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Original Article

Body Mass Index Trends in Children and Adolescents on Antiretroviral Therapy in Nigeria: A Prospective Evaluation of Regimen-Specific Effects

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Abstract: Children and adolescents living with HIV (CALHIV) on antiretroviral therapy (ART) are susceptible to metabolic changes as they develop into adulthood, including significant variations in body mass index (BMI). This study evaluates the relationship between ART regimens and BMI trends in a cohort of paediatric population, exploring demographic influences and regimen-specific outcomes. This prospective observational study analyzed BMI trends in 147 children and adolescent living with HIV (CALHIV) (aged 2-16 years) on various ART regimens across three clinic visits. *Participants were grouped into six ART regimen categories, including DTG- and LPV/r-based therapies*. BMI (calculated from weight and height), CD4 counts, and viral load data were collected and analyzed to assess changes over time in each clinic visit. The data obtained were analyzed using SPSS version 20, with descriptive statistics and BMI changes assessed across visits; significance was set at $p < 0.05$. The mean participant age was 10.87±3.64 years, with most (95) aged ≥10 years and a male predominance (85 males, 62 females). BMI increased across all groups, with the TLD regimen showing the highest increase (22.99±3.45, 24.94±4.20, 26.79±4.97; $p<0.05$). **BMI increases were progressive across the 3 visits** in the TLD group with a consistent >85th percentile CDC BMI category. Adolescents (mean age: 13 years) had higher BMI, while gender had no significant impact (p=0.48). Despite BMI increases, CD4+ counts remained stable, and viral load was notably higher in ALD and ALE groups, though not statistically significant (p>0.05). Dolutegravir-based ART regimens, particularly TLD, are linked to significant BMI increases while maintaining virological *while maintaining immunological stability, with variable viral load outcomes.* Routine metabolic monitoring and targeted interventions are essential, especially for adolescents. Future studies should explore long-term metabolic outcomes and ART optimization in pediatric populations.

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INTRODUCTION

The administration of antiretroviral therapy (ART) in the management of the human immunodeficiency virus infection (HIV) has transformed the care landscape of the infection making what was once a fatal disease into a chronic and manageable condition. Due to this, many people living with HIV (PLHIV) are leading healthier lives, with an increasing number of adolescents living with HIV (ALWH) reaching adulthood, particularly in sub-Saharan Africa where the burden of HIV is high (Karim and Baxter, 2019; Rosenberg *et al*., 2023)

The various ARTs being administered are combinations of various agents of the classes which act to increase adherence and long- term effectiveness (Kemnic and Gulick, 2022). The FDA approved ART classes and drugs with their actions include: Nucleoside reverse transcriptase inhibitors (NRTIs)- Abacavir, emtricitabine, lamivudine; tenofovir disoproxil fumarate, zidovudine (FDA, 2022); Non-nucleoside reverse transcriptase inhibitors (NNRTIs)- Efavirenz, etravirine, nevirapine, rilpivirine; Protease inhibitors (PIs) which blocks protease enzymes thereby preventing maturation of new immature virus- Atazanavir, darunavir, fosamprenavir, ritonavir, saquinavir, tipranavir; Fusion inhibitors which blocks the HIV envelope from fusing with the host CD4 cell membrane- Enfuvirtide ; Chemokine Receptor 5 (CCR5) antagonist which block the CCR5 coreceptor on the surface of CD4 T lymphocytes to viral entrance- Maraviroc; Integrase strand transfer inhibitors (INSTIs) which block integrase thereby preventing the insertion of viral DNA into the DNA of the host CD4 cell- Dolutegavir, raltegravir, elvitegravir, bictegravir (Lockman *et al.*, 2021); Post attachment inhibitors which blocks HIV from attaching to the CCR5 and CXCR4 coreceptors thereby preventing its entrance into the cell- Ibalizumab; and the Pharmacokinetic Enhancers which inhibit human CYP3A protein and increasing plasma concentration of other anti-HIV drugs (Kausar *et al*., 2021; FDA ,2022; Kemnic and Gulick, 2022).

As advantageous as ARTs are in plummeting the burden of HIV-related morbidity and mortality through reduction of viral load, they are not without some long-term side effects some of which include renal impairment, cardiovascular disorders, bone density disorder, depression, myopathy etc (Matza *et al*., 2017). One of the complications which has been gaining attention recently is weight gain associated with ART (Dupont and Yombi, 2023). Some studies have reported that ART, especially the new integrase strand transfer inhibitors (INSTIs), can induce excessive weight gain, dyslipidemia, and insulin resistance—which could be possible factors that poses as risk for cardiovascular diseases (CVD) and metabolic disorders (Norwood *et al*., 2018; Kolakowska *et al*., 2019).

In adolescents, studies have shown that DTG-containing regimens are more likely to experience accelerated weight gain and central adiposity, raising concerns about future cardiovascular and metabolic diseases (Sax *et al*., 2020; Sawry *et al*., 2024). For example, the VESTED trial observed notable BMI increases in individuals who initiated DTG-based regimens

during pregnancy, suggesting similar trends may exist in adolescent populations (Lockman *et al*., 2021). This weight gain is often disproportionate to height increases, predisposing adolescents to overweight and obesity classifications, especially during puberty when hormonal changes already influence fat distribution. Beyond weight changes, ART—particularly protease inhibitors and some nucleoside reverse transcriptase inhibitors (NRTIs)—has been linked to dyslipidemia, insulin resistance, and altered glucose metabolism in adolescents (Dirajlal-Fargo *et al*., 2021). These effects contribute to a heightened risk of developing metabolic syndrome and type 2 diabetes in early adulthood (Dupont & Yombi, 2023). In addition, long-term ART may impact bone mineral density, compounding risks for osteopenia and osteoporosis during a critical period of bone development in children and adolescents (Eva *et al*., 2023).

This weight gain has raised clinical concern, particularly in resource-constrained settings like Nigeria, where healthcare infrastructure is already stretched, and comorbidities such as tuberculosis and malnutrition are prevalent. Despite growing concerns about weight gain in adults, limited data exist on the effects of ART on adolescent body composition in resource-limited settings hence the need for this study in order to prevent metabolic complications in the patients.

MATERIALS AND METHODS

Study Design and Setting

This is a prospective observational cohort study whereby 147 children and adolescents aged 2-16 years living with HIV (CALWH) on ART and enrolled in the HIV clinic of the State Hospital, Oyo state, Nigeria, were recruited as participants between June 2022 and December, 2023. The laboratory analyses were performed at the Virology Clinical Laboratory and the Haematology laboratory of the Department of Biomedical Science, College of Medicine, University of Ibadan, Nigeria. The HIV clinic of the State Hospital is a tertiary clinic and referral center for HIV cases in the thirty-three (33) local government of Oyo state and environ within the Southwestern region of Nigeria.

Ethical Consideration

Ethical approval was obtained from the Ethical Research Committee of the Ministry of Health, Oyo state, Nigeria (NHREC/OYOSHRIEC/10/11/22) and informed consent was obtained from the parent/guardian of the children. Explanation on the study was also given to children from 7 years and above and they gave their consent before being enrolled into the study. The inclusion criteria were consenting participants by parents/caregivers aged 2 to 16years with confirmed diagnosis of HIV infection, participant receiving one of the specified ART regimens, has a regular clinic history and complete data available. On the other hand, the exclusion criteria were non-consenting individuals, children with co-morbidities such as tuberculosis, endocrine disorders, or those on recovery in the last 3 months, incomplete clinical records or irregular clinic attendance, those on non-standard ART (outside the six pre-defined), pregnant adolescents and those who are non-adherence to ART.

Study Population

The participants recruited are on their first line regimen grouped into six categories based on ART regimen being administered as seen Table 1.

Sample collection and Laboratory Analyses

Their clinical histories were obtained from their records while the body mass index (BMI) was obtained through the weight (kg) and height (m) measurement from each participant on ART across three clinic visits for a period of 18-months , at 6 months interval, after ensuring calibration for weighing scales and stadiometer.

The BMI was calculated as Body Mass Index (BMI)=

$$\frac{\text{Weight (kg)}}{\text{Height}(m^2)}$$

Concurrently, 5ml of whole blood samples were collected and dispensed into two EDTA bottles, one bottle was analyzed on the same day for CD4 assay while the other bottle was stored at 4°C for viral load assay the following day. The viral load was analyzed by HIV-1 quantitative qPCR test with commercial kit (Guangdong Huayin Medicine Science Co., Ltd) while the CD4-T cell count was estimated by flow cytometer (Partec Western Germany) respectively. Standard and control samples were analysed along with the tests to ensure accuracy.

Table 1: The grouping of participants by their regimen.

Group	Regimen Composition	Name Abbreviation
1	ABC(Abacavir)-3TC(Lamivudine)-LP/r (ritonavir boosted Lopinavir)	ALLpr
2	ABC(Abacavir)-3TC(Lamivudine)-DTG(Dolutegravir)	ALD
3	ABC(Abacavir)-3TC(Lamivudine)-EFV(Efavirenz)	ALE
4	TDF(Tenofovirdisoproxilfumarate)-3TC(Lamivudine)-DTG (Dolutegravir)	TLD
5	AZT(Zidovudine)-3TC(Lamivudine)-NVP(Nevirapine)	ZLN
6	AZT(Zidovudine)-3TC(Lamivudine)-LP(Lopinavir)	ZLLp

Data Analysis

All data obtained for this study were analyzed using the Statistical Package for Social Sciences (SPSS, version 20). Descriptive statistics were used to summarize the data, with normally distributed continuous variables presented as mean ± standard deviation ($\bar{x} \pm SD$), and categorical variables expressed as frequencies and percentages (%). Variability in percentile ranges were assessed within the central 90% of the dataset while excluding outliers.

Changes in BMI across different ART regimens were assessed using repeated measures ANOVA to determine within- and between-group differences. Post-hoc tests were performed where necessary to identify specific group differences. Associations between demographic variables (e.g., age, gender) and BMI changes were examined using linear regression analysis. A p-value of <0.05 was considered to be statistically significant.

The primary outcome variable was change in body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (kg/m^2), which were measured across three clinic visits. The participants whose BMI is below the 5^{th} percentile were categorized as underweight, those in the 5^{th} to less than 85^{th} percentile are within the normal group and those within 85^{th} to $<95^{th}$ percentile were termed the overweight group according the CDC (2022) child and teen BMI charts.

RESULTS

The participants' mean age was 10.87±3.64 years, with 95 of them aged ≥10 years accounting for majority of the participants. Other participants aged 6-10 years are 32 in proportion, and ≤5 years are 20. The gender distribution shows the males participants (85) outnumbered the females (62). The regimen administration grouping with the participants' distributions in Figure 1 shows those on Group 1 (ALLpr) are highest (50) followed closely by those on group 4 (TLD) who are 36 in number while those on group 5 (ZLN) regimen are the lowest in distribution.

The mean BMI across the three clinic visits shows significant increase ($p<0.05$) from the first to the third visit (Figure 2).

Table 1 represents the mean±SD of all participants across each clinic day and it shows the BMI for participants in the TLD regimen group are significantly the highest with mean±SD 22.99±3.45, 24.94±4.20 and 26.79±4.97 followed closely by those in groups ZLLp, ALE, ALLpr and ALD respectively while group ZLN had the lowest mean BMI ($p<0.05$). A significant increase in mean±SD BMI were observed in group 4 when compared at each clinic visit within the same group ($p<0.05$). The TLD group also depict more than double average difference increase in BMI across each visit when compared with other groups.

In Table 2, the CD4 counts of all participants across each clinic visits for each treatment regimen does not differ significantly ($p>0.05$), while, there were significant differences in the viral loads across majority of the groups with group ZLN having the

highest viral load followed closely by group ALD while the group ZLLp has the lowest viral load. Noticeably, the ALD group is the group with the highest CD4 level with corresponding high viral loads across all visits.

Furthermore, the distribution of participants based on their percentile weight categories was displayed and in the TLD group displayed consistent increase in BMI in 27% (9.7), 44% (15.8) and 50 % (18) ($p<0.05$) of the group population across each clinic visit respectively but a consistent normal CD4 (>300 cells/mm^3) and reduced viral load (<20copies/ml) in the same set of individuals (Table 3). Also, the ALD group has two (14.3%) participants who are noticeably overweight by the third clinic.

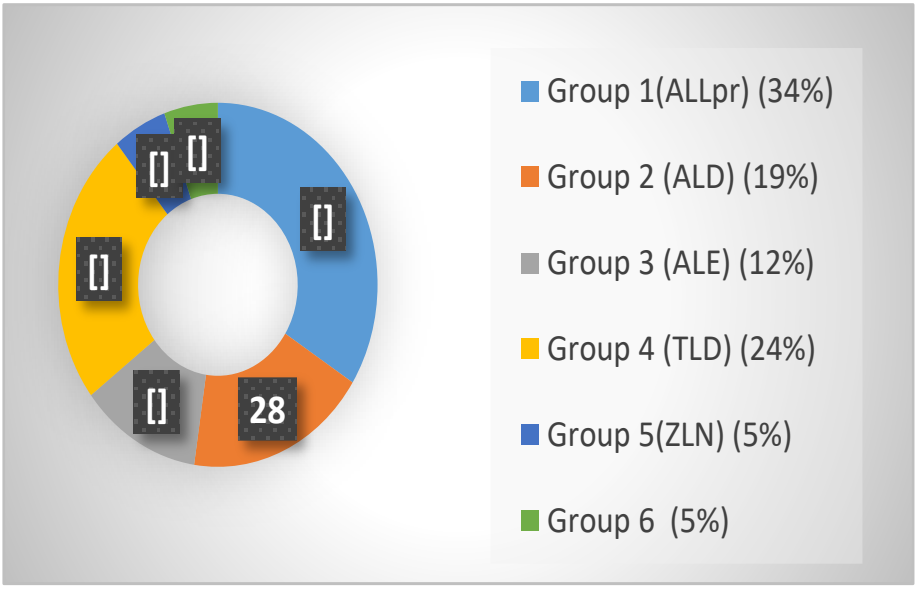


Figure 1: Distribution of participants by the Antiretroviral therapy regimen.
Legend: Group1 (ALLpr) =ABC(Abacavir)-3TC(Lamivudine)-LP/r (ritonavir boosted Lopinavir); Group2 (ALD) =ABC-3TC-DTG(Dolutegravir); Group3 (ALE)=ABC-3TC-EFV(Efavirenz); Group4 (TLD)= TDF (Tenofovir disoproxil fumarate)-3TC-DTG; Group5 (ZLN) =AZT(Zidovudine)-3TC-NVP(Nevirapine); and Group 6 (ZLLp)=AZT-3TC-LP(Lopinavir).

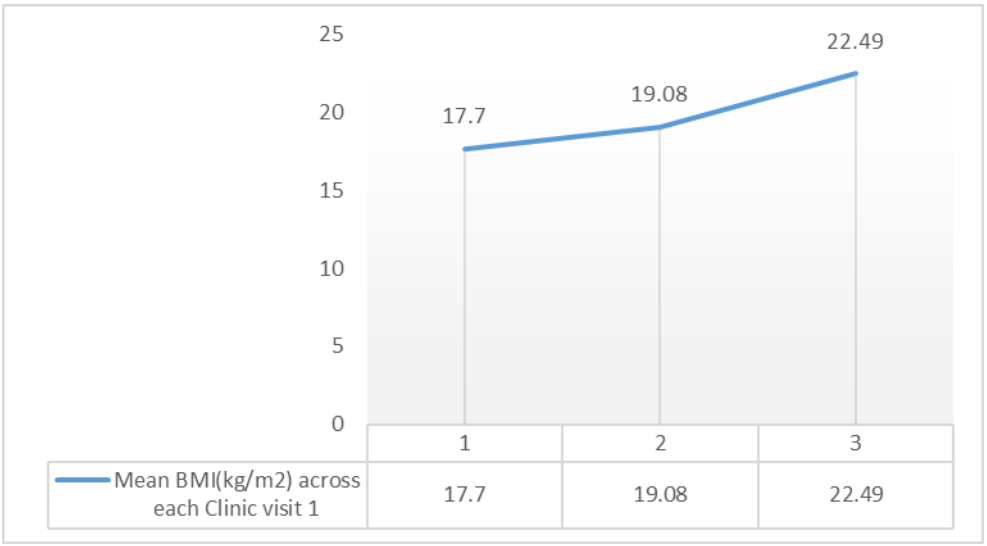


Figure 2: The mean Body mass index (BMI) across the clinic visits (1-3) for the participants (n=147).
Legend: 1- Clinic Visit 1; 2- Clinic Visit 2; 3- Clinic visit 3;

Table 1: Mean±SD of Body Mass Index (BMI) of all participants across each Clinic Visit

Group	Regimen	BMI1 (kg/m^2)	BMI2 (kg/m^2)	BMI3 (kg/m^2)	F-val	p-val
1 (ALLpr)	ABC-3TC-LP/r	14.39±2.43	14.69±2.54	15.04±2.71	1.65	0.47
2 (ALD)	ABC-3TC-DTG	14.33±4.31	14.33±4.39	14.55±4.38	0.99	0.80
3 (ALE)	ABC-3TC-EFV	17.71±2.41	17.84±2.29	18.13±2.19	1.70	0.65
4 (TLD)	TDF-3TC-DTG	22.99±3.45	23.94±4.20	25.79±4.97	6.30	0.04*
5 (ZLN)	AZT-3TC-NVP	12.18±4.88	12.17±4.89	12.17±4.89	0.08	0.91
6 (ZLLp)	AZT-3TC-LP	17.91±7.99	18.41±7.28	18.67±6.95	0.89	0.87

Legend: *- p-value significant at ≤0.05
Group1 (ALLpr) =ABC(Abacavir)-3TC(Lamivudine)-LP/r(ritonavir boosted Lopinavir); Group2 (ALD) =ABC-3TC-DTG(Dolutegravir); Group3 (ALE)=ABC-3TC-EFV(Efavirenz); Group4 (TLD)=TDF (Tenofovir disoproxil fumarate)-3TC-DTG; Group5 (ZLN) =AZT(Zidovudine)-3TC-NVP(Nevirapine); and Group6 (ZLLp)=AZT-3TC-LP(Lopinavir).

Table 2: Mean±SD of Viral load and CD4 count of all participants across each Clinic Visit

Group	Regimen	CD4Count1 (cells/ul)	CD4Count2 (cells/ul)	CD4 Count 3 (cells/ul)	F-val	p- val
1 (ALLpr)	ABC-3TC-LP/r	600.20±338.19	601.00±337.47	602.80±336.03	0.07	0.90
2 (ALD)	ABC-3TC-DTG	637.79±278.03	665.43±324.36	683.64±382.44	0.85	0.89
3 (ALE)	ABC-3TC-EFV	441.67±584.17	441.67±203.11	441.67±203.11	0.05	0.99
4 (TLD)	TDF-3TC-DTG	584.17±347.04	599.61±357.15	632.22±369.23	1.37	0.56
5 (ZLN)	AZT-3TC-NVP	367.75±145.71	367.75±145.71	367.75±145.71	0.00	0.99
6 (ZLLp)	AZT-3TC-LP	435.50±174.47	435.50±174.47	435.50±174.47	0.00	0.99
Group	REGIMEN	Viralload1 (copies/ml)	Viral load 2 (copies/ml)	Viralload3 (copies/ml)	F-val	p-val
1 (ALLpr)	ABC-3TC-LP/r	1232.76±759.17	1141.50±710.62	1429.80±783.72	2.12	0.29
2 (ALD)	ABC-3TC-DTG	6820.93±5246.46	18947.14±14061.50	6737.64±5105.76	8.04	0.02*
3 (ALE)	ABC-3TC-EFV	4542.89±3964.90	4553.00±3959.88	4494.11±4008.19	1.44	0.50
4 (TLD)	TDF-3TC-DTG	294.78±165.15	324.94±187.22	403.33±251.60	7.19	0.03*
5 (ZLN)	AZT-3TC-NVP	26539.50±16994.30	8064.25±7978.72	78454.25±7835.25	6.27	0.03*
6 (ZLLp)	AZT-3TC-LP	26.75±7.75	21.75±5.50	24.00±10.00	6.24	0.04*

*- p-value significant at ≤0.05

Table 3: Frequency Distribution of all participants on various antiretroviral therapy by Body mass Index grading

BMI/Clinic Visit	Treatment Regimen (F/%)							
BMI 1	Group1(ALL)	Group2(ALD)	Group3(ALE)	Group4(TLD)	Group5(ZLN)	Group6(ZLLp)	X^2 val	p-val
Underweight	2(4.0)	1(3.7)	0	0	2(25.0)	2(25.0)		
Normal	48(96.0)	25(92.6)	18(100.0)	29(80.5)	6(75.0)	6(75.0)	22.99	0.01*
Overweight	0	1(3.7)	0	7(19.4)	0	0		
BMI 2								
Underweight	0	0	0	0	2(25.0)	0		
Normal	50(100.0)	25(92.6)	18(100.0)	26(72.2)	6(75.0)	8(100.0)	37.73	0.00*
Overweight	0	2 (7.4)	0	10(27.7)	0	0		
BMI 3								
Underweight	0	0	0	0	2(25.0)	0		
Normal	50(100.0)	25(85.7)	18(100.0)	24(66.6)	6(75.0)	8(100.0)	41.36	0.00*
Overweight	0	2 (7.4)	0	12(33.3)	0	0		

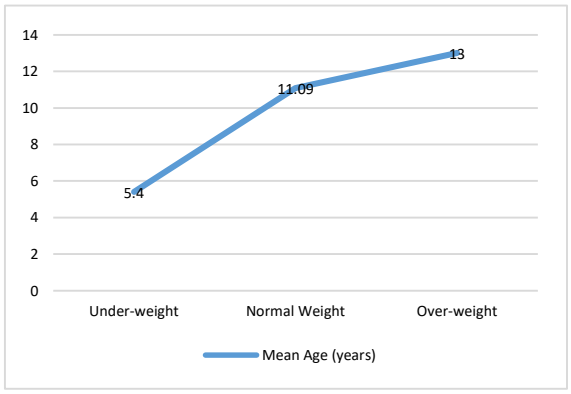
Legend: *- p-value significant at <0.01;
Underweight- <5th percentile; Normal – 5th -<85th percentile; Overweight- 85th -<95th percentile

There was a significant relationship (p=0.001) in the age distribution and BMI grading of the participants as those with overweight are within the adolescent age bracket with mean age 13 years having adjusted for their gender and age (Figure 3). Also, no relationship (p=0.48) was observed with gender of the participants as the sex of the participant does not seem to have a profound effect on the various BMI grading.

DISCUSSION

This prospective observational cohort study evaluated BMI variations among CALHIV who are on different antiretroviral therapy (ART) regimens, although there has been reported incidences of dolutegravir (DTG) associated weight-gain at initiation and transitioning in adults (Saw *et al*., 2020; Esber *et al*., 2022). The findings provided important insights into the ART-associated variations in BMI, highlighting areas for clinical attention and potential intervention for ART especially DTG administration in the children therapy.

From this study the mean age of the participants was 10.87±13.64 years, with the majority aged from 10years indicates a skew towards older children within the adolescent age range. As much as this is reflecting the successes of HIV pediatric intervention into adulthood, it could also influence the observed BMI trends, as older children are generally more susceptible to weight and metabolic changes due to pubertal development. This is because normal puberty is seen to be initiated centrally with increased gonadotropin-releasing hormone (GnRH) and gonadotropin secretion driving gonadal function. And obesity on the other hand has been associated with accelerated linear growth during puberty, possibly due to early oestrogenization and the action of insulin on the insulin-like growth factor- 1 (IGF-1) receptor, amongst other potential mechanisms (Burt Solorzano and McCartney, 2010; Marcus *et al*., 2022). However, the normal increase in growth rate associated with puberty were considered effectively in assessment of the ART associated weight changes when compared across groups in this study, also the smaller proportion of participants who are less than 5 years provides an opportunity to explore ART effects across different growth stages as well.



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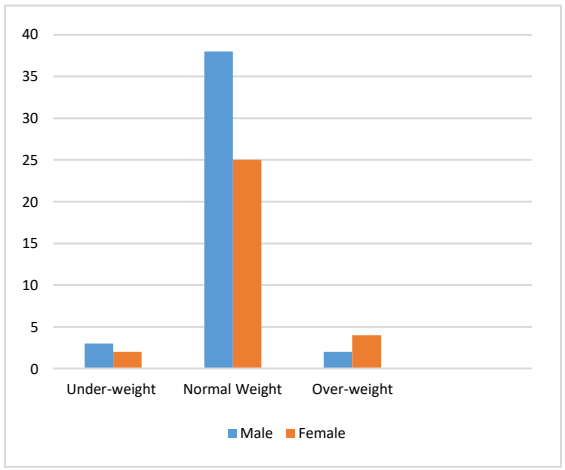

B

Figure 3: Distribution of a: The mean age across various Body Mass Index Grading (p=0.001) ; and b: The mean age across the gender of the participants (p=0.48)
Legend: Underweight- <5th percentile; Normal – 5th -<85th percentile; Overweight- 85th -<95th. Percentile; n= 147

The gender distribution revealed a male predominance, this may reflect the population demographics in the clinic setting which is quite in contrast with some other reported observation where females are seen to be dominant in population of adult and pediatric HIV cohorts (UNICEF, 2024). However, similar studies observing changes in BMI in people living with HIV on initiation of ART also had the male gender predominance and with notably increased BMI over a period of 2 years which demonstrates the impact of the ARTs on the BMI irrespective of the gender of the individuals (Lam *et al*., 2024; Bailin *et al.*, 2020).

The distribution of participants on various ART regimen is consistent with the preference for certain regimens in pediatric HIV management, particularly those that balance efficacy and tolerability as observed in frequency of ALLpr and TLD with Abacavir, Lamivudine and Dolutegravir regimen. Their higher representation may also reflect their broader clinical use and availability in the setting studied, Nigeria, as certain regimen are more available for use and supply than others (Oreagba *et al*., 2014; Awodele *et al*., 2018). This highlights critical patterns that could impact BMI and weight changes. Dolutegravir (DTG), an INSTIs based ART and a key component of the group 4 (TLD) regimen with a substantial (not the largest) representation, is known to be associated with weight gain in adults resulting from imbalance metabolic activities (Bourgi *et al*., 2022; Sawry *et al*., 2024). In previous studies, distinct metabolic mechanisms have been linked to weight gains to stem from the drug influence by the dolutegravir and other INSTIs as a stimulator of melanocortin-4 receptor (MC4R) to promote energy homeostasis, weight gain and obesity (Palella *et al*., 2024). Through an invitro inhibition of activities of melanocortin-4 receptor (MC4R), there was leptin- induced stimulation of production of pro-opiomelanocortin peptides which results in reduced food intake and body weight through agonistic effects on the MC4R as seen in the literatures (Gautron *et al*., 2015; Palella *et al*., 2023). This study finding therefore highlight the importance of balancing the efficacy of ART regimens with their potential metabolic side effects, especially in younger populations vulnerable to long-term health risks necessitating close monitoring of weight and BMI in children prescribed DTG-containing regimens. Also, the least populated group ZLN, may reflect a shift away from older regimens with higher toxicity profiles. Zidovudine-based regimens have been associated with adverse effects, including potential impacts on growth and weight loss in some patient (van Vonderen *et al*., 2009), however the association with weight gain was also recorded (Sax *et al*., 2020).

Furthermore, the distribution of participants in the TLD group showed a consistent increase in BMI of notable frequency of the group population across each clinic visit with corresponding maintenance of normal CD4 counts and reduced viral loads in the same set of individuals indicating the possible metabolic implication of the regimen despite its immunological and virological efficacy. Evidence suggests that DTG may alter adipogenesis and lipid metabolism by promoting mitochondrial dysfunction and disrupting energy balance, ultimately leading to increased fat mass and central adiposity (Sax *et al*., 2020). In addition, DTG has been associated with reduced insulin sensitivity and dysregulation of glucose homeostasis, further compounding its obesogenic effects (Sax *et al*., 2020). Similarly, Group 2 (ALD) regimen with 14.3% participants who were noticeably overweight by the third clinic visit further suggested the impact of DTG on the regimen in contributing to disturbed metabolic activities leading to increase in weight despite the less association of others on weight gain.This supports prior findings from observational and clinical trials that link Dolutegravir to disproportionate weight gain, particularly among adolescents and women (Esber *et al*., 2022; Sawry *et al*., 2024). While other regimens such as those containing Efavirenz (EFV) or Nevirapine (NVP) showed comparatively less association with weight gain, the findings emphasize the need for close metabolic monitoring in individuals on integrase strand transfer inhibitor (INSTI)-based therapies which calls for a careful balance in regimen selection, especially in vulnerable pediatric populations.

Further analysis revealed a significant relationship between age distribution and BMI grading (p=0.001), with overweight participants predominantly within the adolescent age bracket, averaging a mean age of 13 years underscoring the critical interplay between age-related physiological changes and ART-associated metabolic effects. This is evidenced by the increasing obesity and its associated cardiometabolic effects seen in HIV-positive children who live a longer life and develop fatal cardiometabolic sequelae in adulthood (Patel and Kennedy, 2021). Conversely, it was observed that BMI grading is not profoundly influenced by the sex of the participants due to absence of relationship between both variables.

Furthermore, a temporary lapse in adherence between visits 1 and 2 observed in participants could explain the transient elevation observed in some participants such as those on ALD regimen. Additionally, intercurrent infections or concurrent medications may briefly influence viral replication and ART pharmacodynamics. Although transient elevations—often referred to as “viral blips”—have been reported in literature even in individuals with generally good virological control. These blips are usually not associated with treatment failure and often resolve without regimen change (Suzuki *et al.,* 2021). The return to lower viral loads at visit 3 in the ALD group supports this interpretation and suggests that these were likely not indicative of drug resistance or treatment failure.

Finally, the stability of CD4 counts across all participants and regimens indicates effective immune recovery regardless of the observed BMI trends while variable viral load is observed across the groups. The ALD and ALE groups with mean viral load beyond the WHO recommended value (1000 copies/ml) (WHO, 2014; Jiamsakul *et al*., 2017) could indicate ineffective virological suppression which could majorly result from the inefficiency of the regimen as well as other factors such as poor adherence, regimen dosage amongst other factors which could contribute to viral non-suppression (Mageda *et al*., 2023). This dissociation of CD4 level and viral load from BMI suggests that BMI changes in the cohort are independent of immunological and virological outcomes, thereby emphasizing the metabolic effects of specific ART regimens rather than differences in treatment efficacy.

This study has some limitations that should be acknowledged. Firstly, the relatively small sample sizes within each ART regimen group may limit the generalizability and statistical power of the findings. Additionally, the absence of dietary intake data, physical activity levels, and other lifestyle factors restricts our ability to account for unmeasured confounders that could influence BMI changes. The short duration of follow-up may also be insufficient to fully capture long-term metabolic outcomes associated with ART use.

CONCLUSION

The DTG associated regimens indicates a substantial BMI increase majorly in the adolescent participants, paired with stable CD4 counts and variable viral loads. This highlights the association of the regimen's effect on the metabolic activities in the participants coupled with effective immunological protection irrespective of the viral population. This emphasizes the need for an integrated approach to ART care that includes routine metabolic assessments and tailored nutritional interventions to mitigate the long-term health implications of ART-associated weight changes.

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Data Availability
All data generated are represented in this manuscript.

Conflict of Interest
The authors declare no conflict of interest in this study

Author Contribution
OEB and IDA conceived and designed the study; ECO, IDA and OLS collected and analyzed the samples; OEB and BBJ wrote the initial draft, OEB, ECO, IDA, OLS, BBJ reviewed the final draft, while OEB and ECO supervised the entire research.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: The authors declare that no AI-assisted technologies or AI-generated data were used in this study.

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