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Research article

Nutritional aberration and related morphological disorders among patients with human immunodeficiency virus infection on combination antiretroviral therapy (cART) in Ghana: A retrospective study

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ABSTRACT

Background: Metabolic and nutritional abnormalities among people living with human immunodeficiency virus (PLHIV) have been reported due to either their HIV infection, primary malnutrition caused by insufficient intake or consequences of the ART regimen provided. This study investigated the prevalence and patterns of nutritional abnormalities including morphological changes among HIV patients under combination Antiretroviral Therapy (cART) in the Bia-West District of the Western North Region.

Methods: We employed a hospital-based retrospective longitudinal design. Records of 180 patients with HIV infection before and after antiretroviral therapy (ART) initiation were extracted at the Essam Government Hospital. Eligibility criteria included being on treatment without change in regimen for at least one year and without defaulting in scheduled visits. Data extracted included patients' demography, nutritional parameters and medication history. We assessed patients' nutritional characteristics with the subjective global assessment (SGA) tool which includes five components of medical history (weight change, dietary intake, gastrointestinal symptoms, functional capacity & metabolic stress) and two components of physical examination (signs of fat loss and muscle wasting, alterations in fluid balance).

Results: Malnutrition, lipodystrophy and body wasting among HIV patients were 48.3% (36.5–62.4), 43.9% (32.6–57.7) and 33.3% (23.6–46.0) respectively. Incremental percentage trends of malnutrition (stage I- 7.4%, stage II -22.4%, stage III-24.7%) and lipodystrophy (Stage I - 22.2%, Stage II - 48.7%, Stage III - 51.9%) were significantly associated with worsening disease status. Patients on AZT+3TC + NVP combined regimen presented with the highest malnutrition [52.9% (28.5–76.1)], lipodystrophy [64.7% (38.6–84.7)] and loss of muscle mass [47.1% (23.9–71.5)]. Long-term ART use was significantly associated with high malnutrition rate *($p = 0.02620$)* and increasing muscle mass loss *($p = 0.0040$)*.

Conclusion: High malnutrition, lipodystrophy and muscle wasting exist in PLHIV on cART in the Bia-West District. These adverse nutritional effects may be modulated by disease severity, ARV medication and duration.

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1. Introduction

Globally, major improvements have been made in the protocol for caring and supporting persons living with HIV (PLHIV) since the introduction of effective antiretroviral therapy (ART) resulting in substantial improvements in morbidity and mortality. In fact, patients on antiretroviral therapy (ART) management are expected to achieve near to normal longevity [1]. Nonetheless, these gains have generated concerns about the health and nutritional status of PLHIV. Several reports have indicated metabolic and nutritional abnormalities among PLHIV [2, 3, 4], which are either HIV infection related [1], due to primary malnutrition caused by insufficient intake [2] or consequences of the ART regimen provided. Long-term ART use has been associated with morphological changes and metabolic complications including lipodystrophy [5] which is characterized by peripheral fat loss in the face, limbs, and buttocks, as well as central fat accumulation in the abdomen and breasts and over the dorsocervical spine and lipomas [6]. Body fat changes have also been linked to psychological trauma, depression and anxiety which may be severe enough to affect a patient's desire to continue with the HIV treatment, limit therapy options, and profoundly affect the quality of life [7]. This situation is further exacerbated by the continuous existence of HIV wasting syndrome [8], a chief complaint of PLHIVs since the epidemic erupted [9]. HIV wasting syndrome is characterized by unintended and progressive weight loss often accompanied by weakness, fever, nutritional deficiencies and diarrhea [8]. Though reports suggest that the incidence of wasting in HIV has decreased dramatically post-ART introduction [10,11], HIV wasting syndrome prevalence remains high, estimated between 14% and 38% [9]. In Ghana, however, there is dearth of data on nutritional anomalies and morphological irregularities in HIV management. This limits our understanding of the nature of the problem of changes in physical appearance among PLHIV. The present study was therefore designed to investigate the prevalence and patterns of nutritional abnormalities and morphological changes among HIV patients on cART management at the Essam Government Hospital in the Bia-West District of the Western North Region of Ghana.

2. Materials and methods

2.1. Study site and study area

Essam Government Hospital is a 96-bed capacity hospital which provides health needs including ART services for communities located within the Bia-West Districts and beyond. Bia-West District is located in the Western North Region of Ghana, with Essam as its capital, and has a total surface area of 1,287.265 square kilometres. The district shares boundaries with the Bia-East District to the north and east, the Republic of La Cote d'Ivoire to the west, and Juaboso District to the south. According to the 2010 population and housing census, the population of the district stands at 88,939 with 45,717 males and 43,222 females [12].

2.2. Study design and study population

We employed a hospital-based retrospective study with a longitudinal approach in this study. Records from 180 HIV infected patients' folders before and after initiation of combination Active Anti-Retroviral Therapy (cART) were reviewed at the ART Clinic of the Essam Government Hospital. Eligibility criteria included being on treatment without change in regimen for at least one year and without defaulting in scheduled visits.

2.3. Sampling technique

Convenience and purposive sampling techniques were used to retrieve folders of HIV/AIDS registrants at the ART Clinic of the Essam Government Hospital.

2.4. Sample size determination

Using the total number of registrants of PLHIV on ART at the ART Clinic of the Essam Government Hospital as of January 2018 (2000 patients), the Raosoft Online Sample Size Calculator was used to calculate the minimum sample size of 176 at 95% confidence interval, a 6% margin of error and a response distribution of 23.6% being the prevalence of nutritional abnormalities reported by Gebremichael, et al. [13].

2.5. Data collection

Information relevant for the study were extracted from patients' folders. Data extracted included patients' demography, nutritional parameters and medication history.

2.6. Nutritional assessment

PLHIV were classified using the subjective global assessment (SGA) tool. The SGA tool includes five components of a medical history (weight change, dietary intake, gastrointestinal (GI) symptoms, functional capacity, and metabolic stress). Also, three components of a brief physical examination were used. This includes signs of fat loss (lipodystrophy), muscle wasting and alterations in fluid balance. All these aforementioned parameters were obtained from patient's folders [14]. A qualified dietitian assessed the SGA scores and these were used to classify PLHIV as "normally nourished," "moderately malnourished" or "severely malnourished" as previously described [14].

2.7. Data analysis

Categorical variables were expressed as frequency and proportion with 95% confidence interval of the proportion calculated using the Wilson procedure with continuity correction [15]. Difference between proportions were tested using Fishers Exact test or Chi square test where appropriate. Trends were tested using Chi square test for trend. A p-value less than 0.05 was considered statistically significant. IBM Statistical Package for the Social Sciences version 22.00 was used for data analysis (SPSS Inc, Chicago, USA; www.spss.com).

3. Results

The average age of the study population was 38.6 ± 11.3 years, ranging from a minimum of 18–70 years, with majority falling within the 30-to-50-year age group. A greater percentage of patients were females [78.9% (72.1–84.5)], from a Christian background [83.9% (77.5–88.8)]. At the time of this study, majority of patients had attained at least basic education [65.6% (58.1–72.4)] and 83.2% (76.3–87.8) were working in the informal sector of employment (See Table 1).

Most of the patients were either in the second [42.2% (35.0–49.8)] or third stage [42.8% (35.5–50.4)] of the disease. All patients were on first line antiretroviral regimen, with majority on Tenofovir/Lamivudine/Efavirenz combination. Duration of therapy ranged from 1 year to 7 years. Pain on eating was the most predominant GI complaint, followed by dysphagia and diarrhoea (See Table 2).

Adequate nutritional intake was recorded in about a third [31.1% (24.6–38.5)] of the study sample. Apart from 8 patients that did not experience weight change from the initial weight to the present, equal proportions of patients experienced loss [47.8% (33.7–66.4)] and gain [47.8% (33.6–66.5)] in their weight during the period of ART treatment. Lipodystrophy was recorded in 43.9% (32.6–57.7) of patients with 20.0% (14.6–26.7) classified as severe. About a third [33.3% (23.6–46.0)] of the study sample were observed to have experienced loss of muscle mass, with 11.1% (7.1–16.9) classified as severe muscle loss. Thirty percent [30.0% (18.6–46.7)] of patients presented with both lipodystrophy and loss of muscle mass at varied degrees. Change in functional capacity was observed in almost half of patients as 31.1% (24.6–38.5) and 17.2%

Table 1. Demographic characteristics of people living with HIV in the Bia-West District.

Parameter	Frequency	Percentage (95% CI)
Total	180	100.0 (97.4–100.0)
Age Range		
<30 years	44	24.4 (18.5–31.5)
30–40 years	62	34.4 (27.6–41.9)
41–50 years	50	27.8 (21.5–35.0)
>50 years	24	13.4 (8.9–19.4)
Gender		
Female	142	78.9 (72.1–84.5)
Male	38	21.1 (15.5–27.9)
Marital Status		
Single	52	28.9 (22.5–36.2)
Married	92	51.1 (43.6–58.6)
Widow	17	9.44 (5.8–14.9)
Divorced	19	10.6 (6.6–16.2)
Religious Background		
Christian	151	83.9 (77.5–88.8)
Muslim	27	15.0 (10.3–21.3)
Traditional	2	1.1 (0.2–4.4)
Educational Background		
None	32	17.8 (12.7–24.3)
Basic	118	65.6 (58.1–72.4)
Secondary	25	13.9 (9.4–20.0)
Tertiary	5	2.8 (1.0–6.7)
Occupation		
None	15	8.4 (4.9–13.6)
Informal	149	83.2 (76.3–87.8)
Formal	15	8.4 (4.9–13.6)

Data presented as frequency and percentages and 95% confidence interval of the proportion in parenthesis.

Table 2. Pharmacological and Clinical profile of people living with HIV in the Bia-West District.

Parameter	Frequency	Percentage (95% CI)
WHO Stage of disease		
Stage 1	27	15.0 (10.3–21.3)
Stage 2	76	42.2 (35.0–49.8)
Stage 3	77	42.78 (35.5–50.4)
cART Regimen		
Tenofovir/Lamivudine/Efavirenz	122	67.8 (60.4–74.4)
Tenofovir/Lamivudine/Nevirapine	23	12.8 (8.4–18.8)
Zidovudine/Lamivudine/Nevirapine	17	9.4 (5.8–14.9)
Zidovudine/Lamivudine/Efavirenz	15	8.3 (4.9–13.6)
Tenofovir/Emtricitabine/Efivarenz	3	1.7 (0.4–5.2)
Duration on ART		
1–2 years	65	36.1 (29.2–43.6)
3–4 years	95	52.8 (45.2–60.2)
5–7 years	20	11.1 (7.1–16.9)
GI Symptoms		
Pain on eating	63	35.0 (28.2–42.5)
Dysphagia	52	28.9 (22.5–36.2)
Diarrhoea	49	27.2 (21.0–34.4)
Vomiting nausea	19	10.6 (6.6–16.2)
Dental problems	18	10.0 (6.2–15.6)
Gastritis	6	3.3 (13.6–7.4)
Constipation	3	1.7 (0.4–5.2)

Data presented as frequency and percentages and 95% confidence interval of the proportion in parenthesis.

(12.2–23.7) experienced increased and decreased functional capacity, respectively. Among the 180 patients, 87 [48.3% (36.5–62.4)] were malnourished, with 27.2% (21.0–34.4) classified as moderate and 21.1% (15.5–27.9) as severely malnourished. Cachexia and Sarcopenia was recorded in 8.3% (4.9–13.6) and 7.2% (4.1–12.3) respectively, with 16.1% (11.2–22.5) presenting with both (See Table 3).

It was observed that nutritional status deteriorated with the advancement of the disease. Majority of patients in the stage I of the disease (81.5%) were well nourished as compared to 47.5% of those in stage II and 45.5% of those in stage III. Severely malnourished patients were significantly tilted toward stage III (24.7%), followed by stage II (22.4%) and stage I (7.4%) (Figure 1A). Though not statistically significant, there was a progressive improvement in nutritional status as education levels increased until the secondary school level. However, the tertiary group bucked the trend with the highest percentage of moderately malnourished persons (60%) (Figure 1B). Longer periods of ARV treatment were accompanied by higher rates of malnutrition (p for trend 0.02620). Majority of patients who have been on therapy for more than four years, clustered at either severely malnourished (40%) or moderately malnourished (25%) (Figure 1C). Majority of patients who were forty years or lower were found to be well nourished, while the reverse was observed among those over forty, though not statistically significant (Figure 1D) (See Figure 1).

Table 3. Nutritional characteristics and Body composition of people living with HIV in the Bia-West District.

Percentage	Frequency	Percentage (95% CI)
Nutritional intake		
Adequate	56	31.1 (24.6–38.5)
Improved but inadequate	62	34.4 (27.6–41.9)
No improvement/inadequate	62	34.4 (27.6–41.9)
Weight Change		
No weight change	8	4.4 (2.1–8.9)
>10% loss	46	25.6 (19.5–32.7)
>5% loss	22	12.2 (8.0–18.1)
<5% loss	18	10.0 (6.2–15.6)
<5% gain	43	23.9 (18.0–30.9)
>5% gain	26	14.4 (9.8–20.6)
>10% gain	17	9.4 (5.8–14.9)
Physical Appearance		
Mild Lipodystrophy	43	23.9 (18.0–30.9)
Severe Lipodystrophy	36	20.0 (14.6–26.7)
Mild loss of muscle mass	40	22.2 (16.5–29.1)
Severe loss of muscle mass	20	11.1 (7.1–16.9)
Mild Lipodystrophy + Mild LMM	18	10.0 (6.2–15.6)
Severe Lipodystrophy + Mild LMM	17	9.4 (5.8–14.9)
Severe Lipodystrophy + Severe LMM	19	10.6 (6.6–16.2)
Functional Capacity		
No Change	93	51.7 (44.1–59.1)
Decrease	31	17.2 (12.2–23.7)
Increase	56	31.1 (24.6–38.5)
High Metabolic Requirement	126	70.0 (62.7–76.5)
SGA Rating		
Well nourished	93	51.7 (44.1–59.1)
Moderately Malnourished	49	27.2 (21.0–34.4)
Severely Malnourished	38	21.1 (15.5–27.9)
Contributing factor		
Cachexia	15	8.3 (4.9–13.6)
Sarcopenia	13	7.2 (4.1–12.3)
Cachexia + sarcopenia	29	16.1 (11.2–22.5)

Data presented as frequency and percentages and 95% confidence interval of the proportion in parenthesis.

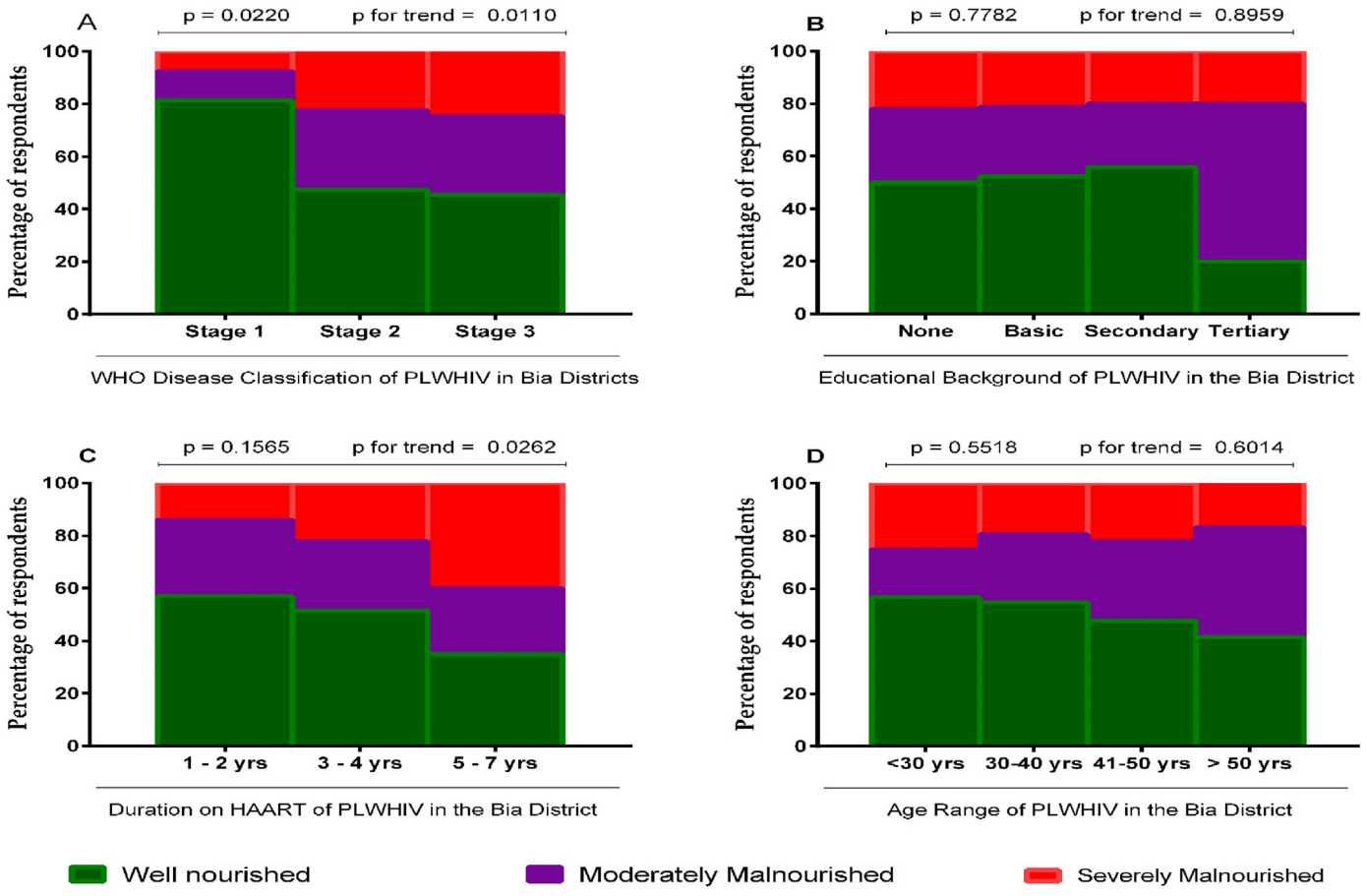

Figure 1. Factors affecting malnutrition among people living with HIV (PLHIV) in the Bia-West District.

In the continuum of lipodystrophy, 40.0%, 47.4% and 60.0% were observed for the scalar duration of ARV treatment from within 2 years to more than 4 years of treatment respectively. Similarly, at the degree of lipodystrophy, severe lipodystrophy ranged from a minimum of 12.3% to a maximum of 35.0% for within 2 years of treatment to 5 years or more (Figure 2A). An increasing trend of percentage lipodystrophy was observed with worsening disease stage (Stage I - 22.2%, Stage II - 48.7%, Stage III - 51.9%) (Figure 2B). Longer period on ARV treatment was found to significantly associate with increasing loss of muscle mass, ranging from a minimum of 26.2% to a maximum of 60.0% (Figure 2C). When loss of muscle mass was stratified by disease stage, loss of muscle mass peaked among those classified as stage II of the disease (Figure 2D) (See Figure 2).

With regard to ART combination therapy, patients on AZT+3TC + NVP regimen presented with the highest rate of malnutrition [52.9% (28.5–76.1)], lipodystrophy [64.7% (38.6–84.7)] and loss of muscle mass [47.1% (23.9–71.5)]. Patients on TDF+3TC + EFV and TDF+3TC + NVP regimens presented with second and third highest malnutrition and lipodystrophy proportions respectively. The second and the third regimen implicative of loss of muscle mass were TDF+3TC + NVP and TDF+3TC + EFV respectively. As seen in Table 4, Tenofovir was the drug with the highest proportion of malnourished patients, followed by Lamivudine. Nevirapine, Zidovudine and Lamivudine were the drugs with the highest, second and third highest lipodystrophy and loss of muscle mass respectively (Table 4).

A significant proportion of PLHIV with insufficient dietary intake developed lipodystrophy [severe (48.4%) or mild (29.0%), $p < 0.0001$]. Meanwhile, the majority of PLHIV on ART with appropriate nutritional intake were normal (75.0%), with little evidence of lipodystrophy ($p < 0.0001$). Similarly, as compared to patients with inadequate nutritional intake, only 11.3% whose nutritional intake improved had lipodystrophy while the majority (62.9%) were normal (See Figure 3A). Patients with adequate nutritional intake had significantly less severe muscle loss (2.0%) compared with those who had improved intake (7.7 %) or inadequate intake (27.8%) [$p < 0.0001$] (see Table 3B). In addition, patients with adequate nutritional intake significantly gained more weight (71.4%) than those whose intakes were improved (53.3%) or inadequate (21.0%) [$p < 00001$] (See Figure 3C).

4. Discussion

In the present study, we found that majority [42.8% (35.5–50.4)] of the HIV infected patients were in the clinical third stage of the disease based on the WHO clinical staging system for HIV/AIDS [16]. All patients were on first line antiretroviral management, with majority [67.8% (60.4–74.4)] on Tenofovir/Lamivudine/Efavirenz combination for a duration of 1–7 years at the time of this study (Table 2). The clinical and pharmacological profile of PLHIV in this study compares favourably with similar works undertaken previously where averagely HIV individuals on 3–4 years of antiretroviral medication were associated with advanced stages of the disease [13, 17, 18, 19, 20].

Malnutrition poses a major threat to the health of PLHIV and is consistently associated with increased risks of morbidity and mortality among this vulnerable population [21, 22, 23]. In the current study, out of a total of 180 patients, we observed 48.3% (36.5–62.4) to be malnourished, while 27.2% (21.0–34.4) and 21.1% (15.5–27.9) presented with moderate and severe malnutrition respectively (See Table 3). This finding suggests a high malnutrition rate among patients with HIV infection in the Bia-West District of the Western North Region of Ghana. Gebremichael, et al. [13] recently reported a lower prevalence of malnutrition (23.6%) among PLHIV in Central Ethiopia. In Nigeria, Obi, et al. [24] recorded 58.3% of mild to moderate malnutrition and 32.5%

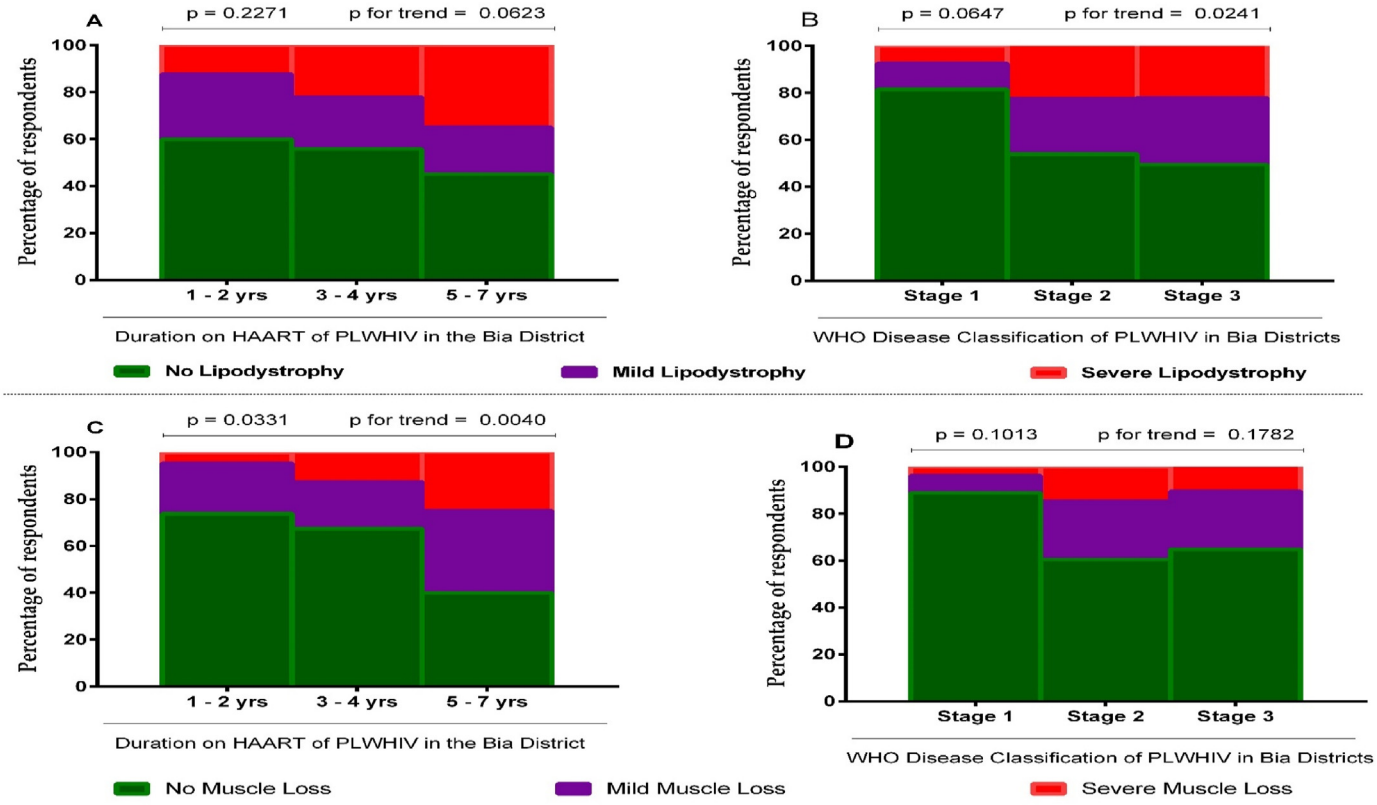

Figure 2. Factors affecting abnormal body composition among PLHIV in the Bia-West District stratified by duration of ART and stage of disease. A & B -Lipodystrophy, C & D- Loss of Muscle Mass.

of severe malnutrition among HIV-positive individuals on ART at a Tertiary Hospital. A number of factors have been proposed to contribute to malnutrition in people with HIV infection. These include metabolic alterations, infection, fever, gastrointestinal (GI) changes and illnesses, developmental/neurological problems, and economic and psychosocial issues [25]. At the time of this study, self-report of pain on eating [35.0% (28.2–42.5)], dysphagia [28.9% (22.5–36.2)] and diarrhoea [27.2% (21.0–34.4)] were the predominant GI complaints (Table 2). The GI changes observed in our study are partly consistent with the assertions posited by Garcia-Prats, et al. [25]. The individual's inability to eat food secondary to complicated medical regimens or fatigue could exacerbate the nutritional risk [26]. Moreover, HIV-related enteropathy is associated with a reduction in the immunologic capacity of the gastrointestinal tract, resulting in villous atrophy, leading to diarrhoea and malabsorption; processes which can further be aggravated by opportunistic enteric pathogens [22].

In HIV infection, poor nutritional status is thought to be associated with disease progression [27]. In line with this view, our study revealed a deterioration of nutritional status with the severity of HIV infection. While majority of the well-nourished patients were found in stage I of the disease (81.5%), only 47.5% and 45.5% of the well-nourished patients recorded clinical syndromes consistent with stages II and III of the disease respectively. Moreover, patients with severe malnutrition were significantly clustered in stage III (24.7%), followed by stage II (22.4%) and stage I (7.4%) (Figure 1A). Our findings are in tandem with those reported previously in Ethiopia [13], Uganda [28], Zimbabwe [29] and Nepal [30]. There is evidence to the effect that HIV-induced immune impairment and the subsequent increase in the risk of opportunistic infections can worsen nutritional status [31]. Notably, among the cART, patients on AZT+3TC + NVP regimen [52.9% (28.5–76.1)] and those on Tenofovir (single drug) treatment [49.3% (41.1–57.6)] presented with the highest rate of malnutrition (Table 4). Prolonged period of ARV treatment was significantly associated with a higher rate of malnutrition (p for trend 0.02620) (Figure 1C). It is quite unclear from this study the precise mechanism that underlies the effect of ARV medication on malnutrition in HIV infection. However, according to Clay and Crutchley [32], the side effects attributable to HIV and ARV, particularly diarrhoea and nausea tend to promote inadequate dietary intake and weight loss.

Lipodystrophy is characterized by subcutaneous peripheral fat loss and/or visceral adiposity often accompanied by metabolic abnormalities in people with HIV infection on ART [33, 34]. The disorder could also predispose to increased cardiovascular risk [33]. In the current study, lipodystrophy was recorded in 43.9% (32.6–57.7) of the HIV patients, with 20.0% (14.6–26.7) classified as severe lipodystrophy (Table 3). Zannou, et al. [35] reported 30% rate of lipodystrophy among HIV individuals in a similar study in Benin. In Geneva, Verolet, et al. [7] found 57.8% of HIV persons with lipodystrophy. Of these, 39.7% suffered from severe to very severe lipodystrophy. Moreover, an incremental percentage trend of lipodystrophy was observed with worsening disease status (Stage I - 22.2%, Stage II - 48.7%, Stage III - 51.9%) (Figure 2B) while inadequate nutritional intake was significantly linked to severe lipodystrophy (Figure 3A). The severity of HIV-infection, increased viral load, and low CD4 count are known to be determinant factors for HIV associated lipodystrophy [36]. However, we were unable to corroborate these assertions due to data unavailability on viral load and CD4 count in a resource-limited setting such as our study site, and it is therefore a limitation in the current study. Meanwhile, inadequate nutritional intake hampers the body's immunity, increases it's susceptibility to opportunistic infections [37] and worsens ART-associated lipodystrophy secondary to increased resting energy expenditure and higher rates of lipid oxidation in PLHIV [38]. Patients on AZT+3TC + NVP combined regimen [64.7% (38.6–84.7)] and those on component drug, Nevirapine [52.5% (36.3–68.2)] presented with the highest percentage of lipodystrophy (Table 4). Though not fully elucidated, the pathway proposed to link ARVs to the development of body fat redistribution in HIV infection has been described. This is thought to involve the binding of protease

inhibitors to the cytoplasmic retinoic-acid binding protein-1, inhibition of the action of lipoprotein receptor-related protein, a hepatic receptor important for chylomicron clearance, thus interfering with fatty acid metabolism [39].

Body muscle mass represents the structural protein pool and is a proxy measure of wasting or weight loss in HIV infection [40]. Wasting and weight loss have been strongly associated with increased risk of death among people with HIV infection [41]. In this study, the proportion of patients who experienced weight loss was 47.8% (33.7–66.4), and muscle mass loss, 33.3% (23.6–46.0) with 11.1% (7.1–16.9) severely affected. Cachexia and Sarcopenia was recorded in 8.3% (4.9–13.6) and 7.2% (4.1–12.3) respectively, while 16.1% (11.2–22.5) of patients presented with both disorders (Table 3). Moreover, inadequate nutritional intake was significantly associated with severe muscle and weight loss (Figure 3B&C). In a longitudinal study of Nutrition for Healthy Living (NFHL) cohort, 13.9% presented with weight loss and wasting at the entry point, whereas the overall prevalence was 38% after six months follow-up [42]. Change in functional capacity was observed in about half of the patients with 17.2% (12.2–23.7) experiencing a decrease in functional capacity (Table 3). Human immunodeficiency virus and ARV negatively influence oxygen kinetics, limiting the extraction or oxygen usage in the peripheral musculature, lowering physical fitness, and consequently, the individual's motivation to perform routine activities [43].

Long-term ARV treatment was found to be significantly associated with increasing loss of muscle mass, from 26.2% to 60.0% (Figure 2C). Patients on AZT+3TC + NVP combination recorded the highest loss of muscle mass (47.1%) while those on component drug, Nevirapine [42.5 (27.4–59.0)] presented with the greatest percentage loss of muscle mass (Table 4). The findings above suggest a probable role of ARV in muscle wasting, contrary to the view that ART is associated with increased body muscle mass. Grant, et al. [44] in their study of body composition among PLHIV reported significant increases in lean mass after ART initiation during the first 96 weeks. It is not apparent from our study, precisely how ARV medications affect muscle mass wasting among HIV people, however, it is said to involve multiplicity of factors [42]. Potential contributing factors include malnutrition, abnormal cytokine production and endocrine dysfunction; this influences protein turnover, resulting in a shift towards excess protein breakdown leading to muscle wasting [45].

Table 4. Body composition and malnutrition stratified by Antiretroviral regimen and component drug among PLHIV in the Bia-West District.

ARV Regimen	Well Nourished n [% (95 CI)]	Malnourished n [% (95 CI)]	Rank
AZT+3TC + NVP	8 [47.1 (23.9–71.5)]	9 [52.9 (28.5–76.1)]	1st
TDF+3TC + EFV	60 [49.2 (40.1–58.3)]	62 [50.8 (41.7–59.9)]	2nd
TDF+3TC + NVP	13 [56.5 (34.9–76.1)]	10 [43.5 (23.9–65.1)]	3rd
AZT+3TC + EFV	10 [66.7 (38.7–87.0)]	5 [33.3 (13.0–61.3)]	4th
TDF + FTC + EFV	2 [66.7 (12.5–98.2)]	1 [33.3 (1.8–87.5)]	4th
Component Drugs			
Tenofovir (TDF)	75 [50.7 (42.4–58.9)]	73 [49.3 (41.1–57.6)]	1st
Lamivudine (3TC)	91 [51.4 (43.8–58.9)]	86 [48.6 (41.1–56.2)]	2nd
Efavirenz (EFV)	72 [51.4 (42.9–59.9)]	68 [48.6 (40.1–57.1)]	3rd
Nevirapine (NVP)	21 [52.5 (36.3–68.2)]	19 [47.5 (31.8–63.7)]	4th
Zidovudine (AZT)	18 [56.3 (37.9–73.2)]	14 [43.8 (26.8–62.1)]	5th
Emtricabine (FTC)	2 [66.7 (12.5–98.2)]	1 [33.3 (1.8–87.5)]	6th
ARV Regimen	**No Lipodystrophy**	**Lipodystrophy**	**Rank**
AZT+3TC + NVP	6 [35.3 (15.3–61.4)]	11 [64.7 (38.6–84.7)]	1st
TDF+3TC + EFV	65 [53.3 (44.1–62.3)]	57 [46.7 (37.7–55.9)]	2nd
TDF+3TC + NVP	13 [56.5 (34.9–76.1)]	10 [43.5 (23.9–65.1)]	3rd
TDF + FTC + EFV	2 [66.7 (12.5–98.2)]	1 [33.3 (1.8–87.5)]	4th
AZT+3TC + EFV	11 [73.3 (44.8–91.1)]	4 [26.7 (8.9–55.2)]	5th
Component Drugs			
Nevirapine (NVP)	19 [47.5 (31.8–63.7)]	21 [52.5 (36.3–68.2)]	1st
Zidovudine (AZT)	17 [53.1 (35.0–70.5)]	15 [46.9 (29.5–65.0)]	2nd
Lamivudine (3TC)	95 [53.7 (46.0–61.1)]	82 [46.3 (38.9–54.0)]	3rd
Tenofovir (TDF)	80 [54.1 (45.7–62.2)]	68 [46.0 (37.8–54.3)]	4th
Efavirenz (EFV)	78 [55.7 (47.1–64.0)]	62 [44.3 (36.0–52.9)]	5th
Emtricabine (FTC)	2 [66.7 (12.5–98.2)]	1 [33.3 (1.8–87.5)]	6th
ARV Regimen	**No Muscle Loss**	**Muscle Loss**	**Rank**
AZT+3TC + NVP	9 [52.9 (28.5–76.1)]	8 [47.1 (23.9–71.5)]	1st
TDF+3TC + NVP	14 [60.9 (38.8–79.5)]	9 [39.1 (20.5–61.2)]	2nd
TDF+3TC + EFV	83 [68.0 (58.9–76.0)]	39 [32.0 (24.0–41.1)]	3rd
AZT+3TC + EFV	11 [73.3 (44.8–91.1)]	4 [26.7 (8.9–55.2)]	4th
Component Drugs			
Nevirapine (NVP)	23 [57.5 (41.0–72.6)]	17 [42.5 (27.4–59.0)]	1st
Zidovudine (AZT)	20 [62.5 (43.8–78.3)]	12 [37.5 (21.7–56.3)]	2nd
Lamivudine (3TC)	117 [66.1 (58.6–72.9)]	60 [33.9 (27.1–41.4)]	3rd
Tenofovir (TDF)	100 [67.6 (59.3–74.9)]	48 [32.4 (25.1–40.7)]	4th
Efavirenz (EFV)	97 [69.3 (60.8–76.3)]	43 [30.6 (23.4–39.2)]	5th

Data presented as frequency with corresponding percentage and 95% confidence interval of the proportion in parenthesis and ranks of nutritional abnormalities.

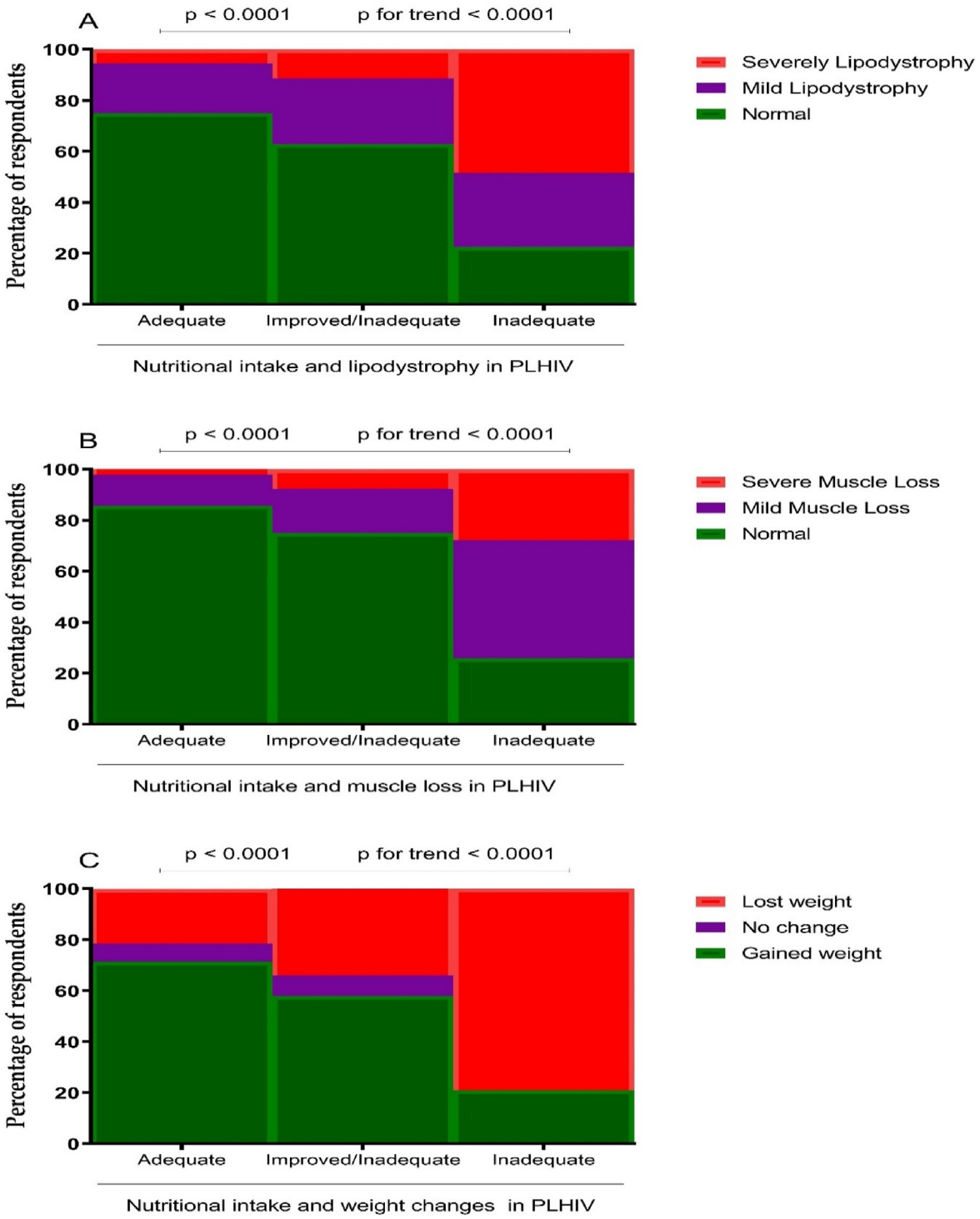

Figure 3. Relationship between nutritional intake and (A) lipodystrophy (B) muscle loss and (C) weight changes among PLHIV in the Bia-West District.

5. Conclusion

Nutritional aberrations manifesting as malnutrition, lipodystrophy and body muscle wasting exist among people living with HIV infection in the Bia-West District. These adverse nutritional effects may be modulated by disease severity, ARV medication and duration. This suggests that interventions to address malnutrition may be essential to reduce the prevalence of morphological changes in PLHIV on ART.

Ethical statements

Approval for the study was obtained from the Essam Government Hospital. Ethical clearance for the study was obtained from the Research Ethics Committee of the University of Health and Allied Sciences, Ho (UHASREC/A.5 [63] 17-18). The research was anonymous and non-linked and no patient's name or identity was extracted during data capture.

Declarations

Author contribution statement

Percival Delali Agordoh, Sylvester Yao Lokpo and James Osei-Yeboah: Conceived and designed the experiments, Performed the experiments, Analyzed and interpreted the data, Wrote the paper.

John Agyemang Sah, Lydia Enyonam Kuatsienu, Louis Selassie Ameke: Performed the experiments; Wrote the paper.

William K.B.A Owiredu, Verner N. Orish, Clement Okraku Tettey: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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