followed by researcher-led health education, peer-led health education, and the control condition, respectively. Factorial-based combined peer- and researcher-led health education significantly improves ART adherence and clinical outcomes; scale up integrated, theory-driven HIV interventions.*

KEYWORDS: Adherence, ART, Behaviour, Enabling, Health education, Intervention study, Medication adherence, Nigeria, People Living with HIV (PLWHIV), Reinforcing, Viral load.

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INTRODUCTION

Human Immunodeficiency Virus (HIV) remains a major global public health challenge, with an estimated 39 million people living with the infection worldwide. Despite decades of global response efforts, sub-Saharan Africa continues to bear a disproportionate burden, accounting for nearly two-thirds of all cases globally. Recent global surveillance reports indicate that while progress has been made toward achieving the UNAIDS 95-95-95 targets, substantial gaps persist in diagnosis, treatment coverage, adherence, and sustained viral suppression, particularly in low-resource settings where structural and behavioural barriers remain deeply entrenched (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2024; Saenjun et al., 2025).

The introduction and scale-up of antiretroviral therapy (ART) have fundamentally transformed HIV infection from a rapidly fatal disease into a chronic, manageable condition. ART works by suppressing viral replication, restoring immune function, and significantly reducing HIV-related morbidity and mortality. However, the long-term effectiveness of ART is highly dependent on sustained and optimal adherence to prescribed regimens. High-level adherence, commonly defined as taking at least 95% of prescribed doses, is essential for achieving and maintaining viral suppression, preventing disease progression, reducing HIV transmission, and limiting the emergence of drug-resistant viral strains (Bangsberg, 2006; Cohen et al., 2011; Paterson et al., 2000). Despite these benefits, adherence remains a persistent challenge across sub-Saharan Africa, undermining the full potential of ART programmes.

Evidence indicates that ART adherence levels vary widely across settings, with reported estimates influenced by methodological differences and measurement approaches. Self-reported adherence, although widely used in clinical practice and research, has been consistently shown to overestimate actual adherence when compared with objective biomarkers such as viral load suppression (Bangsberg, 2006). This discrepancy raises significant concerns about the accuracy of adherence monitoring systems and highlights the need for more robust evaluation approaches that integrate both behavioural and clinical indicators.

ART adherence is a complex and multidimensional behaviour influenced by interacting psychological, social, and structural determinants. The PRECEDE framework provides a useful theoretical lens for understanding these determinants by categorizing them into predisposing, reinforcing, and enabling factors. Predisposing factors include knowledge, beliefs, perceptions, and attitudes toward HIV and ART; reinforcing factors include social support, peer influence, and motivational encouragement; while enabling factors involve access to healthcare services, financial capacity, transportation, and health system functionality (Green & Kreuter, 2005). Empirical studies across sub-Saharan Africa consistently demonstrate that ART adherence is shaped by a combination of these factors rather than a single determinant. Commonly reported barriers include stigma and discrimination, forgetfulness, medication side effects, long waiting times at clinics, transport difficulties, food insecurity, and inconsistent drug supply chains (Tarkang et al., 2024; Magura et al., 2025; Mills et al., 2006). However, recent evidence suggests that these barriers are not independent but interact dynamically, with socioeconomic deprivation and weak

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health systems amplifying psychosocial vulnerabilities and further compromising adherence outcomes (Magura et al., 2025; Saenjun et al., 2025).

In Nigeria, ART adherence remains variable, with reported rates ranging between 56% and 90% depending on study design, population, and measurement method. This variability reflects both methodological inconsistencies and significant disparities in access to HIV services across different regions. Despite improvements in ART availability, structural challenges within the Nigerian health system persist, including uneven distribution of healthcare facilities, shortages of trained health personnel, and intermittent drug supply chains. These challenges are more pronounced in rural and underserved areas, where geographic barriers and limited infrastructure further restrict access to consistent HIV care.

In Taraba State, these challenges are intensified by predominantly rural settlement patterns, weak health infrastructure, and pronounced rural–urban disparities in access to HIV services. Many patients must travel long distances to access treatment centres, experience prolonged waiting times, and face persistent stigma and discrimination, all of which negatively influence adherence behaviour. Recent programmatic reports suggest improvements in ART coverage and viral suppression in selected intervention areas; however, persistent gaps remain in sustained adherence and equitable service delivery, particularly among hard-to-reach populations (Centre for Initiative Development [CFID], 2024). Despite these challenges, empirical evidence focusing specifically on behavioural and structural determinants of ART adherence in Taraba State remains limited.

Health education interventions have been widely implemented as a strategy to improve ART adherence by targeting modifiable behavioural determinants such as knowledge, attitudes, and self-efficacy. However, most interventions in low-resource settings are single-component in design and do not adequately address the multidimensional nature of adherence behaviour. Contemporary evidence suggests that despite numerous intervention efforts, adherence outcomes remain inconsistent, indicating that isolated strategies are insufficient to address the complex interplay of behavioural and structural barriers (Keene et al., 2024; World Health Organization [WHO], 2021; UNAIDS, 2023). This has led to growing recognition of the need for more comprehensive, theory-driven, and context-specific intervention approaches.

Multi-arm intervention designs provide a robust methodological framework for evaluating the comparative effectiveness of different intervention strategies within a single study. Such designs allow for the simultaneous assessment of distinct behavioural pathways influencing adherence outcomes. For example, one intervention arm may target predisposing factors by improving knowledge and correcting misconceptions about ART, another may target reinforcing factors by strengthening peer and family support systems, and a third may address enabling factors by improving access to care and treatment navigation. This comparative structure enables the identification of the most effective behavioural pathway or combination of pathways for improving adherence and associated health outcomes.

Despite increasing global attention to ART adherence, there remains a paucity of rigorous comparative evidence evaluating multi-arm, theory-based health education interventions in resource-limited and culturally diverse settings such as Taraba State. Furthermore, limited studies integrate behavioural theory with objective clinical outcomes such as viral load suppression, thereby limiting the strength of causal inference and practical applicability of findings. Given the persistent challenge of suboptimal adherence, inconsistencies in existing

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evidence, and the absence of comparative multi-arm intervention studies in this context, there is a compelling need for rigorous empirical investigation.

Therefore, this study examines the comparative effectiveness of a multi-arm health education intervention on adherence behaviour and health outcomes among people living with HIV in Taraba State, Nigeria. The findings are expected to contribute to strengthening evidence-based HIV programming by identifying the most effective behavioural intervention strategies and informing policy and practice in similar resource-limited settings.

LITERATURE/THEORETICAL UNDERPINNING

Conceptual Framework

The PRECEDE Model (PM) provides a framework for understanding and influencing health behaviours, including antiretroviral therapy (ART) adherence. It serves as an organizational strategy for planning interventions by focusing on modifiable determinants of behaviour categorized as predisposing, reinforcing, and enabling factors (Green, 1974). These factors interact to promote and sustain behaviour change.

Predisposing factors are antecedents that motivate behaviour and include knowledge, awareness, attitudes, beliefs, perceptions, and self-efficacy. In this study, they encompass clients' understanding of HIV and ART, perceived benefits of treatment, confidence in information provided by healthcare professionals, perceived severity of HIV-related consequences and non-adherence, and perceived barriers to treatment. Self-efficacy, defined as an individual's belief in their ability to achieve desired outcomes, influences coping behaviours and persistence in overcoming challenges (Bandura, 1995).

Reinforcing factors are influences that strengthen behaviour after it occurs. These include social support from peers and family members, participation in support groups, access to resources, and incentives that encourage continued adherence and health-promoting behaviours.

Enabling factors are environmental conditions and resources necessary for behaviour performance. They include access to healthcare services, financial resources, transportation, treatment-related skills, and other supportive conditions that allow individuals to translate positive intentions into actual adherence behaviour. Without these enabling conditions, sustained behaviour change may be difficult to achieve.

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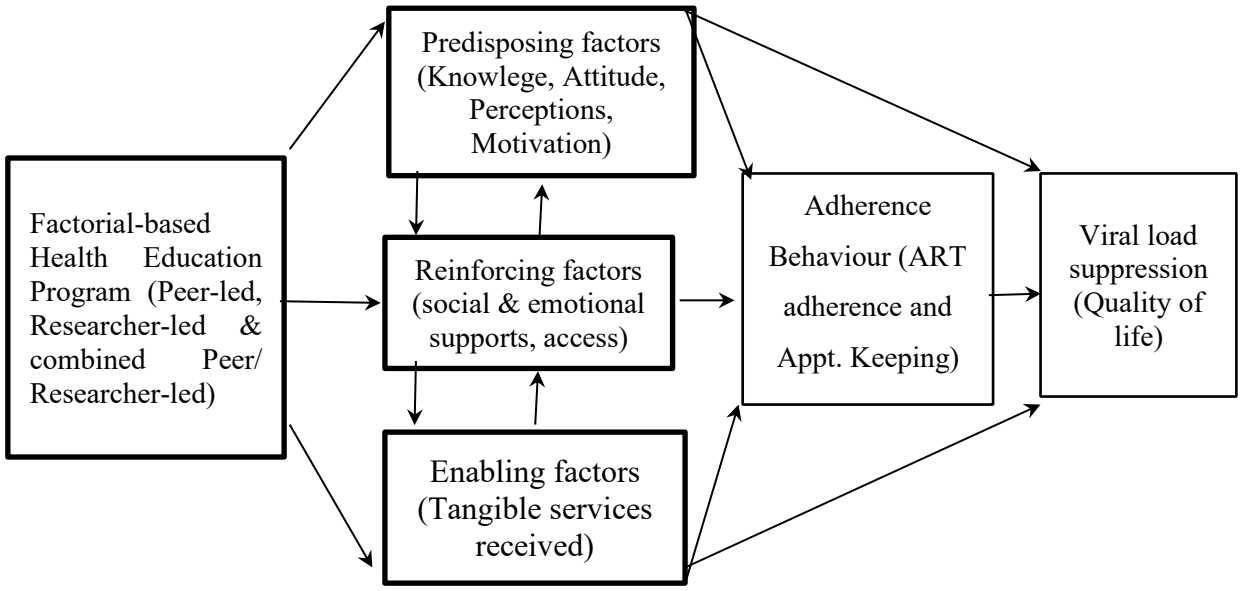
Fig. 1: Precede model framework (Green, 1974)



METHODOLOGY

Research Design and Setting

This study adopted a pretest–posttest quasi-experimental design to evaluate the effectiveness of a factorial-based health education intervention programme aimed at improving antiretroviral therapy (ART) adherence among people living with HIV. The intervention was structured into four study arms comprising one control group and three intervention groups: researcher-led education (General Hospital Gembu), peer-led education (General Hospital Bali), and a combined researcher- and peer-led intervention (General Hospital Zing). The control group was drawn from General Hospital Donga and received standard care. Participants in all groups were assessed at baseline and at 13 weeks post-intervention.

The intervention was informed by a comprehensive needs assessment of the target population to ensure contextual relevance and responsiveness to identified adherence challenges. The study was conducted across selected secondary health facilities within the three senatorial districts of Taraba State, Nigeria. Taraba State, located in northeastern Nigeria, is characterized by a heterogeneous topography that includes lowlands and mountainous regions, notably the Mambilla Plateau. The state was purposively selected due to its relatively high HIV prevalence rate of 10.5% as reported in the National Demographic and Health Survey (NDHS, 2013).

Study Participants, Sampling, and Eligibility Criteria

The study population comprised people living with HIV/AIDS (PLWHIV) attending ART clinics in selected health facilities. Inclusion criteria consisted of individuals aged 11 years and above, confirmed HIV-positive status, receipt of ART for a minimum duration of six months, ability to provide informed consent, residency within Taraba State, willingness to

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participate and provide follow-up contact information, and capacity to communicate in any of the predominant local languages (Mambilla, Jukun, Mumuye, Hausa, Fulfulde, or English).

Exclusion criteria included individuals with severe mental or physical conditions likely to affect adherence or participation, pregnant or breastfeeding women, individuals with a history of substance abuse, those with known contraindications to ART, participants with incomplete medical records, individuals who had transferred care to another facility, those who had participated in similar studies within the preceding six months, and healthcare workers employed at the selected facilities.

Sampling Procedure

A multistage systematic random sampling technique was employed to recruit 60 eligible participants. In the first stage, Taraba State was stratified into four geographically distinct regions to ensure adequate representation of its socio-demographic diversity. In the second stage, one secondary health facility was randomly selected from each region, yielding four study sites: General Hospital Zing (Intervention Group 1), General Hospital Bali (Intervention Group 2), General Hospital Gembu (Intervention Group 3), and First Referral Hospital Donga (Control Group).

In the third stage, systematic random sampling was used to select 15 participants from each facility, resulting in a total sample size of 60 participants, allocated as 45 in the intervention arms and 15 in the control group. Recruitment was facilitated by trained research assistants who engaged participants in appropriate local languages and obtained informed consent. This sampling approach enhanced representativeness, minimized selection bias, and improved the generalizability of findings.

Sample size computation

The sample size for this study was determined using a Z-based normal approximation formula for comparing proportions between two independent groups, as described by Fleiss, Levin, and Paik (2013). The formula is expressed as:

$$N = \frac{(\mathrm{Z}\alpha + \mathrm{Z}\beta)^2 \text{ x } \mathrm{p}\,(1 - \mathrm{p})}{\mathrm{D}^2}$$

Where N represents the minimum required sample size per group, $Z\alpha$ corresponds to the standard normal deviate at a 95% confidence level (1.96) sufficient to minimize type I error, and $Z\beta$ represents the standard normal deviate corresponding to 90% statistical power (1.28) for a one-tailed test, sufficient to minimize Type II error. The term $p(1 - p)$ denotes the estimated pooled proportion, with $p = 0.45$ based on baseline medication adherence levels, while D represents the minimum tolerable difference in antiretroviral therapy (ART) adherence between the pre- and post-intervention groups. An adherence level of 95% was considered optimal for effective HIV treatment outcomes. Therefore computation shows that;

Minimum 'N' per health district = $N = \frac{(1.96 + 1.28)^2 \text{ x } 45\,(1-0.45)}{45(1-0.45)} = 10.5$

The minimum sample size per region was 10 but to account for, or take care of response bias, up to 50% per region was added in the four sampling regions (Hence 10 x 50/100 =5. Therefore, 10 + 5 = 15 x 4 sampling areas =60 participants). This increase of up to 50% is

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necessitated by the sensitive nature of the clients the study is dealing with. This puts into Consideration their HIV status and the level of their vulnerability so that study gives them the liberty to withdraw at any stage of the study, hence, attrition rate is suspected to be high.

Data Collection Instrument and Procedures

Data were collected using the self-developed Questionnaire called the Chiegil Solomon 8-items Medication Adherence Scale (CSMAS-8) and structured in alignment with the PRECEDE behavioural model. The instrument comprised five sections covering socio-demographic characteristics, predisposing factors, reinforcing factors, enabling factors, and ART adherence behaviour. It assessed domains such as knowledge, attitudes, perceptions, social support, health system access, self-efficacy, and appointment adherence.

Responses were scored and transformed into percentage indices and categorical levels to identify adherence patterns and behavioural gaps. The instrument also captured perceived barriers to adherence and contextual factors influencing treatment continuity.

Validity of the Instrument

The instrument underwent rigorous validation processes, including face, content, and constructs validation through expert review and alignment with established literature, WHO guidelines, and UNAIDS frameworks. Criterion validity was supported through adaptation from the MMAS-8 scale. Internal validity was strengthened using a quasi-experimental pretest–posttest design, while external validity was enhanced through representative sampling across diverse health facilities.

Reliability of the Instrument

Reliability was established through pretesting and test–retest procedures, yielding a reliability coefficient of $r = 0.85$. Internal consistency was confirmed using Cronbach's alpha (≥ 0.70). Additional refinements were made following pilot testing, and research assistants were trained to ensure uniformity, clarity, and cultural appropriateness in data collection.

Intervention and Data Collection Procedure

Participants were randomly assigned to four groups: control, researcher-led intervention, peer-led intervention, and combined researcher–peer-led intervention. Baseline data were collected prior to intervention implementation. The intervention phase lasted six weeks and involved structured factorial health education sessions focusing on ART adherence, complemented by adherence monitoring strategies including pill counts, appointment tracking, medication refill follow-up, and CD4 assessment where applicable.

Post-intervention data were collected using the same validated instrument administered at baseline. All data collection procedures were conducted by trained research assistants under strict supervision.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 21 and descriptive statistics such as frequencies, means, and standard deviations were used to summarize socio-demographic and adherence variables. Inferential statistics, including paired sample t-tests and analysis of

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variance (ANOVA), were employed to assess within-group and between-group differences. Effect sizes and 95% confidence intervals were reported where appropriate, with statistical significance set at $p \leq 0.05$. Results were presented using tables, means, variances, and comparative statistical outputs.

Ethical Considerations

Ethical approval for the study was obtained from the Babcock University Health Research Ethics Committee and the Taraba State Ministry of Health Research Ethics Committee. The study adhered strictly to ethical principles of autonomy, beneficence, non-maleficence, and justice. Participants were provided with clear, culturally appropriate information and gave voluntary written informed consent, with the right to withdraw at any stage without penalty.

Confidentiality was ensured through anonymized data coding and secure data storage. The intervention posed minimal risk as it was non-invasive and educational in nature. Cultural sensitivity was maintained throughout the study, and institutional permissions were obtained from all participating health facilities. No financial incentives were provided; however, participants benefited directly from the educational intervention designed to improve adherence outcomes.

RESULTS/FINDINGS

A total of 60 participants were initially enrolled across four groups (three intervention arms and a control), with 57 valid responses retained, yielding a 95% response rate (attrition rate of (3) 5%). The sample was predominantly female (61.4%), with variations across groups, while ethnic composition differed markedly, with the control group largely Tiv-dominated and Intervention 1 predominantly Mumuye, whereas Interventions 2 and 3 showed greater ethnic diversity. Educational attainment was generally low in the control group but higher in Intervention 1. Occupational and religious distributions also varied significantly across groups, while most participants were married (58.3%), indicating heterogeneous sociodemographic characteristics across study arms.

Table 1: Demographic Characteristics of Participants at Baseline for each arm in the Study (n=60).

Variables	**Control Group n=15**		**Intervention One n=15**		**Intervention Two n=15**		**Intervention Three n=15**		**Total**
	Frequency n (%)		**Frequency n (%)**		**Frequency n (%)**		**Frequency n (%)**		
Gender:									
Males	4	26.7	5	31.3	8	53.3	5	41.7	22
Females	11	73.3	10	62.5	7	46.7	7	58.3	35
Ethnicity:									
Jukun	1	6.7	1	6.3	2	13.3	0	0	4
Hausa	1	6.7	0	0	3	20.0	1	8.3	5
Tiv	13	86.7	0	0	0	0	0	0	13

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Mambilla	0	0.0	0	0	1	6.7	4	33.3	5
Mumuye	0	0.0	13	81.3	3	20.0	0	0	16
Fulani	0	0.0	0	0	2	13.3	1	8.3	3
Kaka	0	0.0	0	0	3	20.0	4	33.3	7
Others	0	0	1	6.3	1	6.7	2	16.7	4
Education:									
Non-Formal	7	46.7	0	0	5	33.3	2	16.7	14
Primary	5	33.3	0	0	1	6.7	2	16.7	8
Secondary	3	20.0	10	62.5	5	33.3	2	16.7	20
Higher	0	0	5	31.3	4	26.7	6	50	15
Occupation:									
Civil Servant	0	0	3	18.8	4	26.7	4	33.3	11
Self-Employed	6	40.0	9	56.3	0	0	3	25.0	18
Housewife	3	20.0	1	6.3	3	20.0	3	25.0	10
Student	6	40.0	0	0	0	0	0	0	6
Applicant	0	0	2	12.5	8	53.3	2	16.7	12
Religion:									
Christian	13	86.7	14	93.3	5	33.3	3	25	35
Islam	2	13.3	1	6.7	10	66.7	9	75	22
Marital Status:									
Single	6	40.0	4	25.0	5	33.3	3	25	18
Married	6	40.0	10	62.5	10	66.7	9	75	35
Separated	1	6.7	1	6.3	0	0	0	0	2
Widowed	2	13.3	0	0	0	0	0	0	2

Components of the factorial-based health education intervention program that are most strongly associated with improved medication adherence

Compelling evidence shows that the factorial-based health education intervention significantly improved antiretroviral therapy (ART) adherence behaviour among participants through the modification of predisposing, reinforcing, and enabling factors that collectively influence adherence-related behaviours. The Combined Peer-led/ researcher-directed educational component of the intervention was the most strongly associated with improved medication adherence, followed by the Researcher-led intervention approach. The strength of these associations is supported by behavioural, adherence, and clinical outcome indicators measured at the 13th week post-intervention.

At the behavioural level, the Combined Peer-led and researcher-directed intervention produced the most substantial improvements in treatment behaviour, medication adherence, and appointment-keeping patterns. Participants exposed to this component (Intervention One) recorded the largest increase in treatment behaviour scores, rising from a baseline mean score of $\underline{X} =$ 7.67 ± 4.41 to $\underline{X} =$ 16.27 ± 1.20 at the 13th week post-intervention. This improvement corresponded to a very large intervention effect size (Cohen's d = 2.72; 95% CI: 1.56–3.87; p = 0.001), indicating a strong behavioural change attributable to the intervention. In contrast, the control group showed only a marginal increase in treatment behaviour from $\underline{X} =$ 2.56 ± 0.31 at baseline to $\underline{X} =$ 3.00 ± 0.41 post-intervention, with a

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non-significant effect size (d = 1.25; 95% CI: 1.13–1.38; p = 0.50). The peer-led intervention (Intervention Two) demonstrated a smaller but statistically significant improvement in treatment behaviour, increasing from $\underline{X}$ = 2.92 ± 0.80 to $\underline{X}$ = 3.70 ± 1.47, with a moderate effect size (d = 0.70; 95% CI: 0.29–1.11; p = 0.049). Similarly, the researcher-led (Intervention Three) showed an increase from 2.85 ± 0.30 to 4.83 ± 2.60, corresponding to a large effect size (d = 1.18; 95% CI: 0.55–1.81; p = 0.001). These findings indicate that while all intervention approaches improved treatment behaviour, the combined peer-led and researcher-directed intervention produced the most substantial behavioural changes.

Similar patterns were observed in medication adherence outcomes, which further demonstrate the strong influence of the combined peer-led and researcher-directed educational component. Participants in Intervention One recorded the most dramatic improvement in adherence scores, increasing from $\underline{X}$ = 3.20 ± 1.10 at baseline to $\underline{X}$ = 8.33 ± 1.76 post-intervention. This increase corresponded to an extremely large effect size (d = 3.65; 95% CI: 3.14–4.16; p = 0.001), indicating a profound improvement in medication-taking behaviour. By comparison, the control group recorded a smaller increase from $\underline{X}$ = 2.00 ± 0.74 to $\underline{X}$ = 2.92 ± 0.63, corresponding to an effect size of 1.40 (95% CI: 1.15–1.62; p = 0.045). Participants in the peer-led intervention group recorded a moderate improvement in adherence, increasing from $\underline{X}$ = 2.76 ± 0.50 to $\underline{X}$ = 3.36 ± 1.19 with an effect size of 0.70 (95% CI: 0.38–1.02; p = 0.049). Likewise, the researcher-led intervention group demonstrated an improvement from $\underline{X}$ = 2.24 ± 0.93 to $\underline{X}$ = 3.17 ± 0.28, corresponding to a large effect size of 1.34 (95% CI: 1.08–1.60; p = 0.001).

Further support for the effectiveness of this component is reflected in improvements in appointment-keeping behaviour, which is an important indicator of engagement with HIV care services. Participants in the combined peer-led and researcher-directed intervention group recorded a substantial increase in appointment-keeping scores from $\underline{X}$ = 4.47 ± 1.23 at baseline to 7.93 ± 1.53 at post-intervention, corresponding to a very large effect size (d = 2.59; 95% CI: 2.11–3.08; p = 0.001). In contrast, the control group experienced a decline in appointment-keeping behaviour, decreasing from $\underline{X}$ = 0.56 ± 0.89 to $\underline{X}$ = 0.08 ± 0.93, resulting in a negative effect size of −0.55 (95% CI: −0.86 to −0.23; p = 0.061). The peer-led intervention group showed only modest improvement, increasing from $\underline{X}$ = 0.16 ± 0.01 to $\underline{X}$ = 0.36 ± 1.08, with a small effect size of 0.28 (95% CI: 0.02–0.55; p = 0.050). However, the researcher-led intervention group demonstrated a remarkable increase from $\underline{X}$ = 0.62 ± 0.10 to $\underline{X}$ = 1.67 ± 0.28, corresponding to an exceptionally large effect size of 5.45 (95% CI: 5.38–5.52; p = 0.001).

The behavioural improvements observed in this study were strongly linked to changes in **predisposing factors**, particularly knowledge, perception, and attitudinal disposition toward ART adherence. At baseline, knowledge levels were generally low across all groups, with mean scores ranging from $\underline{X}$ = **1.53 ± 0.83 in the control group to** $\underline{X}$ = **3.10 ± 1.29 in Intervention Three**, and no statistically significant difference across groups (**F = 1.22, p = 0.771**). However, by the 13th week post-intervention, knowledge scores increased dramatically among participants exposed to the combined peer-led and researcher-directed intervention, reaching $\underline{X}$ = **8.20 ± 1.08**, compared with $\underline{X}$ = **1.92 ± 1.08 in the control group**. This difference across groups was highly statistically significant (**F = 282.05, p < 0.001**).

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The intervention also strengthened several **perception-related constructs** that influence adherence behaviour. Participants in the combined peer-led and researcher-directed intervention group recorded significantly higher levels of **perceived confidence ($\underline{X}$ = 8.20 ± 1.08; F = 38.18, p < 0.001)**, **perceived benefits ($\underline{X}$ = 8.71 ± 0.83; F = 12.42, p < 0.001)**, **perceived threat ($\underline{X}$ = 20.0 ± 3.01; F = 7.07, p < 0.001)**, and **perceived self-efficacy ($\underline{X}$ = 6.33 ± 1.00; F = 18.33, p < 0.001)**. These improvements indicate that the intervention successfully strengthened cognitive and motivational determinants that predispose individuals toward adherence behaviour. Attitudinal disposition toward ART also improved significantly, with Intervention One recording a mean score of 13.60 ± **0.50**, compared with 9.07 ± **0.91 in the control group** (**F = 28.03, p < 0.001**).

In addition to modifying predisposing factors, the intervention improved **reinforcing factors**, particularly incentives and motivational support. Reinforcing factors improved significantly across groups (**F = 8.13, p < 0.001**), with the combined peer-led and researcher-directed intervention recording the highest incentive-related reinforcement score (**5.13 ± 0.97; F = 8.78, p < 0.001**). However, **social support did not show a statistically significant difference across groups (F = 1.67, p = 0.186)**, suggesting that external social networks may not have changed substantially during the intervention period.

The intervention also improved **enabling factors**, which represent structural conditions that facilitate adherence behaviour. Enabling factor scores increased significantly across groups (**F = 6.83, p = 0.001**), with the researcher-directed intervention group recording the highest mean score of **6.39 ± 1.63**, compared with **4.13 ± 1.81 in the control group**.

Objective measures of adherence further confirm the effectiveness of the intervention components. **Pill-count adherence rates exceeded 95% in all intervention groups**, with the combined peer-led and **researcher-directed intervention achieving the highest adherence rate of 97.99%**, followed by the **researcher-led intervention at 95.84%** and the **peer-led intervention at 95.05%**. The control group recorded a lower adherence rate of **93.37%**, indicating that structured adherence support contributed to higher medication-taking consistency.

Finally, the improvements in adherence behaviour translated into measurable **clinical outcomes**, particularly reductions in viral load levels. At the **13th week post-intervention**, viral load levels differed significantly across groups (**F = 4.85, p = 0.005**). The **lowest viral load was recorded in Intervention Three (18.83 ± 12.65)**, followed by **Intervention One (24.64 ± 10.76)** and **Intervention Two (29.31 ± 5.47)**, while the **control group recorded the highest viral load (32.27 ± 4.67)**.

Comparing the effectiveness of the health education intervention program in improving adherence behaviour and health outcomes

A comparative evaluation of the three intervention arms, researcher-directed, peer-led, and the combined researcher- and peer-led approach, revealed clear differences in their overall effectiveness (Table 4.4). The evaluation of the health education intervention program revealed marked differences in its impact across the control and experimental groups. In the control arm, changes in adherence behavior were minimal, with treatment behavior showing only a slight increase from $\underline{X} = 2.56$ at baseline to $\underline{X} = 3.00$ post-intervention. Pill count rose

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marginally from 60.01% to 62.13%, neither of which reached statistical significance. Medication adherence improved modestly from 2.00 to 2.92, achieving significance at p = 0.045, while appointment-keeping declined from 0.56 to 0.08. This suggests that without structured intervention, improvements in adherence were inconsistent and limited.

In contrast, the combined researcher- and peer-led intervention (Experimental Group One) produced consistent improvements across all domains. Treatment behavior nearly doubled, rising from $\underline{X} = 7.67$ to $\underline{X} = 16.27$ (p = 0.001), while medication adherence increased sharply from $\underline{X} = 3.20$ to $\underline{X} = 8.33$ (p = 0.001). Pill count improved from $\underline{X} = 66.16\%$ to 98.98% (p = 0.001), and appointment-keeping rose significantly from $\underline{X} = 4.47$ to $\underline{X} = 7.93$ (p = 0.001).

The peer-led intervention (Experimental Group Two) yielded more modest improvements. Treatment behavior rose slightly from $\underline{X} = 2.92$ to $\underline{X} = \underline{X} = 3.70$ (p = 0.049), and medication adherence increased from $\underline{X} = 2.76$ to $\underline{X} = \underline{X} = 3.36$ (p = 0.049). Pill count showed a notable improvement, rising from 61% to 90.01% (p = 0.002), while appointment-keeping improved only marginally. Psychosocial outcomes were mixed, with modest improvements in knowledge and attitudinal dispositions, but little or no change in perception, confidence, and perceived benefits.

The researcher-led intervention (Experimental Group Three) demonstrated strong behavioral outcomes, though psychosocial improvements were less consistent. Treatment behavior increased from $\underline{X} = 2.85$ to 4.83 (p = 0.001), medication adherence rose from 2.24 to 3.17 (p = 0.001), and pill count improved substantially from 59.99% to 97.99% (p = 0.010). Appointment-keeping showed the most pronounced gain, rising from -0.62 to -1.67 (p = 0.001). However, knowledge remained unchanged, perception and perceived benefits declined slightly, and self-efficacy decreased significantly.

Overall, the results establish a clear comparative hierarchy of effectiveness, with the combined researcher-directed/ peer-directed intervention emerging as the most effective, producing the greatest and most consistent improvements across behavioral, psychosocial, and clinical outcomes. The researcher-led intervention ranked second, achieving excellent behavioral and clinical results but weaker psychosocial gains. The peer-led intervention produced modest behavioral improvements but was limited by declines in reinforcing and enabling factors. The control group showed negligible changes. These findings underscore that professionally guided, theory-driven interventions, either alone or in combination with peer support, are the most effective strategies for improving adherenc and health outcomes in ART programs. Refer to Table 4.4 for this information.

Table 2: Impact Evaluation for Treatment Behaviours in Anti-retroviral Medication Adherence Intervention for Control and all Groups in this Study

Variables	Maximum Scale of Measure	Baseline n=15		Post- Intervention n=14		*ES (95%CI)	p-value
		$\underline{X}(SE)$	±SD	$\underline{X}$ (SE)	±SD		
Control							
Treatment Behaviour	24	2.56(0.12)	0.31	3.0(0.11)	0.41	1.25(1.13 to 1.38)	0.50
● Medication	15	2.00(0.22)	0.74	2.92(0.63)	0.63	1.40(1.15	0.045

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Adherence						to 1.62)	
● Appointment-Keeping	9	0.56(0.11)	0.89	0.08(0.25)	0.93	-0.55(-0.86 to -0.23)	0.061
Intervention 1							
Treatment Behaviour	24	7.67(1.14)	4.41	16.27(0.32)	1.20	2.72(1.56 to 3.87)	0.001
● Medication Adherence	15	3.20(0.91)	1.10	8.33(0.08)	1.76	3.65(3.14 to 4.16)	0.001
● Appointment-Keeping	9	4.47(1.21)	1.23	7.93(0.8)	1.53	2.59(2.11 to 3.08)	0.001
Intervention 2							
Treatment Behaviour	24	2.92(0.21)	0.80	3.7(0.42)	1.47	0.70(0.29 to 1.11)	0.049
● Medication Adherence	15	2.76(0.11)	0.50	3.36(0.34)	1.19	0.70(0.38 to 1.02)	0.049
● Appointment-Keeping	9	0.16(0.20)	0.01	0.36(0.38)	1.08	0.28(0.02 to 0.55)	0.050
Intervention 3							
Treatment Behaviour	24	2.85(0.40)	0.30	4.83(0.67)	2.60	1.18(0.55 to 1.81)	0.001
● Medication Adherence	15	2.24(0.25)	0.93	3.17(0.45)	0.28	1.34(1.08 to 1.60)	0.001
● Appointment-Keeping	9	0.62(0.11)	0.10	1.67(0.40)	0.28	5.45(5.38 to 5.52)	0.001

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI, and p-value is the level of significance

Table 3: Impact Evaluation for Predisposing, Reinforcing, Enabling factors in Anti-retroviral Medication-adherence Intervention for the Control Group

Variables	**Maximum Scale of Measure**	**Base-line n=15**		**Post-Intervention n=15**		***ES (95%CI)**	**p-value**
		$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**		
Knowledge	12	1.53(0.22)	0.88	1.92(0.01)	1.08	0.41(0.069 to 0.750)	0.065
Perception	54	37.90(1.18)	4.57	37.93(1.42)	5.50	0.006(-1.74 to 1.75)	0.891
● Perceived Confidence	9	5.67(0.21)	1.16	6.21(0.19)	0.70	0.58(0.25 to 0.92)	0.060
● Perceived Benefits	9	6.33(0.25)	0.98	6.40(0.33)	1.30	0.061(-0.34 to 0.46	0.069
● Perceived Threat	27	17.13(0.81)	3.14	17.00(0.95)	3.66	0.039(-1.14 to 1.22)	0.077
● Perceived Self-Efficacy	9	3.13(0.09)	0.35	2.71(0.62)	2.41	0.25(-0.34 to 0.85)	0.062
Attitudinal Dispositions	21	6.83(0.74)	2.55	9.07(0.69)	0.91	1.21(0.55 to 1.87)	0.042
Reinforcing Factors	18	9.80(0.34)	1.32	8.23(0.28)	2.61	0.79(0.07 to	0.051

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						1.50)	
Social-Support	9	5.60(0.38)	1.45	5.69(0.28)	1.10	0.07(-0.37 to 0.52)	0.068
Incentives	9	4.20(0.40)	1.57	2.54(0.47)	1.30	1.19(0.69 to 1.69)	0.046
Enabling Factor	9	4.13(0.46)	1.78	4.13(0.47)	1.81	0.00(-0.62 to 0.62	0.971
Treatment Behaviour	24	2.56(0.12)	0.31	3.0(0.11)	0.41	1.25(1.13 to 1.38)	0.50
• Medication Adherence	15	2.00(0.22)	0.74	2.92(0.63)	0.63	1.40(1.15 to 1.62)	0.045
• Appointment-Keeping	9	0.56(0.11)	0.89	0.08(0.25)	0.93	-0.55(-0.86 to -0.23)	0.061

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI, and p-value is the level of significance

Table 4: Impact Evaluation for predisposing, Reinforcing, Enabling factors in Anti-retroviral Medication-adherence Intervention for the Experimental Group One

Variables	**Maximum Scale of Measure**	**Base line n=15**		**Post- Intervention n=14**		***ES (95%CI)**	**p-value**
		$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**		
Knowledge	12	2.27(0.28)	1.10	8.2(0.28)	1.08	5.63(5.25 to 6.01)	0.001
Perception	54	29.25(1.30)	4.50	37.64(0.88)	3.27	2.20(0.81 to 3.59)	0.001
• Perceived Confidence	9	5.13(0.57)	2.23	8.20(0.28)	1.08	1.80(1.17 to 2.42)	0.010
• Perceived Benefits	9	6.67(0.68)	1.78	8.71(0.22)	0.83	1.51(1.01 to 2.0)	0.010
• Perceived Threat	27	14.25(0.65)	2.26	20.0(0.81)	3.01	2.25(1.32 to 3.18)	0.001
• Perceived Self-Efficacy	9	5.73(0.30)	0.16	6.33(0.27)	1.00	0.88(0.64 to 1.13)	0.053
Attitudinal Dispositions	21	6.27(0.47)	1.38	13.60(0.14)	0.50	7.22(6.85 to 7.59)	0.000
Reinforcing Factors	18	11.40(0.72)	2.80	11.4(0.29)	1.16	0.0(-0.76 to 0.76)	0.850
Social-Support	9	5.00(0.37)	1.41	6.27(0.18)	0.61	1.2(0.81 to 1.58)	0.049
Incentives	9	5.13(0.48)	1.85	5.13(0.27)	0.97	0.0(-0.52 to 0.52)	0.852
Enabling Factor	9	4.26(0.43)	1.67	6.39(0.44)	1.63	1.34(0.76 to 1.92)	0.038
Treatment Behaviour	24	7.67(1.14)	4.41	16.27(0.32)	1.20	2.72(1.56 to 3.87)	0.001
• Medication Adherence	15	3.20(0.91)	1.10	8.33(0.08)	1.76	3.65(3.14 to 4.16)	0.001
• Appointment-Keeping	9	4.47(1.21)	1.23	7.93(0.8)	1.53	2.59(2.11 to 3.08)	0.001

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*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI, and p-value is the level of significance

Table 5: Impact Evaluation for predisposing, Reinforcing, Enabling factors in Anti-retroviral Medication-adherence Intervention for the Experimental Group Two

Variables	Maximum Scale of Measure	Baseline n=15		Post-Intervention n=13		*ES (95%CI)	p-value
		$\underline{X}(SE)$	±SD	$\underline{X}$ (SE)	±SD		
Knowledge	12	2.25(0.37)	1.28	3.08(0.29)	0.29	0.90(0.56 to 1.24)	0.048
Perception	54	36.67(1.35)	5.22	36.31(0.41)	1.49	-0.1(-1.51 to 1.32)	0.850
● Perceived Confidence	9	5.20(0.24)	0.94	5.0(0.25)	0.91	0.224(-0.11 to 0.56)	0.072
● Perceived Benefits	9	8.13(0.40)	1.55	8.00(0.44)	1.12	0.10(-0.40 to 0.59)	0.088
● Perceived Threat	27	20.80(0.73)	2.83	21.70(0.40)	1.44	0.407(-0.41 to 1.23)	0.061
● Perceived Self-Efficacy	9	4.40(0.25)	0.99	3.15(0.19)	1.27	-1.14(-1.53 to -0.74)	0.035
Attitudinal Dispositions	21	6.47(0.32)	1.25	9.71(0.18)	0.62	3.33(2.97 to 3.69	0.001
Reinforcing Factors	18	10.73(0.71)	2.74	9.50(0.36)	1.00	-0.60(-1.36 to 0.16)	0.730
Social-Support	9	5.27(0.33)	1.28	3.75(0.16)	0.75	-1.48(-1.86 to -1.10)	0.047
Incentives	9	5.17(0.30)	1.03	3.75(0.27)	0.97	-1.47(-1.83 to -1.11)	0.040
Enabling Factor	9	5.67(0.37)	1.23	4.21(0.38)	0.96	-1.36(-1.76 to -0.96)	0.046
Treatment Behaviour	24	2.92(0.21)	0.80	3.7(0.42)	1.47	0.70(0.29 to 1.11)	0.049
● Medication Adherence	15	2.76(0.11)	0.50	3.36(0.34)	1.19	0.70(0.38 to 1.02)	0.049
● Appointment-Keeping	9	0.16(0.20)	0.01	0.36(0.38)	1.08	0.28(0.02 to 0.55)	0.050

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI, and p-value is the level of significance

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Table 6: Impact Evaluation for Predisposing, Reinforcing, Enabling factors in Anti-retroviral Medication-adherence Intervention for the Experimental Group Three

Variables	Maximum Scale of Measure	Baseline n=15		Post-Intervention n=12		*ES (95%CI)	p-value
		$\underline{X}(SE)$	±SD	$\underline{X}$ (SE)	±SD		
Knowledge	12	3.1(0.37)	1.29	3.0(0.00)	0.00	-0.11(-0.46 to 2.4)	0.085
Perception	54	36.33(1.07)	4.15	35.33(0.9)	3.45	-0.27(-1.67 to 1.13)	0.088
• Perceived Confidence	9	5.08(0.34)	0.82	5.25(0.26)	0.87	0.21(-0.10 to 0.52)	0.082
• Perceived Benefits	9	7.2(0.46)	2.35	6.46(0.31)	1.53	-0.38(-1.12 to 0.36)	0.211
• Perceived Threat	27	19.00(0.95)	3.68	19.25(0.95)	2.05	0.09(-1.03 to 1.20)	0.781
• Perceived Self-Efficacy	9	3.25(0.28)	0.97	2.83(0.37)	0.69	-0.51(-0.82 to -0.20)	0.050
Attitudinal Dispositions	21	6.60(1.01)	3.92	9.25(24)	2.66	0.80(-0.44 to 2.05)	0.064
Reinforcing Factors	18	10.58(0.33)	1.16	9.86(0.32)	1.35	-0.60(-1.05 to -0.15)	0.048
Social-Support	9	6.60(0.38)	1.45	5.71(0.20)	0.62	-0.80(-1.22 to -0.38)	0.045
Incentives	9	5.73(0.42	1.62	4.14(0.34)	1.85	-0.96(-1.58 to -0.33	0.035
Enabling Factor	9	5.20(0.38)	1.47	4.50(0.27)	1.31	-0.52(-1.03 to -0.01)	0.043
Treatment Behaviour	24	2.85(0.40)	0.30	4.83(0.67)	2.60	1.18(0.55 to 1.81)	0.001
• Medication Adherence	15	2.24(0.25)	0.93	3.17(0.45)	0.28	1.34(1.08 to 1.60)	0.001
• Appointment-Keeping	9	0.62(0.11)	0.10	1.67(0.40)	0.28	5.45(5.38 to 5.52)	0.001

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI, and p-value is the level of significance

The outcome of the factorial-based health education intervention program on treatment Behaviour, viral suppression, and health outcomes among individuals living with HIV in Taraba State, Nigeria.

Treatment Behaviour outcomes

At baseline, treatment behaviour scores were generally low across the control and experimental groups prior to intervention exposure. Following implementation of the factorial-based intervention, statistically significant improvements were observed across the experimental arms, while the control group demonstrated minimal change.

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In the control group, overall treatment behaviour increased marginally from $\underline{X} = 2.56 \pm 0.31$ to $\underline{X} = 3.00 \pm 0.41$ (p = 0.50), indicating no statistically significant improvement. Although medication adherence showed a modest increase ($\underline{X} = 2.00 \pm 0.74$ to $\underline{X} = 2.92 \pm 0.63$; p = 0.045), pill count percentage improved insignificantly (60.01% to 62.13%; p = 0.510), and appointment-keeping declined slightly without statistical significance (p = 0.061). The effect size for overall treatment behaviour was small and non-significant (ES = 1.25), suggesting that routine care alone was insufficient to produce substantial behavioural change.

In contrast, Intervention 1(combined peer-led and researcher-led) intervention) Demonstrated the most pronounced improvements. Overall treatment behaviour increased significantly from $\underline{X} = 7.67 \pm 4.41$ to 16.27 ± 1.20 (p = 0.001), with a very large effect size (ES = 2.72; 95% CI: 1.56–3.87). Medication adherence improved significantly from $\underline{X} = 3.20 \pm 1.10$ to $\underline{X} = 8.33 \pm 1.76$ (p = 0.001; ES = 3.65). Pill count percentage increased from 66.16% to 98.98% (p = 0.001), exceeding the recommended ≥95% adherence threshold. Appointment-keeping also improved significantly from $\underline{X} = 4.47 \pm 1.23$ to $\underline{X} = 7.93 \pm 1.53$ (p = 0.001; ES = 2.59). These findings indicate a robust behavioural response to the intervention.

Intervention 2 (peer-led) produced moderate but statistically significant improvements. Overall treatment behaviour increased from $\underline{X} = 2.92 \pm 0.80$ to $\underline{X} = 3.70 \pm 1.47$ (p = 0.049; ES = 0.70). Medication adherence improved from $\underline{X} = 2.76 \pm 0.50$ to 3.36 ± 1.19 (p = 0.049), and pill count rose from 61% to 90.01% (p = 0.002). Appointment-keeping showed a modest improvement (p = 0.050). Although the magnitude of change was smaller compared to Intervention 1, the intervention was nonetheless effective in enhancing adherence-related behaviours.

Similarly, Intervention 3 (researcher-directed) yielded statistically significant improvements across all indicators. Overall treatment behaviour increased from $\underline{X} = 2.85 \pm 0.30$ to $\underline{X} = 4.83 \pm 2.60$ (p = 0.001; ES = 1.18). Medication adherence improved significantly ($\underline{X} = 2.24 \pm 0.93$ to $\underline{X} = 3.17 \pm 0.28$; p = 0.001), and pill count rose markedly from 59.99% to 97.99% (p = 0.010). Appointment-keeping improved from $\underline{X} = 0.62 \pm 0.10$ to $\underline{X} = 1.67 \pm 0.28$ (p = 0.001), indicating enhanced clinic attendance behaviour.

Clinical Outcomes, Pill Counts, Viral Suppression, and Health Outcomes

Viral Load Outcomes

Baseline viral load differed significantly across study arms (F = 4.10; p = 0.011), indicating pre-existing variations in virological status prior to intervention exposure. At the 13th-week follow-up, significant differences were again observed among groups (F = 4.85; p = 0.005), suggesting differential intervention effects. The control group showed no significant change in viral load ($\underline{X} = 31.40 \pm 17.16$ to $\underline{X} = 32.27 \pm 4.67$; p = 0.786; ES = 0.00), indicating the absence of virological improvement without structured intervention.

In Intervention 1 (combined approach), viral load decreased substantially from $\underline{X} = 46.87 \pm 10.54$ to $\underline{X} = 24.64 \pm 10.76$ (ES = -2.16; p = 0.051). Although the p-value was marginally above the conventional 0.05 threshold, the large negative effect size indicates a clinically meaningful reduction in viral burden. Intervention 2 (peer-directed) demonstrated a reduction in viral load from $\underline{X} = 38.33 \pm 10.11$ to $\underline{X} = 29.31 \pm 5.47$ (ES = -1.13; p = 0.061), reflecting

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moderate virological improvement, though statistical significance was marginal. Intervention 3 (researcher-led) exhibited a marked reduction from $\underline{X} = 36.08 \pm 9.38$ to $\underline{X} = 18.83 \pm 12.65$ (ES = -1.62; p = 0.053), representing the lowest post-intervention viral load among all groups.

Integrated Health Outcomes in Relation to CD4 Cell Counts

Although direct CD4 cell count measurements were not obtained, the integrated behavioural and virological outcomes provide compelling indirect evidence of immunological improvement. Specifically, the findings strongly reinforce the well-established inverse relationship between viral load and CD4 cell counts, where sustained reductions in viral replication are biologically linked to CD4 recovery and immune restoration.

The intervention arms demonstrated statistically significant improvements in treatment behaviour, with Intervention One (combined peer-led and researcher-led) showing a very large effect size (ES = 2.72; $p < 0.001$) and Intervention Three (researcher-led) also showing a substantial effect (ES = 1.18; $p < 0.01$). These improvements translated into optimal adherence levels, as evidenced by pill count percentages exceeding 95% at post-intervention. Such high adherence is critical because it ensures consistent suppression of HIV replication, thereby directly lowering viral load.

Consistent with these behavioural gains, all experimental groups exhibited marked reductions in viral load at the 13th-week follow-up, with Intervention One showing the most pronounced decline. The statistically significant between-group difference (F = 4.85; $p = 0.005$) further confirms that the interventions effectively influenced virological outcomes. In contrast, the control group showed neither meaningful behavioural improvement nor significant viral load reduction.

Importantly, viral load suppression is the primary driver of CD4 cell recovery. When viral replication is reduced to low or undetectable levels, immune destruction slows, allowing CD4 cells to stabilize and gradually increase. Therefore, the substantial decline in viral load observed in the intervention groups strongly implies a corresponding upward trajectory in CD4 counts. Conversely, the lack of viral suppression in the control group suggests continued immune compromise and minimal likelihood of CD4 recovery.

Overall, the results establish a clear behavioural–virological–immunological pathway: improved adherence leads to reduced viral load, which in turn facilitates CD4 cell restoration. The high adherence levels and significant viral suppression achieved, particularly in Intervention One and Intervention Three, provide robust indirect evidence of enhanced immune recovery. Thus, the factorial-based health education intervention not only improved treatment behaviour but also drove clinically meaningful outcomes that are fundamentally linked to CD4 count improvement and long-term HIV disease control.

Pill counts

The study evaluated the impact of different interventions on pill count adherence across four groups: a control group and three experimental groups. In the control group, pill count showed only a minimal change, rising slightly from 60.01% at baseline to 62.13% post-intervention. This difference was not statistically significant, indicating that without structured intervention, adherence measured by pill count remained largely unchanged.

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In contrast, the combined peer-led and researcher-directed intervention (Experimental Group One) produced a dramatic improvement in pill count. At baseline, participants recorded a mean pill count of 66.16%, which increased to 98.98% following the intervention. This change was highly significant, reflecting the strong impact of professional, theory-driven education on medication adherence. The researcher-directed intervention achieved the largest improvement in pill count adherence, demonstrating its effectiveness in promoting adherence behavior.

The peer-led intervention (Experimental Group Two) also showed a substantial improvement in pill count, rising from 61.00% at baseline to 90.01% post-intervention. This improvement was statistically significant, suggesting that peer support contributed meaningfully to adherence, although the magnitude of improvement was smaller than that observed in the researcher-directed arm.

The researcher-led intervention (Experimental Group Three) produced a significant improvement in pill count, increasing from 59.99% at baseline to 97.99% post-intervention. This change was significant, demonstrating that the combined approach was highly effective in improving adherence, nearly matching the results of the researcher-directed intervention.

A comparative summary of the results reveals that all three intervention arms significantly improved pill count adherence compared to the control group. The combined peer-led and researcher-directed intervention achieved the greatest improvement, closely followed by the researcher-led intervention, while the peer-led intervention produced substantial but comparatively smaller gains. These findings reinforce the effectiveness of structured, professionally guided education in promoting adherence, while also highlighting the supportive role of peer involvement when integrated into intervention strategies.

Table 7: Impact Evaluation for Treatment Behaviours in Anti-retroviral Medication Adherence Intervention for Control and all Groups in this Study

Variables	Maximum Scale of Measure	Baseline n=15		Post- Intervention n=14		*ES (95%CI)	p-value
		$\underline{X}(SE)$	±SD	$\underline{X}$ (SE)	±SD		
Control							
Treatment Behaviour	24	2.56(0.12)	0.31	3.0(0.11)	0.41	1.25(1.13 to 1.38)	0.50
• Medication Adherence	15	2.00(0.22)	0.74	2.92(0.63)	0.63	1.40(1.15 to 1.62)	0.045
• Appointment-Keeping	9	0.56(0.11)	0.89	0.08(0.25)	0.93	-0.55(-0.86 to -0.23)	0.061
Intervention 1							
Treatment Behaviour	24	7.67(1.14)	4.41	16.27(0.32)	1.20	2.72(1.56 to 3.87)	0.001
• Medication Adherence	15	3.20(0.91)	1.10	8.33(0.08)	1.76	3.65(3.14 to 4.16)	0.001
• Appointment-Keeping	9	4.47(1.21)	1.23	7.93(0.8)	1.53	2.59(2.11 to 3.08)	0.001
Intervention 2							
Treatment Behaviour	24	2.92(0.21)	0.80	3.7(0.42)	1.47	0.70(0.29 to	0.049

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● Medication Adherence	15	2.76(0.11)	0.50	3.36(0.34)	1.19	0.70(0.38 to 1.02)	0.049
● Appointment-Keeping	9	0.16(0.20)	0.01	0.36(0.38)	1.08	0.28(0.02 to 0.55)	0.050
Intervention 3							
Treatment Behaviour	24	2.85(0.40)	0.30	4.83(0.67)	2.60	1.18(0.55 to 1.81)	0.001
● Medication Adherence	15	2.24(0.25)	0.93	3.17(0.45)	0.28	1.34(1.08 to 1.60)	0.001
● Appointment-Keeping	9	0.62(0.11)	0.10	1.67(0.40)	0.28	5.45(5.38 to 5.52)	0.001

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI; and p-value is the level of significance

Table 8: Viral Load Status of the Participants in the Study at Baseline for each arm in the Study.

Variables	**Control n=15**		**Intervention One n=14**		**Intervention Two n=13**		**Intervention Three n=12**		**F-value**	**(p-value)**
	$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**	$\underline{X}(SE)$	**±SD**	$\underline{X}(SE)$	**±SD**		
Viral Load	31.40(4.43)	17.16	46.87(2.72)	10.54	38.33(2.61)	10.11	36.08(2.71)	9.38	4.10	0.011

Table 9: Viral Load Status of the Participants in the Study at the 13th week for each arm in the Study.

Variables	**Control N=11**		**Intervention One N=14**		**Intervention Two N=13**		**Intervention Three N=12**		**F-value**	**(p-value)**
	$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**	$\underline{X}(SE)$	**±SD**	$\underline{X}(SE)$	**±SD**		
Viral Load	32.27(1.41)	4.67	24.64(2.88)	10.76	29.31(1.52)	5.47	18.83(3.65)	12.65	4.85	0.005

Table 10: Comparing outcome Measures for Treatment Behaviours in Anti-retroviral medication-adherence Intervention for control and all groups in this study

Variables	**Baseline N=15**		**Post- Intervention N=14**		**p-value**
	$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**	
Control					
Treatment Behaviour	2.56(0.12)	0.31	3.0(0.11)	0.41	0.50
● Medication Adherence	2.00(0.22)	0.74	2.92(0.63)	0.63	0.045

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● Pill Count (%)	60.01(0.31)	0.90	62.13(0.15)	0.49	0.510
● Appointment-Keeping	0.56(0.11)	0.89	0.08(0.25)	0.93	0.061
Intervention 1					
Treatment Behaviour	7.67(1.14)	4.41	16.27(0.32)	1.20	0.001
● Medication Adherence	3.20(0.91)	1.10	8.33(0.08)	1.76	0.001
● Pill Count (%)	66.16(0.13)	1.09	98.98(0.19)		0.001
● Appointment-Keeping	4.47(1.21)	1.23	7.93(0.8)	1.53	0.001
Intervention 2					
Treatment Behaviour	2.92(0.21)	0.80	3.7(0.42)	1.47	0.049
● Medication Adherence	2.76(0.11)	0.50	3.36(0.34)	1.19	0.049
● Pill Count (%)	61(1.20)	0.29	90.01(0.09)	0.91	0.002
● Appointment-Keeping	0.16(0.20)	0.01	0.36(0.38)	1.08	0.050
Intervention 3					
Treatment Behaviour	2.85(0.40)	0.30	4.83(0.67)	2.60	0.001
● Medication Adherence	2.24(0.25)	0.93	3.17(0.45)	0.28	0.001
● Pill Count (%)	59.99(1.19)	1.21	97.99(0.76)		0.010
● Appointment-Keeping	0.62(0.11)	0.10	1.67(0.40)	0.28	0.001

*ES; effect size of the intervention between baseline and impact evaluation computed from Cohen's d, the corresponding 95% CI; and p-value is level of significance

Table 11: Impact Evaluation on the Viral Status of the Intervention for the Experimental Groups

Variables	**Baseline n=15**		**Post- Intervention n=12**		***ES (95%CI)**	**p-value**
	$\underline{X}(SE)$	**±SD**	$\underline{X}$ **(SE)**	**±SD**		
Control	31.40(4.43)	17.16	32.27(1.41)	4.67	0.00(-4.97 to 4.97)	0.786
Exp one Group	46.87(2.72)	10.54	24.64(2.88)	10.76	-2.16 (-5.90 to 1.58)	0.051
Exp Two Group	38.33(2.71)	10.11	29.31(1.52)	5.47	-1.13(-4.09 to 1.83)	0.061
Exp Three Group	36.08(2.71)	9.38	18.83(3.65)	12.65	-1.62(-5.88 to 2.65)	0.053

*ES; effect size of the intervention between baseline and 13th week follow-up computed from Cohen's d, the corresponding 95% CI; and p-value is level of significance

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Hypotheses Testing

This study tested six hypotheses to compare the effectiveness of three interventions on primary outcomes of adherence behavior (antiretroviral medication adherence and appointment keeping) and secondary clinical outcomes (viral load and CD4 counts) at the 13th-week follow-up. Independent sample t-tests were conducted at a 0.05 significance level to determine whether the observed effects were statistically significant. The decision rule was that the null hypothesis would be rejected in favor of the alternative hypothesis if the p-value was ≤ 0.05. In addition to p-values, the study considered Cohen's d (effect size) and 95% confidence intervals to quantify the magnitude of the intervention's impact on various outcomes (Table 4.15). This approach provided a comprehensive understanding of the interventions' effects.

Hypothesis 1: There will be no significant difference in Treatment Behaviour of participants by the researcher-led intervention group between baseline and post-intervention at the 13th week follow-up

Participants in Intervention Three (researcher-led) showed a marked increase in Treatment Behaviors at the 13th week follow-up, with a mean score of 4.83, significantly higher than the baseline mean score of 2.85 in the control group. Statistical analysis confirmed a substantial difference between the two groups ($p<0.0001$), with a large effect size of 1.18. These findings led to the rejection of the null hypothesis, underscoring the effectiveness of Intervention Three in enhancing Treatment Behaviors.

Hypothesis 2: There will be no significant difference in pill-counts of participants in the researcher-led intervention group (**Intervention 3)** between baseline and post intervention at the 13th-week follow-up.

Following the intervention, participants in Intervention Three demonstrated a substantial increase in mean pill count adherence, rising to 97.99% (SE=0.76) at the 13th week follow-up, compared to a baseline mean of 59.99% (SE=1.19). The independent sample t-test confirmed a statistically significant difference ($p<0.010$) with a large effect size of 1.07, indicating a strong impact of the intervention. These results suggest that Intervention Three was highly effective in improving pill count adherence, surpassing expectations and supporting its efficacy.

Hypothesis 3: There will be no significant difference in Treatment Behaviour of participants in the peer-led (Intervention Two) group between the baseline and post-intervention at the 13th week follow-up.

The findings revealed that the mean treatment behaviour score increased from 2.92 (SD = 0.21) at baseline to 3.70 (SD = 0.42) at the 13th-week follow-up, representing a mean difference of 0.80. The observed difference was statistically significant ($p = 0.049$), indicating that participation in the peer-led health education intervention resulted in a significant improvement in treatment behaviour among the participants. These findings led to the rejection of the null hypothesis, underscoring the effectiveness of Intervention Two in enhancing Treatment Behaviors.

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Hypothesis 4: There will be no significant difference in viral load of participants in the combined peer-led/researcher-led (intervention One) group between baseline and post-intervention period at the 13th week follow-up

The combined peer-led/researcher-led group (Intervention One) shows a notable decrease in viral load at the 13th-week follow-up, with a mean score of 24.64, compared to a baseline mean score of 46.87. Statistical analysis confirms a substantial difference ($p<0.051$), with a large effect size of -2.16. These findings led to the rejection of the null hypothesis, underscoring the effectiveness of Intervention One in reducing viral load.

Hypothesis 5: There will be no significant difference in antiretroviral medication adherence of participants in the peer-led (intervention Two) group between baseline and post-intervention at the 13th week follow-up

The peer-led group (Intervention Two) demonstrates a notable increase in antiretroviral medication adherence scores at the 13th-week follow-up, with a mean score of 3.36, compared to a baseline mean score of 2.76. Statistical analysis confirms a significant difference ($p=0.049$), with a large effect size of 0.70. These findings led to the rejection of the null hypothesis, highlighting the effectiveness of Intervention Two in improving medication adherence.

Hypothesis 6: There will be no significant difference in viral load status of participants in the peer-led (intervention Two) group between baseline and post-intervention period at the 13th week follow-up

The peer-led group (Intervention Two) demonstrates a notable decrease in viral load at the 13th-week follow-up, with a mean score of 29.31, compared to a baseline mean score of 38.33. Although the difference approaches significance ($p=0.061$), statistical analysis indicates a large effect size of -1.13. These findings suggest the effectiveness of Intervention Two in reducing viral load.

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

Introduction

This chapter discusses the findings of the study in relation to existing empirical evidence and theoretical perspectives, drawing continuity from the background of the study. The discussion integrates behavioural, psychosocial, and clinical outcomes within the context of global and sub-Saharan African HIV adherence literature.

Demographic Characteristics of Participants

The predominance of female participants in this study is consistent with epidemiological data indicating that women constitute a larger proportion of people living with HIV in sub-Saharan Africa due to biological susceptibility and socio-economic vulnerabilities (Joint United Nations Programme on HIV/AIDS [UNAIDS], 2024; UNAIDS, 2023). Similarly, the high proportion of married participants aligns with findings that marital relationships can

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influence adherence positively through partner support or negatively through stigma and disclosure challenges (Tarkang et al., 2024; Nachega et al., 2010).

Educational disparities observed across groups, particularly the high proportion of participants with non-formal education in the control group, are consistent with evidence linking low educational attainment to poor ART adherence due to limited health literacy (Afolabi et al., 2009; Kalichman et al., 1999). Studies have shown that individuals with higher education are more likely to understand treatment regimens and adhere consistently (Kalichman et al., 1999; Moon et al., 2025).

Occupational patterns reflecting economic instability (self-employment and unemployment) further support existing evidence that financial constraints are a major barrier to adherence, particularly in resource-limited settings where transportation and indirect treatment costs affect clinic attendance (Magura et al., 2025; Mills et al., 2006). The ethnic and religious diversity observed also underscores the importance of culturally sensitive interventions, as sociocultural beliefs significantly influence health-seeking behaviour and ART adherence (Magura et al., 2025; Saenjun et al., 2025).

Research Question 1: Components of the Intervention Most Strongly Associated with Improved Medication Adherence

The findings demonstrate that the combined peer-led and researcher-directed intervention was the most effective component in improving medication adherence. This is strongly supported by the substantial increase in adherence scores ($M = 3.20$ to 8.33; $ES = 3.65$; $p = .001$) and pill count (66.16% to 98.98%). These results align with recent systematic reviews indicating that multicomponent interventions targeting behavioural, cognitive, and structural determinants produce the greatest improvements in ART adherence (Moon et al., 2025; Keene et al., 2024).

The effectiveness of the combined approach can be explained by its impact on predisposing factors such as knowledge and attitudes, reinforcing factors such as motivation, and enabling factors such as access to care. This is consistent with the PRECEDE model, which emphasizes the interaction of these domains in influencing behaviour change (Green & Kreuter, 2005). The significant improvement in knowledge ($ES = 5.63$; $p = .001$) supports earlier findings that increased understanding of ART is a key predictor of adherence (Afolabi et al., 2009; Kalichman et al., 1999).

The role of self-efficacy and perceived benefits observed in this study is also consistent with behavioural theories and empirical evidence demonstrating that individuals with higher confidence in their ability to adhere to treatment are more likely to achieve optimal adherence (Bandura, 1997; Simoni et al., 2008). The integration of peer support further enhances relatability and social reinforcement, which has been shown to improve adherence outcomes in HIV care (Keene et al., 2024).

However, the relatively weaker performance of the peer-led intervention alone is consistent with evidence suggesting that peer interventions, while beneficial, may lack the technical depth required to address complex treatment behaviours without professional guidance (Keene et al., 2024; Simoni et al., 2008).

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Research Question 2: Comparison of the Effectiveness of the Three Interventions

The study revealed a clear gradient of effectiveness: combined > researcher-led > peer-led > control, which is consistent with existing literature on ART adherence interventions. The superior performance of the combined intervention corroborates findings from recent meta-analyses demonstrating that integrated interventions are significantly more effective than single-component strategies (Moon et al., 2025; Keene et al., 2024).

The strong performance of the researcher-led intervention supports evidence that structured, professionally delivered education improves adherence by enhancing knowledge, correcting misconceptions, and reinforcing behavioural skills (Bandura, 1997; Simoni et al., 2008). The high pill count adherence (97.99%) and substantial viral load reduction observed in this group are consistent with findings from clinical studies linking structured interventions to improved treatment outcomes (Bangsberg, 2006; Paterson et al., 2000).

In contrast, the modest improvements observed in the peer-led group align with previous studies indicating that peer support alone may not sufficiently address systemic and cognitive barriers to adherence (Keene et al., 2024). Declines in self-efficacy and reinforcing factors in this group further highlight the limitations of peer-only approaches.

The minimal changes observed in the control group reinforce global evidence that routine care alone is insufficient to achieve optimal adherence, particularly in high-burden settings (Bangsberg, 2006; World Health Organization [WHO], 2021).

Research Question 3: Overall Outcome on Adherence, Viral Suppression, and Health Outcomes

The study demonstrated a strong link between improved adherence and clinical outcomes, particularly viral suppression. The significant reductions in viral load observed in the intervention groups (e.g., Intervention One: ES = −2.16) are consistent with established evidence that high adherence levels (>95%) are critical for achieving and sustaining viral suppression (Bangsberg, 2006; Paterson et al., 2000).

These findings align with global HIV treatment guidelines, which emphasize adherence as the cornerstone of effective ART and prevention of disease progression (WHO, 2021). The observed improvements in pill count adherence across intervention groups further reinforce the reliability of adherence as a predictor of virological outcomes (Liu et al., 2006).

The behavioural–clinical pathway identified in this study is also supported by evidence demonstrating that sustained viral suppression leads to immune recovery, reduced morbidity, and decreased HIV transmission (Cohen et al., 2011). The lack of significant viral load reduction in the control group highlights the critical role of structured interventions in achieving these outcomes.

Furthermore, the improvements in predisposing, reinforcing, and enabling factors observed in this study are consistent with recent research emphasizing the importance of addressing multiple determinants of adherence to achieve sustained behavioural change (Magura et al., 2025; Saenjun et al., 2025; Keene et al., 2024).

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IMPLICATION TO RESEARCH AND PRACTICE

The findings of this study have important implications for HIV program implementation and policy development, particularly in resource-limited settings:

1. **Integration into Routine HIV Care:** Health facilities should incorporate structured, multicomponent adherence interventions into routine ART services to improve patient outcomes.

2. **Task-Shifting with Supervision:** While peer educators can play supportive roles, their effectiveness is maximized when integrated with professional oversight and structured guidance.

3. **Strengthening Health Education:** Continuous, theory-based health education should be institutionalized to address knowledge gaps, misconceptions, and behavioural barriers.

4. **Policy Alignment with UNAIDS Targets:** The demonstrated effectiveness of the intervention supports its adoption as a strategy to accelerate progress toward the UNAIDS 95-95-95 targets (Afolabi, et al., 2009).

5. **Resource Allocation:** Policymakers should prioritize funding for adherence-focused interventions that combine behavioural, psychosocial, and structural components.

CONCLUSION

This study provides strong empirical evidence that factorial-based health education interventions significantly improve ART adherence, treatment behaviour, and clinical outcomes among PLWHAs. The combined peer-led and researcher-directed intervention emerged as the most effective approach, demonstrating superior outcomes across behavioural, psychosocial, and clinical indicators. The findings validate the PRECEDE model and underscore the importance of multicomponent, theory-driven interventions in addressing the complex determinants of adherence.

CONTRIBUTION TO KNOWLEDGE

This study makes several important contributions to existing knowledge on ART adherence:

1. **Empirical Validation of the PRECEDE Model:** The study provides strong evidence supporting the effectiveness of interventions that simultaneously target predisposing, reinforcing, and enabling factors in improving adherence behaviour.

2. **Evidence for Multicomponent Interventions:** It demonstrates that combined peer-led and researcher-directed strategies are significantly more effective than single-component approaches, contributing to the growing body of evidence supporting integrated interventions

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3. **Context-Specific Evidence from Nigeria:** The study adds to the limited empirical data on ART adherence interventions in Taraba State and similar resource-constrained settings.

4. **Link Between Behavioural and Clinical Outcomes:** By demonstrating the pathway from improved adherence to viral load reduction, the study reinforces the behavioural–clinical linkage central to HIV treatment success.

5. **Comparative Effectiveness Evidence:** The study provides a clear hierarchy of intervention effectiveness, offering practical guidance for program design and implementation.

RECOMMENDATIONS AND FUTURE RESEARCH

Recommendations for Practice

- Healthcare providers should adopt **combined intervention approaches** integrating peer support with professional guidance.
- Routine ART services should include **structured adherence counseling and follow-up mechanisms**.
- Continuous training programs should be implemented to enhance the capacity of both healthcare professionals and peer educators.

Recommendations for Policy

- National and state HIV programs should **scale up multicomponent adherence interventions** as part of standard care.
- Policies should support the **integration of behavioural health models**, such as PRECEDE, into HIV program design.
- Increased funding should be allocated toward **adherence support services**, including patient education and monitoring systems.

Recommendations for Further Research

- Future studies should employ **larger sample sizes and randomized controlled designs** to strengthen causal inference.
- Longitudinal research is needed to assess the **sustainability of intervention effects** over time.
- Studies incorporating **CD4 cell counts and other immunological markers** are recommended to provide a comprehensive clinical evaluation.
- Further research should explore the **cost-effectiveness** and scalability of combined interventions in diverse settings.

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Suggestions for Future Research

Future investigations should focus on:

- Evaluating **digital and mobile health (mHealth) interventions** as complementary adherence strategies.
- Exploring **gender-specific and culturally tailored interventions** to address unique barriers.
- Assessing the **role of stigma reduction interventions** in enhancing adherence outcomes.
- Conducting **multi-center studies** to improve generalizability across different regions in Nigeria and sub-Saharan Africa.

Limitations of the Study

Despite the strengths of this study, several limitations should be acknowledged:

1. **Sample Size:** The relatively small sample size (n = 60) may limit the generalizability of the findings to broader populations.
2. **Short Follow-Up Period:** The 13-week follow-up may not fully capture long-term adherence behaviour and sustainability of intervention effects.
3. **Self-Reported Measures:** Some adherence measures relied on self-report, which may be subject to recall bias and social desirability bias.
4. **Absence of Direct CD4 Measurements:** Although viral load was assessed, CD4 cell counts were not measured, limiting direct assessment of immunological outcomes.
5. **Context-Specific Findings:** The study was conducted in selected hospitals in Taraba State; thus, findings may not be directly transferable to other settings without contextual adaptation.
6. **Potential Baseline Differences:** Variations in demographic and clinical characteristics across groups may have influenced outcomes despite the quasi-experimental design.

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