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# Body composition of adults living with HIV in two cities in Ghana

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**Abstract:** Background: Human immunodeficiency virus (HIV) infection affects nutrition through increases in resting energy expenditure, reduction in food intake, nutrient malabsorption and loss, and complex metabolic alterations that culminates in weight loss and wasting common in acquired immune deficiency syndrome. This study sought to assess body composition of adults living with HIV. Methods: This cross-sectional study involved 63 adults living with HIV in two cities in Ghana. Socio-demographic information was obtained with a questionnaire. Body composition was measured with the deuterium dilution method and with anthropometry. Data analysis was done by SPSS version 16.0. Descriptive statistics and frequencies and percentages were calculated. The independent sample t-test was used for comparisons between groups. Differences were considered significant at $p < 0.05$. Results: Median (interquartile range) body mass index was within normal for both males (20.6, [18.9, 21.6 $kg/m^2$]) and females (21.6; [19.8, 24.9 $kg/m^2$]). Underweight (7.9%) and overweight (19.0%) were however prevalent. Males have significantly higher median fat free mass than females (52.7 kg versus 40.1 kg; $p<0.0001$) kg whereas females have a significantly higher fat mass (27.5% versus 12.2%; $p<0.0001$), and high abdominal obesity (49.0%). Almost 21% and 8% of participants have depleted fat free mass and fat mass respectively. Conclusion: The study demonstrates some level of malnutrition among the study participants. This underscores the importance of monitoring body composition in people living with HIV. Measurements of waist and hip circumferences should form part of the assessment tools. This will help in identifying those on antiretroviral treatment that are at risk of developing abdominal obesity and thereby supporting the need for modifying treatment regimens when necessary. In addition, regular screening for hypertension, diabetes and other indicators of metabolic abnormalities is recommended.

**Keywords:** Body Composition, HIV Infection, Deuterium Dilution, Anthropometry, Ghana

## 1. Introduction

Human immunodeficiency virus HIV/acquired immunodeficiency syndrome (AIDS) and malnutrition often operate in tandem. HIV infection affects nutrition through increases in resting energy expenditure, reduction in food intake, nutrients malabsorption and loss, and complex metabolic alterations that culminate in AIDS related weight loss and wasting [1, 2].

Weight loss in HIV is generally recognized as an independent predictor of morbidity and mortality. However loss of fat free mass (FFM) is a better predictor of survival [2-5]. The importance of FFM to survival in HIV has led to an increased interest in body composition changes that accompany disease progression [6-8].

Results of body composition studies in HIV infection can serve as a warning sign before wasting sets in [1-2]. The assessment of body composition is as efficient as viral load and can provide information on the efficacy of antiretroviral therapy (ART) [7, 9] because some of these drugs increase fat mass leading to insulin resistance [10-11].

Monitoring of the nutritional status of PLHIV is important to ascertain the level of nutrition intervention needed for improvement of their nutritional status. A variety of assessment tools are available to measure body composition in both sick and healthy adults. In developing countries, most of these evaluations have been limited to anthropometric measures such as weight, skinfold thickness, mid-upper-arm circumference (MUAC), waist circumference, and body mass index (BMI).

Incidentally, work done on body composition in Ghana was primarily by the conventional anthropometric methods [12-13]. These methods tend to provide important information on regional fat distribution but are not adequate to detect underlying changes in fat free mass and body fat. Isotopic methods on the other hand give valuable information with more sensitivity and accuracy. Isotopes thus provide a monitoring system to track the rapidly changing HIV/AIDS situation and to initiate timely actions in care, thus slowing down the progress of the disease.

This study sought to address the issue of data paucity on body composition by providing additional information on FM and FFM of PLHIV. The stable isotope deuterium method was used to assess body composition. In addition, the associations among body composition variables measured with anthropometry and deuterium oxide were explored.

# 2. Methods

### 2.1. Study Participants and Study Site

This study was a cross-sectional study involving 63 free living individuals with membership in support groups for PLHIV/AIDS in Accra, the national capital, and Kumasi, capital of the Ashanti Region. Participants were part of a longitudinal study on the use of stable isotopes to assess the impact of food supplements on nutritional status of PLHIV in Ghana.

### 2.2. Inclusion Criteria

Adults aged 18-45 years with CD4 cells counts ≥300 cells/mL and willing to participate in the study were recruited. Exclusion criteria included severe malnutrition, pregnancy or lactation, World Health Organisation (WHO) advanced stages (stages III and IV) of the disease and other serious systemic diseases such as cardiovascular disease, diabetes and renal disease. Individuals who were already receiving nutritional support in the form of food supplements were also excluded.

### 2.3. Ethical Considerations

Approval for the study was given by the Ethical Review Committee of the Health Research Unit of the Ghana Health Service. Prior to enrolment, all persons were informed about the objectives, procedures to be employed and nature of the study after which written informed consent was obtained from each of them. Subjects were informed that participation in the study was voluntary.

### 2.4. Procedures

Socio-demographic information was collected by questionnaires administration. Questions asked include age, level of education, marital status, employment category and status, and household size.

Body weight, height, mid-upper arm circumference (MUAC), waist and hip circumferences and triceps skinfold thickness were measured using standard procedures. Body mass index (BMI) was computed as weight/height$^2$ (kg/m$^2$) and participants classified as: underweight: < 18.5 kg/m$^2$; normal 18.5-25 kg/m$^2$; overweight > 25.0 kg/m$^2$ and > 30 kg/m$^2$. Arm fat area (AFA) and arm muscle area in cm$^2$ were calculated using the equation developed by Frisancho [14]. Arm muscle area (AMA) was obtained by subtracting 6.5 for females and 10 for males. Cut-off values of < 32 cm$^2$ for males and < 18 cm$^2$ for females were used to classify participants. Waist to hip ratio (WHR) was calculated as waist circumference divided by hip circumference. WHR greater than 0.90 for men and 0.85 for women were used to describe abdominal obesity. In addition, male waist circumference ≥ 102 cm and female waist circumference ≥ 88 cm are considered unhealthy [15]

Body composition was measured by the deuterium oxide method [16], with Fourier Transform Infrared Spectrometer (FTIR). After a 2 hour fast, basal saliva (pre-dose) was collected from participants into dry, sterile vials and immediately capped. Participants were given a measured dose of deuterium oxide (about 30g) to drink after which the container was rinsed with water. Each participant was asked to drink the water to ensure complete dosing. Post-dose samples were collected after 3 and 4 hours. The samples were kept on ice, transferred to the laboratory and frozen at -20$^0$C prior to analysis. The saliva samples were analysed for deuterium enrichment with the FTIR. Mean enrichment of 3 and 4 hour samples were used to calculate the TBW (kg) from deuterium enrichment at time zero with the use of a correction factor (1.041) for non-aqueous dilution of deuterium oxide. This correction accounts for the exchange of labile hydrogen that occurs in humans during the equilibration period:

(1) Deuterium space = dose ingested (mg) ÷ enrichment of deuterium in saliva (mg/kg)
(2) TBW (kg) = deuterium space ÷ 1.041
(3) FFM (kg) = TBW (kg) ÷ hydration factor (0.73)
(4) FM = Weight (kg) – FFM (kg)

The percentage body fat (%) was calculated as FM (kg) divided by body weight and multiplied by 100. FM between 25-30% and > 33% for females and 15-20% and > 25% for males are healthy and obese respectively [17]. Participants are classified as having depleted body reserves when FM and FFM values fall below the healthy range.

Approximately 5mL venous blood was collected in EDTA-containing tubes and transferred to the laboratory for measurement of cell differentiation antigen 4 (CD4 count) using the Guava Easy count machine.

### *2.5. Data Analysis*

Data entry was done using SPSS version 16.0. Descriptive statistics (mean, standard deviations, median, interquartile ranges) were calculated for continuous variables while categorical variables were reported as frequencies and percentages. Pearson correlation analyses were conducted to assess the degree of linear relationship between measured variables. The independent sample t-test was used for comparisons between groups. Differences were considered significant at $p < 0.05$.

## 3. Results

This paper discusses the baseline characteristics of 63 participants on the longitudinal study on the use of stable isotopes to assess the impact of food supplements on nutritional status of PLHIV in Ghana.

### *3.1. Socio-Demographic Characteristics and Health*

Table 1 summarises the socio-demographic characteristics and health of participants. Participants were asymptomatic at the time of the study. Most of the participants (77.8%) are females with majority aged between 31 and 40 years (66.7%). Over 30% participants are either married or widowed. More than 50% of the participants completed JSS or middle school and 16% have had primary education. Although a high level of employment was recorded among participants (63.5%), this was mainly in the informal sector. About 2 out of 3 participants (67.5%) have not had any training in employable skills. The majority of participants did not live alone; household size ranged between 3 and 10, with a few (6.3%) having more than 10. Nineteen participants (3 males and 16 females, 30.2%) reported of illnesses such as fever (47.4%) and diarrhoea (10.5%), 2 weeks prior to data collection. Median CD4 cell counts was 485 cells/mL, similar to median values observed when analysed separately for males (480 [306, 880] cells/mL and females 485 [291, 793] cells/mL).

### *3.2. Anthropometry and Body Composition*

The anthropometric and body composition data are presented in Table 2.0. Median (interquartile range), weight and height were 58.1 (44.8, 89.1) kg and 162.3 (149.9, 176.8) cm respectively. Waist circumference, hip circumference, MUAC and triceps were 82.0 (65.9, 103.0) cm; 93.3 (82.7, 116.0) cm; 27.8 (22.1, 35.7) cm, and 11.2 (3.2, 41.1) mm. Median BMI for participants was 21.2 kg/m$^2$ which is within the healthy range. When analysed separately, BMI for males was lower (20.6 [18.9, 21.6] kg/m$^2$ versus 21.6 [19.8, 24.9] kg/m$^2$). Both BMI and deuterium oxide methods identified 14% of the males and 6% females as having reduced body fat. About 25% females were overweight. Among the male participants, neither overweight nor obesity was recorded (Table 2.0).

Median (IQR) AFA and AMA were 16.3 (11.6, 25.1) cm$^2$ and 37.1 (31.9, 41.5) cm$^2$ respectively among female participants. Median AFA and AMA for males were 7.5 (6.3, 10.1) and 43.1 (38.1, 50.1) cm$^2$. Males had significantly higher AMA ($p<0.0029$) and females had significantly higher AFA ($p<0.02$). High abdominal obesity (49%) was observed among female participants compared with 28.6% among males. However, a relatively small proportion (22.4%) has high waist circumference indicative of abdominal obesity and this was observed in females only (Table 2.0).

***Table 1.0.*** *Socio-demographic characteristics and health of study participants* [a]

| | Male (n=14) | Female (n=49) | Total (n=63) |
|---|---|---|---|
| Age group | | | |
| 21-30 | 0 (0.0) | 12 (28.6) | 12 (19.0) |
| 31-35 | 4 (28.6) | 12 (24.5) | 16 (25.4) |
| 36-40 | 6 (42.9) | 20 (40.8) | 26 (41.3) |
| 41-45 | 4 (28.6) | 5 (10.2) | 9 (14.3) |
| Marital status | | | |
| Single | 1 (7.1) | 8 (16.3) | 9 (14.3) |
| Married | 6 (42.9) | 18 (36.7) | 24 (38.1) |
| Widowed | 3 (21.4) | 17 (34.7) | 20 (31.7) |
| Divorced | 2 (14.3) | 3 (6.1) | 5 (7.9) |
| Cohabiting | 2 (14.3) | 3 (6.1) | 5 (7.9) |
| Level of education | | | |
| None | 1 (7.1) | 2 (4.1) | 3 (4.8) |
| Primary | 0 (0.0) | 10 (20.4) | 10 (15.9) |
| JSS/Middle | 5 (35.7) | 31 (63.3) | 36 (57.1) |
| SSS | 5 (35.7) | 3 (6.1) | 8 (12.7) |
| Vocational/Secretariat | 2 (14.3) | 2 (4.1) | 4 (6.3) |
| Non formal | 1 (7.1) | 1 (2.0) | 2 (3.2) |
| Current employment | | | |
| Employed | 9 (64.3) | 31 (63.3) | 40 (63.5) |

| | Male (n=14) | Female (n=49) | Total (n=63) |
|---|---|---|---|
| Unemployed | 5 (35.7) | 18 (36.7) | 23 (36.5) |
| Occupation category [b] | | | |
| Salaried workers | 1 (11.1) | 2 (6.5) | 3 (7.5) |
| Semi-skilled workers | 3 (33.3) | 7 (22.6) | 10 (25.0) |
| Unskilled workers | 5 (55.6) | 22 (44.9) | 27 (67.5) |
| Household size | | | |
| Between 2 and 3 | 3 (21.4) | 19 (38.8) | 22 (34.9) |
| Between 4 and 6 | 8 (57.1) | 21 (42.9) | 29 (46.0) |
| Between 7 and 10 | 1 (7.1) | 7 (14.3) | 8 (12.7) |
| More than 10 | 2 (14.3) | 2 (4.1) | 4 (6.3) |
| Illness reported | 3 (100) | 6 (37.5) | 19 (47.4) |
| Fever | 0 (0.0) | 2 (12.5) | 2 (10.5) |
| Diarrhoea | 0 (0.0) | 8 (50.0) | 8 (42.1) |
| Others | | | |

[a] Results presented as frequency and percentage; [b] those employed at the time of the study

***Table 2.0.*** *Malnutrition among study participants*[1]

| | Male (n=14) | Female (n=49) | Total (n=63) |
|---|---|---|---|
| *Body mass index* | | | |
| Underweight | 2 (14.3) | 3 (6.1) | 5 (7.9) |
| Overweight | 0 (0.00) | 12 (24.5) | 12 (19.0) |
| *Abdominal obesity* | | | |
| Waist circumference | 0 (0.0) | 11 (22.4) | 11 (17.5) |
| Waist-to-hip ratio | 4 (28.6) | 24 (49.0) | 28 (38.1) |
| *Deuterium oxide method* | | | |
| Reduced fat mass | 2 (14.3) | 3 (6.1) | 5 (7.9) |
| Reduced fat free mass | 0 (0.0) | 13 (26.7) | 13 (20.6) |

[1] Results presented as frequency and percentage

***Table 3.0.*** *Anthropometry, fat mass and fat free mass of participants*

| | Male (n=14) | Female (n=49) | Total (n=63) |
|---|---|---|---|
| *Anthropometry* | | | |
| Weight (kg) | 61.0 (57.1, 63.9) | 57.9 (49.7, 63.0) | 58.1 (50.3, 63.5 |
| Height (cm) | 173.0 (169.2, 175.2) | 160.8 (155.8, 165.7) | 162.3 (158.4, 169.2) |
| BMI ($kgm^2$) | 20.6 (18.9, 21.6) | 21.6 (19.8, 24.9) | 21.2 (19.8, 23.7) |
| Waist circum. (cm) | 77.4 (73.4, 82.7) | 82.4 (76.6, 87.3) | 82.0 (76.4, 85.9) |
| Hip circum. (cm) | 92.4 (87.9, 94.0) | 98.8 (89.7, 102.6) | 93.3 (89.2, 101.1) |
| Waist-hip ratio | 0.86 (0.82, 0.91) | 0.85 (0.82, 0.90) | 0.85 (0.82, 0.90) |
| MUAC (cm) | 28.8 (26.9, 29.6) | 27.6 (26.3, 30.4) | 27.8 27.4, 29.7) |
| Triceps (mm) | 5.5 (5.0, 7.3) | 12.4 (9.3, 19.3) | 11.2 (7.0, 18.1) |
| AFA | 7.5 (6.3, 10.1) | 16.3 (11.6, 25.1) | 14.0 (9.0, 23.9) |
| CAMA | 43.1 (38.1, 50.1) | 37.1 (31.9, 41.5) | 37.7 (33.7, 43.3) |
| *Deuterium oxide method* | | | |
| FFM (kg) | 52.7 (51.0, 56.4) | 40.1 (36.8, 45.6) | 44.2 (37.6, 48.5) |
| FFM (%) | 87.8 (86.6, 89.3) | 73.0 (66.0, 77.9) | 76.1 (68.7, 84.2) |
| FM (kg) | 7.4 (6.0, 8.4) | 15.5 (10.9, 21.1) | 13.4 (9.3, 18.7) |
| FM (%) | 12.2 (10.7, 13.5) | 27.5 (22.2, 34.0) | 24.9 (15.8, 31.3) |

Results presented as median (interquartile range)

### *3.3. Associations Among Measured Variables*

Good significant positive correlations were observed between fat free mass and arm muscle area (r = 0.529; p <0.001); and between fat mass and arm fat area (r = 0.767; p <0.001). Moreover, there were high positive correlations between percentage fat mass measured with the deuterium oxide method and other indicators of body fat (Table 4.0).

***Table 4.0.*** *Correlation between fat mass, fat free mass and anthropometry*

| | FM | FFM |
|---|---|---|
| Weight | 0.650; p< 0.001** | 0.623; p < 0.001* |
| Body mass index | 0.861; p < 0.001** | -.0106; p = 0.186 |
| Waist circumference | 0.702; p < 0.001** | 0.248; p < 0.05* |
| Hip circumference | 0.861; p < 0.001** | 0.193; p = 0.130 |
| Waist-to-hip ratio | -0.150; p = 0.241 | 0.060; p = 0.639 |
| Mid upper arm circumference | 0.590; p < 0.001** | 0.395; p < 0.001** |
| Triceps | 0.761; p < 0.001** | -0.106; p = 406 |
| Arm fat area | 0.767; p < 0.001** | -0.041; p = 0.751 |
| Arm muscle area | -0.057; p = 657 | 0.529; p < 0.001** |

**Correlation is significant at the 0.001 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed

# 4. Discussion

Body composition is important for nutritional studies of HIV infected individuals as an indicator of health and performance status even in the era of ART. Most studies involving the nutritional status of PLHIV in Ghana have been confined to hospitals, particularly the referral hospitals such as Korle-Bu and Komfo Anokye Teaching Hospitals. BMI and skinfold thickness have been the most commonly used conventional methods in majority of these studies. This is one of the first studies that combined anthropometry with deuterium oxide dilution technique to assess body composition among a sample of free living individuals with membership in support groups for PLHIV/AIDS in Ghana.

The deuterium oxide method revealed an overall reduced fat mass and fat free mass among participants. Whereas the BMI did not detect overall obesity, the deuterium oxide method classified 22% participants as obese. Percent FFM indicative of depleted muscle reserves was recorded in 27% of only female participants but not with arm muscle area. Similarly depleted fat stores were not detected using arm fat area. However, good significant positive correlations between fat free mass and arm muscle area, and between fat mass and arm fat area observed in the present study is consistent with the literature [18].

Sex differences in the HIV infection and body composition has been documented. Kotler *et al* [1] have reported females who are HIV negative have more body fat than HIV-positive females while males had more fat free mass than females irrespective of HIV status. Females in the present study generally tend to be heavier compared to their height with significant high fat mass. This is consistent with the observation in a sample of Ghanaian adults living with HIV [19]. Compared to the report of Visnegarwala [20] however, participants in the current study have reduced fat mass and fat free mass.

Waist circumference and waist-hip ratio increase with the accumulation of visceral fat in individuals with or without HIV infection [1, 25]. In healthy populations this has been attributed to dietary intake [25] whereas in HIV positive individuals on Highly Active Antiretroviral Therapy (HAART) abdominal fat deposition has been identified as a common morphological alteration. A high proportion of participants in the present study have developed abdominal obesity. This mirrors findings reported elsewhere [21-22]. The trend predisposes participants in the present study to cardiometabolic complications [23] in addition to the known health complications associated with the infection.

There is evidence to suggest that the high WHR in PLHIV who are on ART is due to prescription of protease inhibitors resulting in decreased hip circumference as opposed to faster fat deposition in the waist [24]. ART regimen used in Ghana is based on the HAART involving triple drug therapy but no quantitative data on duration and specific drugs was collected in the present study. However two-thirds of participants in the present study were on ART. The inverse association observed suggests that those on ART have increasing waist-to-hip ratio, and waist circumference as opposed to those not on ART since no such association was observed with dietary intake [26].

# 5. Conclusion

The study demonstrates some level of malnutrition among the study participants. Depleted FFM and FM were observed. The incidence of abdominal obesity was high especially among females. This study underscores the importance of body composition as a measure for monitoring changes in PLHIV. It is recommended that measurements of waist and hip circumferences should form part of the assessment tools used in monitoring PLHIV to help in identifying those on ART therapy that are at risk of developing abdominal obesity. This may be helpful in modifying treatment regimens when necessary. In addition, regular screening for hypertension and diabetes is recommended.

It is recommended that simpler field techniques such as anthropometry and bioelectrical impedance technique that are already being used in body composition studies be validated with the deuterium oxide method, which is more sensitive and accurate to detect changes in fat mass and fat free mass.

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