AfroGlobal Perspectives
Vol. 3 No. 8 (2026): August 2026
https://doi.org/10.70572/agp.v3i8.39
Original Article

CLINICAL FACTORS ASSOCIATED WITH OVERWEIGHT/OBESITY AND THE RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHIC FACTORS AND OVERWEIGHT/OBESITY AMONG PEOPLE LIVING WITH HIV AT KAJJANSI HEALTH CENTRE IV. A CROSS SECTIONAL STUDY.

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Abstract
Background
Overweight and obesity are predominant health distresses among people living with HIV (PLWH), impacting both their quality of life and treatment outcomes. The study aimed to determine the clinical factors associated with overweight/obesity and the relationship between socio-demographic factors and overweight/obesity among PLWH at Kajjansi Health Centre IV.

Methodology
A descriptive cross-sectional study with a mixed-methods approach was conducted on 50 PLWH. Data were collected through questionnaires, interviews, and medical record reviews. Descriptive statistics, chi-square tests, t-tests, and multiple logistic regression analyses were performed to examine associations between various factors and overweight/obesity status.

Results
On clinical factors, dyslipidemia demonstrated an inverse relationship with overweight/obesity status, strengthening over time (baseline: $\chi^2 = 7.031$, $p = 0.008$; end line: $\chi^2 = 12.500$, $p < 0.001$). BMI showed increasingly strong positive correlations with metabolic markers from baseline to end line. Among socio-demographic factors, only gender emerged as a significant predictor of BMI at the end line ($B = 12.116$, $p = 0.012$), with females showing higher BMI.

Conclusion
Notably, dyslipidemia showed an unexpected inverse association with obesity, strengthening over time, while BMI increasingly correlated with metabolic markers. Gender emerged as the only significant socio-demographic predictor of BMI at the end line.

Recommendation
There should be a need for comprehensive, gender-sensitive weight management approaches as well as the importance of regular metabolic monitoring for all HIV patients and suggest future longitudinal research to better understand these temporal dynamics and develop targeted interventions.

Keywords: *Clinical and Socio-demographic factors, Obesity in PLWH, Kajjansi Health Centre IV.*
Submitted: April 20, 2026 Accepted: June 30, 2026 Published: August 13, 2026
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Background of the study
Research indicates a strong link between certain ART regimens and weight gain globally. Studies have consistently shown that protease inhibitor (PI)-based regimens are associated with significant weight gain and metabolic disturbances, including dyslipidemia and insulin resistance (Battista et al., 2015). In Sub-Saharan Africa, where the burden of HIV is highest, studies have confirmed the association between ART and weight gain. A study in South Africa (Mashinya et al., 2015) found that PLWH on ART had a higher prevalence of cardiovascular risk factors, including elevated cholesterol and triglycerides, compared to HIV-negative individuals. Another study in Uganda (Nalugga et al., 2022) reported that weight gain was most rapid in the first few years of ART initiation, highlighting the need for early intervention.

The relationship between age and overweight/obesity in PLWH is complex. While some studies suggest older age is associated with increased risk due to metabolic changes, decreased physical activity, and hormonal shifts (Bloomfield et al., 2017), others indicate younger individuals may also be vulnerable due to ART regimens and lifestyle changes after HIV diagnosis (Lake et al., 2020).

Research in the Sub-Saharan region, including Uganda (Kiyimba et al., 2022), has not specifically addressed the age-related risks of overweight and obesity in PLWH, highlighting a need for further investigation in this context.

This trend is mirrored in Uganda, with women PLWH disproportionately affected by overweight and obesity (Ministry of Health Uganda, 2014; Kiyimba et al., 2022).

Lower education levels are consistently linked to increased risk, potentially due to limited knowledge about healthy lifestyles, lower health literacy, and barriers to accessing healthcare and nutrition information (Shaffer et al., 2014).

This association is also evident in Uganda (Kalibbala et al., 2022), emphasizing the need for educational interventions targeting nutrition and physical activity.

Globally it is recognised that employment status can influence overweight and obesity risk, with unemployed individuals potentially facing financial constraints and higher stress levels, leading to unhealthy eating patterns. This relationship is supported by findings in Uganda (Kalibbala et al., 2022), where unemployment is linked to limited access to healthy foods and increased stress, both contributing to weight gain. Therefore, the objective of this study is to determine the clinical factors associated with overweight/obesity and the relationship between socio-demographic factors and overweight/obesity in PLWH at Kajjansi Health Center IV.

Methodology

Research design

This study will employ a descriptive cross-sectional design with a mixed methods approach. This approach allows for the simultaneous assessment of multiple factors associated with overweight and obesity in People Living With HIV (PLWH) at a single point in time. While it facilitates the exploration of relationships between variables, it cannot establish causation.

This study will utilize both quantitative and qualitative data collection methods. Quantitative methods will gather numerical data on weight, height, and other relevant factors from interactions at the clinic. Qualitative methods will explore participants' experiences and perceptions related to weight management while living with HIV.

Study population

Target population

The target population for this study is all people living with HIV (PLWH) aged 18 years and above who are receiving care at Kajjansi Health Centre IV during the study period (three months).

This population is chosen because it represents a specific and accessible group of PLWH within a defined geographical area.

Accessible Population

The study population is adult male and female persons living with HIV/AIDS, attending and receiving Anti-Retroviral Treatment at Kajjansi Health Centre IV, Wakiso, Uganda.

Inclusion criteria

People living with HIV who are currently receiving ART at Kajjansi Health Centre IV for at least six months and are aged 18 and above.

PLWH who are willing to provide informed consent and participate in data collection activities.

Exclusion Criteria

Individuals below 18 years old receiving care at Kajjansi Health Centre IV

Those who are currently receiving care at Kajjansi Health Centre IV and are critically ill which may interfere with data collection.

Pregnant or breastfeeding women (due to potential confounding factors related to pregnancy and lactation).

Individuals with severe cognitive impairment or mental health conditions hindering informed consent or participation.

PLWH currently receiving ART at Kajjansi Health Centre IV who met the inclusion criteria but did not consent to participate in the study

Sample size determination

The study sample for the quantitative research was determined using a formula developed by (Keish Leslie, 1965):

$$n = z^2pq / d^2$$

Where:

n = desired sample size

z = 1.96 (for 95% confidence interval)

p = Population Proportion (prevalence of the outcome of interest= 28%)

q = (100% - prevalence (72%))

d = margin of error (set at 5% or 0.05)

In determining this, a 95% confidence interval and 5% margin of error will be used. The prevalence of metabolic syndrome and components among people living with HIV is 28% in the Wakiso district (Kiyimba et al., 2022).

Hence, the sample size will be determined as;

Calculation:

Using a 28% prevalence and a 5% margin of error, the sample size is calculated as follows:

Given that:

n =?

z = 1.96

d = 0.05 (5%)

p = 0.28 (28%)

q = 1 – p, (1- 0.28 = 0.72)

Therefore, n =

n= 309.8= 310

The formula developed by Leslie Kish (1965) was used to determine the sample size needed to achieve a 95% confidence interval and a 5% margin of error. Based on a prevalence of metabolic syndrome of 28% among PLWH in Wakiso District (Kiyimba et al., 2022), the statistically derived sample size was approximately 310. However, a sample size of 50 was deemed feasible given the project's limitations. In the discussion section, the potential limitations of a smaller sample size will be addressed.

Therefore, the target sample size will be fifty respondents.

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Sampling techniques

Purposive sampling technique

This is a sampling technique that involves intentional identification and selection of individuals, or groups of individuals that are proficient with a particular community or society (Etikan, et al., 2016). This technique will be employed for the qualitative study

The initial phase involves engaging core contacts at the health center, such as nurses and clinicians, who will introduce the study and facilitate participant recruitment. Subsequently, five focus group discussions (6-12 PLWH each) and seven key informant interviews with PLWH possessing diverse experiences related to weight management will be conducted. Participant selection will prioritize diversity in age, gender, duration of HIV diagnosis, antiretroviral therapy use, and weight management experiences to ensure a comprehensive understanding of potential triggers.

Simple random sampling technique.

The researcher will utilize a systematic random sampling technique will be employed to select participants from the quantitative study.

This is a sampling technique where every item or individual in a population has an even chance or likelihood of being selected in the sample (Sharma, 2017). This method ensures an equal selection probability for all eligible participants and minimizes selection bias.

The first step involves obtaining a complete list of PLWHs aged 18 and above registered at the health center during the study period. This list serves as the sampling frame, encompassing all potential participants. Next, the sampling interval is calculated by dividing the total number of patients in the frame by the desired sample size. This interval determines the frequency at which participants will be selected from the list.

To introduce randomness and eliminate selection bias, a random starting point within the first sampling interval is chosen using a random number generator. From this starting point, every nth patient (where 'n' is the sampling interval) who meets the inclusion criteria is recruited until the desired sample size is reached. This systematic approach ensures that every eligible participant has an equal chance of being included in the study, enhancing the generalizability of the findings.

Systematic sampling technique

Systematic sampling is a probability sampling method where researchers select members of the population at regular intervals. The interval is determined by dividing the population size by the desired sample size. If the population is in a random order, this can mimic the benefits of simple random sampling while often being easier to implement.

Similar to simple random sampling, a complete list of PLWH will serve as the sampling frame. The sampling interval will be calculated, and after a random starting point, every nth individual on the list will be selected.

Data collection methods

Questionnaire Survey

A structured questionnaire will be administered to collect quantitative data from the selected PLWH participants. This questionnaire will include close-ended questions designed to assess socio-demographic information, weight management behaviors, dietary habits, physical activity levels, and relevant knowledge and attitudes related to weight management in the context of HIV. The structured format ensures standardized data collection, allowing for easy comparison and analysis of responses.

Document Review

Relevant medical records and documents at the health center will be reviewed to extract additional data related to participants' weight history and clinical parameters that may influence weight management. This will complement the data gathered through questionnaires and interviews, providing a more comprehensive understanding of the factors impacting weight among PLWH.

Interviews

Structured Interviews: Face-to-face interviews with participants using a standardized questionnaire will be conducted. This approach allows for direct interaction with participants, clarifying any ambiguities in their responses, and ensuring accurate data collection. Close-ended questions with predetermined response options will be used to facilitate data analysis and comparison.

Key Informant Interviews: In-depth interviews with purposively selected key informants, such as clinic in-charges, nurses, and doctors, will be conducted. These interviews will use a semi-structured format, allowing for open-ended questions and probing for deeper insights into the challenges and opportunities related to weight management for PLWH at the health center. The insights from key informants will enrich the understanding of the context and provide valuable information for designing effective interventions.

Data collection tools

Structured questionnaire

Structured Questionnaire is the primary tool for quantitative data collection and it will be administered by trained research assistants. The questionnaire will be translated into the local language to ensure accessibility and comprehension for all participants.

The questionnaire will undergo pre-testing at Kajjansi Health Centre IV in Wakiso District to ensure its clarity, relevance, and cultural appropriateness.

Interview guide

Qualitative data will be collected through interview guides with purposively selected individuals who have expertise and experience relevant to the research topic.

Key Informant Interview Guide: A semi-structured interview guide will be developed to guide the KI interviews. The guide will include open-ended questions.

The KI interviews will be semi-structured, allowing for flexibility and probing to elicit rich and detailed information.

Data Analysis
Data was initially cleaned, coded, and evaluated for missing data using Microsoft Excel 2013 and later transferred to IBM SPSS version 27 for detailed analysis.

Descriptive Statistics
The study began with a comprehensive overview of the sample characteristics. Sociodemographic factors such as age, gender, education level, employment status, and household size were summarized using frequencies, percentages, means, and standard deviations. This provided a clear picture of the study population. Similarly, key variables of interest, including dietary diversity scores, physical activity levels, and sedentary behavior, were described using means, standard deviations, and frequency distributions. HIV-related factors and comorbidities were presented as frequencies and percentages, while biochemical and health data were summarized using means and standard deviations. These descriptive statistics offered a foundational understanding of the dataset.

Inferential Statistics
To examine relationships between variables, the researchers employed a variety of inferential statistical methods. Chi-square tests of independence were used to investigate associations between categorical variables, such as obesity status and dietary diversity, physical activity levels, and comorbidities. This allowed for the identification of significant relationships between these factors. For continuous variables, independent samples t-tests were conducted, particularly to compare sedentary behavior between obese and non-obese participants. Correlation analyses, likely using Pearson's correlation coefficient, were performed to assess relationships between biochemical indicators and BMI at different time points, providing insights into the strength and direction of these associations.

Longitudinal Analysis and Regression Modelling
A key strength of this study was its longitudinal design, collecting data at three-time points: baseline, midline, and end-line. This allowed for the tracking of changes in variables over time, providing a dynamic view of the factors associated with overweight and obesity. To further explore the complex relationships between variables, multiple logistic regression analyses were employed. These models investigated the influence of sociodemographic factors on BMI at each time point, controlling for multiple variables simultaneously. The researchers reported standardized coefficients, significance levels, and collinearity diagnostics, ensuring a thorough examination of the predictors' effects on BMI.

Visual Representations
To enhance the interpretation and presentation of results, the researchers utilized various visual representations. Bar charts and histograms were used to visualize distributions of different factors, while box plots were employed to display the distribution of dietary diversity scores. These visual aids complemented the numerical results, making the findings more accessible. While not explicitly mentioned, the types of analyses performed suggest the use of advanced statistical software such as SPSS, SAS, or R.

Statistical Significance and Multicollinearity
Throughout the analysis, a p-value of less than 0.05 was generally considered statistically significant, aligning with common practices in health research. In the regression analyses, particular attention was paid to potential multicollinearity issues. The researchers reported collinearity diagnostics, including Tolerance and Variance Inflation Factor (VIF), ensuring the reliability of their regression models.

Data Quality Control
Validity
Validity refers to the extent to which a research instrument measures what it is intended to measure.

Instrument Validation
Structured Questionnaires: The questionnaires used for data collection will be based on established and validated instruments such as the IPAQ and the Household Dietary Diversity Score. Modifications or adaptations will be made with careful consideration to maintain validity.
Anthropometric Measurements: Standard operating procedures (SOPs) for anthropometric measurements will be followed, and the measurement tools (height board, weighing scale, tape measure, sphygmomanometer, stethoscope) will be calibrated regularly to ensure accuracy.

Pilot Testing
A pilot study will be conducted with a small sample of PLWHIV to test the feasibility and validity of the data collection tools and procedures. Feedback from the pilot study will be used to refine the instruments and improve the overall data collection process.

Expert Review
The research instruments and data analysis plan will be reviewed by experts in the field of HIV/AIDS and nutrition at Uganda Christian University to ensure the validity of the research design and methodology.
Participant Selection:
Purposive sampling for the qualitative component will be used to select participants with diverse experiences and perspectives, enhancing the richness and validity of the qualitative data.

Member Checking

Key findings from the qualitative data will be shared with participants to verify their accuracy and ensure that the interpretations align with their experiences.

Reliability

Reliability refers to the consistency and stability of research findings over time and across different observers or measurements. In this study, the following strategies will be employed to ensure the reliability of the data:

Standardized Procedures

Data Collection: Detailed standard operating procedures (SOPs) will be developed for all data collection methods (interviews, anthropometric measurements, biochemical assessments, dietary assessments). These SOPs will outline step-by-step instructions to ensure consistency in how data is collected across participants.

Data Coding: A codebook will be developed for the qualitative data to ensure consistent coding practices during the research. The codebook will define each code and provide examples from the data to guide the coding process.

Anthropometric Measurements: An effort will be taken to independently take measurements on a subset of participants to assess inter-rater reliability for anthropometric data. Any discrepancies will be discussed and addressed to ensure consistency in measurement techniques.

Training and Calibration

Research assistants: All research assistants involved in data collection will undergo comprehensive training on the study protocol, data collection procedures, and the use of measurement tools. This will ensure that they are familiar with the study methods and can apply them consistently.

Equipment: All measurement tools (weighing scale, sphygmomanometer, glucometer, CardioChek device) will be regularly calibrated to ensure their accuracy and reliability over time.

Pilot Testing

A pilot study will be conducted to test the reliability of the data collection tools and procedures. The results of the pilot study will be used to refine the methodology and address any inconsistencies or issues before the main data collection phase.

Ethical considerations

To ensure the ethical conduct of this study, the following principles will be strictly adhered to:

Informed Consent: All participants will be provided with clear and comprehensive information about the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without consequences. Written informed consent will be obtained from each participant before enrolment.

Confidentiality: All participant data will be kept confidential and anonymous. Personal identifiers will be removed from data records, and data will be stored securely to protect participant privacy.

Beneficence: The study will strive to maximize benefits and minimize any potential harm to participants. Participants will be offered information about available resources for weight management and will be referred to appropriate healthcare providers if any health concerns arise during the study.

Respect for Autonomy: Participants' right to make autonomous decisions about their participation will be respected throughout the study. They will be free to decline to answer any questions or participate in any procedures that they feel uncomfortable with.

Justice: Participant selection will be fair and equitable, and the study will strive to avoid any discrimination or bias based on age, gender, socioeconomic status, or other factors.

Ethical Review: The study protocol has been reviewed and approved by the relevant ethics committee to ensure that it adheres to all ethical guidelines and regulations for research involving human subjects.

Data Integrity: Data will be collected and analyzed with the utmost integrity and transparency. The study findings will be reported accurately and honestly, without fabrication or falsification of data.

Ethical Review and Approval

The study protocol will be reviewed by the Uganda Christian University Institutional Research and Ethics Committee. Upon approval, permission will be sought from the District Health Offices. An introductory and approval letter from Mild May Institute of Health Sciences affiliated with Uganda Christian University will also be presented to Kajjansi Health Centre IV authorities. Potential participants will be informed of the study's voluntary nature and purpose. Written informed consent, detailing study procedures, risks, benefits, and the right to withdraw, will be obtained from each participant prior to data collection.

Results

Sociodemographic characteristics of participants

Table 1. Sociodemographic characteristics of participants

Variable	Frequency (n)	Percentage (%)	Mean (±SD)
Age (years)	50	100	45.82 (±10.50)
Household size	50	100	4.56 (±2.18)
Gender			
Female	41	82.0	
Male	9	18.0	
Highest level of education			
Tertiary certificate/University	15	30.0	
Secondary school certificate	14	28.0	
Primary Seven	16	32.0	
None	5	10.0	
Current employment status			
Employed	37	74.0	
Not employed	11	22.0	
Student	2	4.0	
Occupation Group			
Volunteer Work and Miscellaneous	12	24.0	
Food Services	8	16.0	
Manual Labor	3	6.0	
Business and Services	13	26.0	
Education	4	8.0	
Healthcare	10	20.0	

Figure 1. Shows the Gender distribution

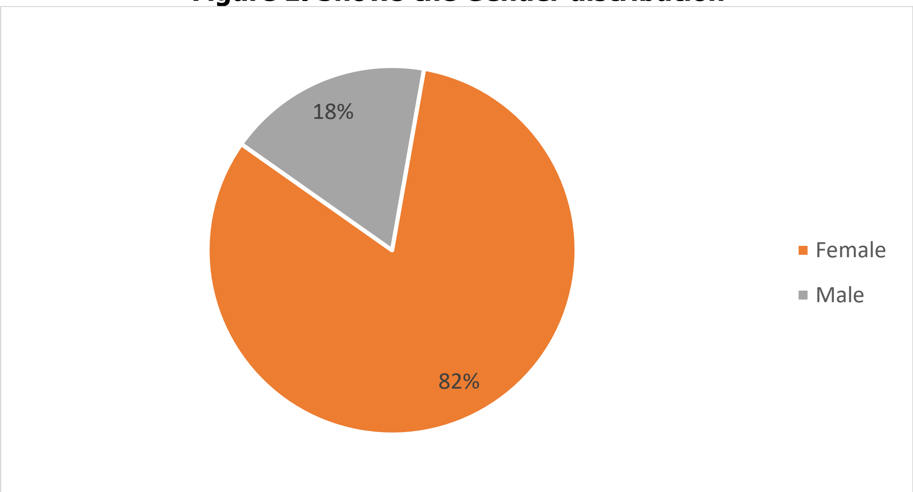
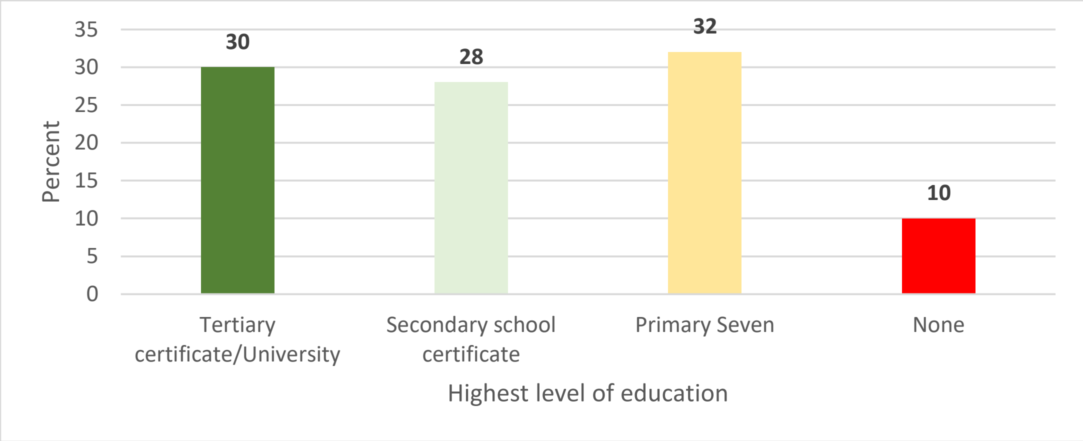


Figure 2. Shows the highest level of education distribution



The sociodemographic characteristics of the study participants are presented in Table 1. The sample consisted of 50 individuals with a mean age of 45.82 years (SD = 10.50). The average household size was 4.56 members (SD = 2.18).

Gender distribution showed a predominance of female participants, with 82% (n = 41) being female and 18% (n = 9) see Figure 1 being male. Educational attainment varied among the participants, with the majority having completed primary education (32%, n = 16) or obtained a tertiary certificate/university degree (30%, n = 15). A smaller proportion had completed secondary school (28%, n = 14), while 10% (n = 5) reported no formal education.

Regarding employment status, nearly three-quarters of the participants (74%, n = 37) were employed at the time of the study. The remaining participants were either not employed (22%, n = 11) or students (4%, n = 2). Among those employed, the most common occupational groups were business and services (26%, n = 13), volunteer work and miscellaneous (24%, n = 12), and healthcare (20%, n = 10). Food services accounted for 16% (n = 8) of the participants' occupations, while education and manual labor represented smaller proportions at 8% (n = 4) and 6% (n = 3), respectively.

Clinical factors associated with overweight/obesity

HIV-related factors

A series of logistic regression analyses were conducted to examine the relationship between HIV-related factors and overweight/obesity status at baseline, midline, and endline (Tables 2, 3, and 4, respectively).

Table 2. Logistic regression of HIV duration and ARV duration on overweight/obesity status (Baseline)

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.853	.106		8.076	.000	.641	1.066
	Duration since HIV diagnosis (years)	.018	.027	.298	.662	.511	-.037	.072
	Duration while taking ARVs	-.025	.032	-.351	-.781	.439	-.089	.039
a. Dependent Variable: Overweight/Obesity status (Baseline)								

At baseline (Table 2), neither the duration since HIV diagnosis (B = 0.018, p = .511) nor the duration of ARV treatment (B = -0.025, p = .439) were significantly associated with overweight/obesity status.

Table 3. Logistic regression of HIV duration and ARV duration on overweight/obesity status (Midline)

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.802	.106		7.563	.000	.589	1.016
	Duration since HIV diagnosis (years)	.013	.027	.222	.491	.626	-.041	.068
	Duration while taking ARVs	-.014	.032	-.199	-.441	.661	-.079	.050
a. Dependent Variable: Overweight/Obesity status (Midline)								

Similar non-significant results were observed at the midline (Table 3), with duration since HIV diagnosis (B = 0.013, p = .626) and duration of ARV treatment (B = -0.014, p = .661) showing no significant relationship with overweight/obesity status.

Table 4. Logistic regression of HIV duration and ARV duration on overweight/obesity status (End line)

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.769	.106		7.251	.000	.555	.982
	Duration since HIV diagnosis (years)	.010	.027	.171	.379	.706	-.044	.065
	Duration while taking ARVs	-.007	.032	-.098	-.218	.829	-.071	.057
a. Dependent Variable: Overweight/Obesity status (Endline)								

The online analysis (Table 4) also revealed no significant associations between overweight/obesity status and duration since HIV diagnosis (B = 0.010, p = .706) or duration of ARV treatment (B = -0.007, p = .829).

Table 5. Association between each comorbidity and overweight/obesity status (Baseline)

Comorbidity	**Not Overweight or Obese**	**Overweight or Obese**	**Total**	**Chi-Square**	**df**	**p-value**
Diabetes				0.104	1	0.747
No	7 (70.0%)	30 (75.0%)	37 (74.0%)			
Yes	3 (30.0%)	10 (25.0%)	13 (26.0%)			
Hypertension				0.087	1	0.768
No	6 (60.0%)	26 (65.0%)	32 (64.0%)			
Yes	4 (40.0%)	14 (35.0%)	18 (36.0%)			
Dyslipidaemia				7.031	1	0.008
No	5 (50.0%)	35 (87.5%)	40 (80.0%)			
Yes	5 (50.0%)	5 (12.5%)	10 (20.0%)			
Total	**10 (100.0%)**	**40 (100.0%)**	**50 (100.0%)**			

https://doi.org/10.70572/agp.v3i8.39

Comorbidities

Chi-square tests (Table 5) were conducted to examine the association between each comorbidity and overweight/obesity status at baseline. A significant association was found between dyslipidemia and overweight/obesity status ($\chi 2 = 7.031$, df = 1, p = .008). Interestingly, 50% of participants who were not overweight or obese had dyslipidemia, compared to only 12.5% of those who were overweight or obese. No significant associations were found between overweight/obesity status and diabetes ($\chi 2 = 0.104$, df = 1, p = .747) or hypertension ($\chi 2 = 0.087$, df = 1, p = .768).

Table 6. Association between each comorbidity and overweight/obesity status (Midline)

Comorbidity	Not Overweight or Obese	Overweight or Obese	Total	Chi-Square	df	p-value
Diabetes				0.234	1	0.629
No	8 (80.0%)	29 (72.5%)	37 (74.0%)			
Yes	2 (20.0%)	11 (27.5%)	13 (26.0%)			
Hypertension				0.087	1	0.768
No	6 (60.0%)	26 (65.0%)	32 (64.0%)			
Yes	4 (40.0%)	14 (35.0%)	18 (36.0%)			
Dyslipidaemia				7.031	1	0.008
No	5 (50.0%)	35 (87.5%)	40 (80.0%)			
Yes	5 (50.0%)	5 (12.5%)	10 (20.0%)			
Total	**10 (100.0%)**	**40 (100.0%)**	**50 (100.0%**			

At midline, the association between comorbidities and overweight/obesity status was reassessed. The results mirrored those observed at baseline, with a significant association between dyslipidemia and overweight/obesity status ($\chi 2 = 7.031$, df = 1, p = .008). The pattern remained consistent, with 50% of non-overweight/obese participants having dyslipidemia, compared to 12.5% of overweight/obese participants. Diabetes ($\chi 2 = 0.234$, df = 1, p = .629) and hypertension ($\chi 2 = 0.087$, df = 1, p = .768) continued to show no significant associations with overweight/obesity status (Table 6).

Table 7. Association between each comorbidity and overweight/obesity status (End line)

Comorbidity	Not Overweight or Obese	Overweight or Obese	Total	Chi-Square	df	p-value
Diabetes				0.234	1	0.629
No	8 (80.0%)	29 (72.5%)	37 (74.0%)			
Yes	2 (20.0%)	11 (27.5%)	13 (26.0%)			
Hypertension				0.087	1	0.768
No	6 (60.0%)	26 (65.0%)	32 (64.0%)			
Yes	4 (40.0%)	14 (35.0%)	18 (36.0%)			
Dyslipidaemia				12.500	1	<0.001
No	4 (40.0%)	36 (90.0%)	40 (80.0%)			
Yes	6 (60.0%)	4 (10.0%)	10 (20.0%)			
Total	10 (100.0%)	40 (100.0%)	50 (100.0%)			

The end-line analysis revealed a strengthened association between dyslipidemia and overweight/obesity status ($\chi 2 = 12.500$, df = 1, p < .001). At this time point, 60% of non-overweight/obese participants had dyslipidemia, compared to only 10% of overweight/obese participants. The associations between overweight/obesity status and diabetes ($\chi 2 = 0.234$, df = 1, p = .629) and hypertension ($\chi 2 = 0.087$, df = 1, p = .768) remained non-significant (Table 7).

Biochemical and Health Data

Correlation analyses were conducted to examine the relationships between biochemical indicators and BMI at baseline, midline, and endline (Tables 8, 9, and 10).

Table 8. Correlation between biochemical indicators and BMI (Baseline)

Variable	1	2	3	4	5	6	7	8
1. Triglycerides level	1							
2. Total cholesterol level	.075	1						
3. LDL cholesterol level	-.330*	.791**	1					
4. HDL cholesterol level	-.068	.429**	.270	1				
5. Fasting blood glucose level	.204	-.022	-.148	-.165	1			
6. Systolic blood pressure	-.035	-.144	-.086	-.166	.133	1		
7. Diastolic blood pressure	.083	-.200	-.118	-.128	.080	.885**	1	
8. Body Mass Index	-.101	-.113	-.061	.002	.180	.611**	.610**	1

Correlation is significant at the 0.05 level (2-tailed).
***** Correlation is significant at the 0.01 level (2-tailed).***

At baseline, significant positive correlations were observed between BMI and both systolic ($r = 0.611$, $p < 0.01$) and diastolic ($r = 0.610$, $p < 0.01$) blood pressure.

Table 9. Correlation between biochemical indicators and BMI (Midline)

Variable	1	2	3	4	5	6	7	8
1. Triglycerides level	1							
2. Total cholesterol level	.232	1						
3. LDL cholesterol level	-.194	.744**	1					
4. HDL cholesterol level	.260	.740**	.549**	1				
5. Fasting blood glucose level	.395**	.323*	.219	.436**	1			
6. Systolic blood pressure	.452**	.714**	.568**	.770**	.594**	1		
7. Diastolic blood pressure	.417**	.727**	.515**	.759**	.544**	.918**	1	
8. Body Mass Index	.370**	.638**	.476**	.764**	.662**	.804**	.797**	1

Correlation is significant at the 0.05 level (2-tailed).
***** Correlation is significant at the 0.01 level (2-tailed).***

The midline analysis revealed an increased number of significant correlations. BMI showed strong positive correlations with HDL cholesterol ($r = 0.764$, $p < 0.01$), fasting blood glucose ($r = 0.662$, $p < 0.01$), systolic blood pressure ($r = 0.804$, $p < 0.01$), and diastolic blood pressure ($r = 0.797$, $p < 0.01$). Moderate positive correlations were also observed between BMI and triglycerides ($r = 0.370$, $p < 0.01$), total cholesterol ($r = 0.638$, $p < 0.01$), and LDL cholesterol ($r = 0.476$, $p < 0.01$).

Table 10. Correlation between biochemical indicators and BMI (End line)

Variable	1	2	3	4	5	6	7	8
1. Triglycerides level	1							
2. Total cholesterol level	.559**	1						
3. LDL cholesterol level	.073	.727**	1					
4. HDL cholesterol level	.337*	.768**	.542**	1				
5. Fasting blood glucose level	.626**	.696**	.384**	.605**	1			
6. Systolic blood pressure	.503**	.834**	.528**	.844**	.758**	1		
7. Diastolic blood pressure	.553**	.903**	.592**	.846**	.741**	.939**	1	
8. Body Mass Index	.485**	.815**	.554**	.864**	.750**	.880**	.865**	1

Correlation is significant at the 0.05 level (2-tailed).
***** Correlation is significant at the 0.01 level (2-tailed).***

At the end line, the strength of correlations between BMI and biochemical indicators further increased. Strong positive correlations were observed between BMI and total cholesterol (r = 0.815, p < 0.01), HDL cholesterol (r = 0.864, p < 0.01), fasting blood glucose (r = 0.750, p < 0.01), systolic blood pressure (r = 0.880, p < 0.01), and diastolic blood pressure (r = 0.865, p < 0.01). Moderate positive correlations were found between BMI and triglycerides (r = 0.485, p < 0.01) and LDL cholesterol (r = 0.554, p < 0.01)

Relationship between socio-demographic factors and overweight/obesity

Table 11. Multiple logistic regression of socio-demographic factors on BMI (Baseline).

Coefficients													
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	26.004	13.108		1.984	.054	-.431	52.438					
	Age of participants (years)	-.107	.126	-.139	-.847	.402	-.362	.148	-.180	-.128	-.124	.806	1.241
	Gender of participants	3.793	3.391	.182	1.118	.270	-3.046	10.633	.131	.168	.164	.818	1.223
	Highest level of education	-.717	1.349	-.088	-.532	.598	-3.437	2.003	-.009	-.081	-.078	.786	1.273
	Current employment status	1.995	2.548	.134	.783	.438	-3.144	7.133	.123	.119	.115	.737	1.356
	Occupation group	-.014	.738	-.003	-.020	.984	-1.503	1.474	.019	-.003	-.003	.767	1.304
	Household size	-.247	.560	-.066	-.442	.661	-1.376	.881	-.103	-.067	-.065	.954	1.048
a. Dependent Variable: Body Mass Index (Baseline)													

A multiple logistic regression analysis was conducted to examine the influence of socio-demographic factors on Body Mass Index (BMI) at baseline (Table 11). The model included age, gender, highest level of education, current employment status, occupation group, and household size as independent variables.

Results indicated that none of the socio-demographic factors were statistically significant predictors of BMI at baseline. Age (B = -0.107, p = .402), gender (B = 3.793, p = .270), highest level of education (B = -0.717, p = .598), current employment status (B = 1.995, p = .438), occupation group (B = -0.014, p = .984), and household size (B = -0.247, p = .661) all showed non-significant associations with BMI.

The standardized coefficients (Beta) suggested that gender had the largest relative influence on BMI (Beta = 0.182), followed by age (Beta = -0.139) and current employment status (Beta = 0.134), although these effects were not statistically significant. The model's constant term was marginally significant (B = 26.004, p = .054), indicating a baseline BMI when all other variables are held constant.

Collinearity statistics, including Tolerance and Variance Inflation Factor (VIF), were within acceptable ranges for all variables, suggesting no significant multicollinearity issues in the model. The partial and part correlation coefficients further confirmed the weak relationships between the predictors and BM

A multiple logistic regression analysis was performed to investigate the relationship between socio-demographic factors and Body Mass Index (BMI) at midline (Table 12). The model incorporated age, gender, highest level of education, current employment status, occupation group, and household size as predictor variables. The analysis revealed that none of the socio-demographic factors were statistically significant predictors of BMI at midline. Age (B = -0.049, p = .755), gender (B = 5.275, p = .218), highest level of education (B = -0.443, p = .793), current employment status (B = 1.472, p = .645), occupation group (B = 0.114, p = .902), and household size (B = -0.101, p = .886) all showed non-significant associations with BMI.

Examining the standardized coefficients (Beta), gender appeared to have the largest relative influence on BMI (Beta = 0.206), followed by current employment status (Beta = 0.080) and age (Beta = -0.052), although these effects were not statistically significant. The model's constant term was not significant (B = 18.963, p = .252).

Collinearity diagnostics, including Tolerance and Variance Inflation Factor (VIF), were within acceptable ranges for all variables, indicating no significant multicollinearity in the model. The partial and part correlation coefficients further confirmed the weak relationships between the predictors and BMI at midline

Table 12. Multiple logistic regression of socio-demographic factors on BMI (Midline).

Coefficients													
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	18.963	16.328		1.161	.252	-13.965	51.891					
	Age of participants (years)	-.049	.157	-.052	-.314	.755	-.367	.268	-.065	-.048	-.047	.806	1.241
	Gender of participants	5.275	4.224	.206	1.249	.218	-3.244	13.795	.183	.187	.186	.818	1.223
	Highest level of education	-.443	1.680	-.044	-.264	.793	-3.831	2.945	.000	-.040	-.039	.786	1.273
	Current employment status	1.472	3.174	.080	.464	.645	-4.929	7.873	.032	.071	.069	.737	1.356
	Occupation group	.114	.919	.021	.124	.902	-1.740	1.969	.063	.019	.019	.767	1.304
	Household size	-.101	.697	-.022	-.144	.886	-1.506	1.305	-.044	-.022	-.021	.954	1.048
a. Dependent Variable: Body Mass Index (Midline)													

Table 13. Multiple logistic regression of socio-demographic factors on BMI (End line)

Coefficients										
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	t	Sig.	**95.0% Confidence Interval for B**		Correlations		**Collinearity Statistics**
1	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
(Constant)	11.283	17.926		.629	.532	-24.869	47.434			
Age of participants (years)	-0.088	0.173	-0.080	-0.509	0.613	-0.436	0.260	-0.064	-0.077	-0.072
Gender of participants	12.116	4.638	0.406	2.612	0.012	2.762	21.469	0.367	0.370	0.367
Highest level of education	-1.053	1.844	-0.091	-0.571	0.571	-4.772	2.667	-0.010	-0.087	-0.080
Current employment status	0.928	3.485	0.044	0.266	0.791	-6.099	7.956	-0.044	0.041	0.037
Occupation group	-0.281	1.010	-0.045	-0.278	0.782	-2.317	1.755	0.071	-0.042	-0.039
Household size	0.070	0.765	0.013	0.092	0.927	-1.473	1.614	-0.016	0.014	0.013
a. Dependent Variable: Body Mass Index (Endline)										

A multiple logistic regression analysis was conducted to examine the relationship between socio-demographic factors and Body Mass Index (BMI) at the end line (Table 13). The model included age, gender, highest level of education, current employment status, occupation group, and household size as independent variables.

The analysis revealed that gender was the only statistically significant predictor of BMI at the end line (B = 12.116, p = .012). This positive coefficient indicates that being female (as females were coded higher in the dataset) was associated with a higher BMI. The standardized coefficient (Beta = 0.406) further emphasizes the relatively strong influence of gender on BMI compared to other factors in the model.

Other socio-demographic factors did not show significant associations with BMI: age (B = -0.088, p = .613), highest level of education (B = -1.053, p = .571), current employment status (B = 0.928, p = .791), occupation group (B = -0.281, p = .782), and household size (B = 0.070, p = .927).

The model's constant term was not significant (B = 11.283, p = .532), indicating no significant baseline BMI when all other variables are held constant. Collinearity statistics (Tolerance and VIF) were within acceptable ranges for all variables, suggesting no significant multicollinearity issues in the model.

Partial and part correlation coefficients further confirmed the stronger relationship between gender and BMI (partial r = 0.370, part r = 0.367) compared to other predictors.

Discussion

The study examined clinical factors associated with overweight/obesity among people living with HIV (PLWH) at Kajjansi Health Centre IV and revealed several important findings. The results indicate no significant associations between HIV-related factors (duration since HIV diagnosis and duration of ARV treatment) and overweight/obesity status across the study timeline. However, a significant association was found between dyslipidemia and overweight/obesity status, with an unexpected inverse relationship strengthening over time. By the end of the study, 60% of non-overweight/obese participants had dyslipidemia, compared to only 10% of overweight/obese participants. No significant associations were found between overweight/obesity status and diabetes or hypertension. The analysis of biochemical indicators showed increasingly strong positive correlations between BMI and various metabolic markers (including blood pressure, cholesterol levels, and fasting blood glucose) as the study progressed.

These findings suggest a complex interplay between HIV treatment, metabolic factors, and weight status among PLWH. The lack of association between HIV duration or ARV treatment duration and obesity status challenges the assumption of a direct, time-dependent relationship between HIV treatment and weight gain. The unexpected inverse relationship between dyslipidemia and overweight/obesity status is particularly intriguing and warrants further investigation. The strengthening correlations between BMI and various metabolic markers over time indicate a progressive metabolic impact associated with weight changes in this population.

Comparing these results with previous research reveals both similarities and differences. The lack of association between HIV treatment duration and obesity status contrasts with some global studies that have reported significant weight gain with certain ART regimens, particularly protease inhibitors (PIs) and integrase strand transfer inhibitors (INSTIs) (Bourgi et al., 2020). This discrepancy might be due to differences in specific ART regimens used, genetic factors, or other population-specific characteristics.

The significant inverse association between dyslipidemia and overweight/obesity status is particularly noteworthy and differs from typical patterns observed in the general population. This finding contrasts with studies like Mashinya et al. (2015) in South Africa, which found a higher prevalence of cardiovascular risk factors, including elevated cholesterol, in PLWH on ART. The reasons for this inverse relationship in our study population are not immediately clear and require further investigation.

The strengthening correlations between BMI and metabolic markers over time align with the literature suggesting that ART can contribute to metabolic disturbances (Lake et al., 2020). However, the lack of association between obesity status and diabetes or hypertension differs from some previous findings and highlights the complex nature of metabolic health in PLWH.

These findings have important implications for understanding and managing obesity and metabolic health among PLWH in Uganda. Theoretically, they challenge simplistic models of obesity and metabolic risk in HIV-positive populations, highlighting the need for more nuanced frameworks that account for the unique physiological and treatment-related factors in PLWH. The results suggest that the relationships between HIV treatment, metabolic factors, and obesity in this population may be non-linear and influenced by multiple interacting variables.

Practically, these findings indicate that healthcare providers should adopt a comprehensive approach to metabolic health monitoring in PLWH, rather than focusing solely on weight or BMI. The inverse relationship between dyslipidemia and obesity status suggests that normal-weight individuals may still be at risk for metabolic disturbances, emphasizing the need for regular lipid profile monitoring regardless of weight status. The strengthening correlations between BMI and various metabolic markers over time underscore the importance of long-term monitoring and early intervention to prevent metabolic complications in PLWH.

These results build on existing evidence of the complex metabolic effects of HIV and its treatment. While previous research has focused on direct associations between ART and weight gain, these findings demonstrate that the metabolic impacts of HIV and its treatment may manifest differently across populations and individuals. The unexpected patterns observed, particularly regarding dyslipidemia, provide new insights into the relationship between HIV, obesity, and metabolic health.

This study contributes to a clearer understanding of the clinical factors associated with overweight/obesity among PLWH in Uganda. The findings underscore the need for personalized, comprehensive metabolic health management in this population. Future research should investigate the mechanisms underlying the observed inverse relationship between dyslipidemia and obesity status, as well as explore potential protective factors that may be present in this population. Additionally, longitudinal studies with larger sample sizes and detailed information on specific ART regimens could help elucidate the long-term metabolic impacts of HIV treatment in this context.

The relationship between socio-demographic factors and overweight/obesity in PLWH, study examined the relationship between socio-demographic factors and overweight/obesity among people living with HIV (PLWH) at Kajjansi Health Centre IV and revealed several important findings. The results indicate that at baseline and midline, none of the socio-demographic factors (age, gender, education level, employment status, occupation group, and household size) were statistically significant predictors of Body Mass Index (BMI). However, at the end line, gender emerged as the only statistically significant predictor of BMI ($B = 12.116$, $p = .012$), with being female associated with a higher BMI.

These findings suggest a complex and evolving relationship between socio-demographic factors and weight status among PLWH over time. The lack of significant associations at baseline and midline challenges some assumptions about the immediate impact of socio-demographic factors on weight in this population. However, the emergence of gender as a significant predictor at the end line aligns with broader trends observed in the literature.

The significant association between the female gender and higher BMI at the end line is consistent with global and regional findings. This result supports previous research, including studies in Uganda (Ministry of Health Uganda, 2014; Kiyimba et al., 2022), which have consistently shown that women living with HIV experience higher rates of overweight and obesity than men. The lack of significant associations between other socio-demographic factors and BMI contrasts with some existing literature. For instance, global studies have suggested that age, education level, and employment status can influence overweight and obesity risk in PLWH (Bloomfield et al., 2017; Shaffer et al., 2014; Kalibbala et al., 2022). The absence of these associations in our study, particularly at baseline and midline, may reflect the specific characteristics of the population served by Kajjansi Health Centre IV or indicate that other factors, such as HIV treatment or metabolic changes, may have a more dominant influence on weight status in this context.

The evolving nature of the associations over time, with gender emerging as significant only at the end line, raises interesting questions about the long-term influences on weight status in PLWH. This pattern might suggest that the impact of gender on weight becomes more pronounced over time, possibly due to cumulative effects of sociocultural factors, long-term metabolic changes, or differences in response to HIV treatment between men and women.

These findings have important implications for understanding and addressing overweight and obesity among PLWH in Uganda. Theoretically, they challenge simplistic models that assume consistent and immediate effects of socio-demographic factors on weight status in this population. Instead, they suggest a more dynamic and time-dependent relationship, particularly regarding gender differences.

Practically, these results indicate that healthcare providers and public health interventions should pay particular attention to the increased risk of overweight and obesity among women living with HIV, especially in long-term care. However, the lack of significant associations with other socio-demographic factors suggests that a broad, inclusive approach to weight management may be necessary, rather than targeting interventions based solely on factors like age or education level.

These findings build on existing evidence of gender disparities in overweight and obesity among PLWH. While previous research has often focused on cross-sectional analyses, our study provides insights into how these relationships may evolve. The results demonstrate that the influence of gender on weight status may become more pronounced as individuals progress through HIV treatment and care.

This study contributes to a more nuanced understanding of the relationship between socio-demographic factors and overweight/obesity among PLWH in Uganda. The findings underscore the need for gender-sensitive approaches to weight management in HIV care, while also highlighting the complexity of factors influencing weight status in this population. Future research should explore the mechanisms underlying the observed gender differences, including potential interactions between socio-demographic factors, HIV treatment, and metabolic changes over time. Additionally, longitudinal studies with larger sample sizes could help elucidate the temporal dynamics of weight changes in PLWH and identify critical periods for intervention.

Conclusion

The study identified significant associations between certain clinical factors and overweight/obesity among PLWH, including an unexpected inverse relationship between dyslipidemia and overweight/obesity status that strengthened over time, and increasingly strong positive correlations between BMI and various metabolic markers. No significant associations were found between HIV-related factors and obesity status. These findings suggest a need for comprehensive metabolic health monitoring in PLWH, regardless of weight status, and challenge existing assumptions about the relationship between dyslipidemia and obesity in this population. Future studies should investigate the mechanisms underlying these observations, potentially leading to an improved understanding of metabolic health in HIV and more tailored approaches to patient care.

Also, the study found that among socio-demographic factors, only gender emerged as a significant predictor of BMI, and only at the end line, with females showing higher BMI. Other factors such as age, education level, employment status, and household size did not show significant associations with BMI throughout the study period. These findings suggest a complex and evolving relationship between socio-demographic factors and weight status in PLWH over time, highlighting the need for gender-sensitive approaches to weight management in long-term HIV care. Future research should focus on longitudinal studies with larger sample sizes to further elucidate the time-dependent effects of socio-demographic factors on weight in PLWH, potentially leading to more targeted and timely interventions. Limitations of the study included the following;

This study acknowledges several limitations inherent in its design and methodology:

Cross-sectional Design: The cross-sectional nature precludes the establishment of causal relationships, limiting the ability to determine if identified factors directly cause overweight/obesity.

Self-Reported Data: Reliance on self-reported data, such as weight history and dietary recall, may introduce recall and social desirability biases, potentially affecting the accuracy of information.

Generalizability: Findings may not be fully generalizable beyond the specific PLWH population at Kajjansi Health Centre IV due to potential variations in demographics, healthcare access, and cultural practices.

Study Duration: The three-month study period may not capture seasonal variations in diet or fluctuations in weight management behaviors.

External Factors: Unforeseen events like policy changes or health crises could influence outcomes but are beyond the researcher's control

Recommendation

Theories should also consider the interplay between HIV treatment, metabolic factors, and weight status, as well as gender-specific influences on weight management in this population. Resource allocation for additional training of healthcare workers and the development of culturally appropriate, sustainable programs should be prioritized.

There should be a need for comprehensive, gender-sensitive weight management approaches as well as the importance of regular metabolic monitoring for all HIV patients and suggest future longitudinal research to better understand these temporal dynamics and develop targeted interventions.

Acknowledgment

My special thanks to my beloved mother, Nansubuga Sarah, and an honorable family that has continuously encouraged and shown staunch support and love to me throughout my life. To all those who have supported encouraged, challenged, and inspired me. The dedicated lecturers and friends for all their guidance, love, and affection which made it possible for me to make it up to this point. To the staff and fellow students who bestowed me with courage, commitment, and awareness to follow the best possible route, by their unmatched style of mentorship possible.

Above all, to the Lord, God who has continuously been good to me.

List of Abbreviations

AIDS: Acquired Immunodeficiency Syndrome
ART: Antiretroviral Therapy
BMI: Body Mass Index
HIV: Human Immunodeficiency Virus
IPAQ: International Physical Activity Questionnaire
PLWH: People Living With HIV/AIDS
SOPs: Standard operating procedures

Source of funding

This study was not funded.

Conflict of interest

No conflict of interest declared

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