



Research article

Malnutrition in HIV infected children on antiretroviral drugs in a cohort of Ghanaian children

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ABSTRACT

Background: HIV infected children are at increased risk of malnutrition which worsens the depressed immune system, leading to poor disease prognosis.**Aim:** To assess the nutritional status of children between 6-12 years on antiretroviral drugs (ARV) at two health facilities in Accra.**Methods:** The study design was cross sectional among children between 6 and 12 years being administered with antiretroviral drugs at two hospitals in Accra. A purposive sample of 100 children was used. Height and weight measurements were taken and used to compute z-scores for stunting, underweight and wasting. Haemoglobin status was obtained from their folders. A semi-structured questionnaire was used to obtain sociodemographic data and a 24-hour dietary intake used to assess nutrient intakes. Data was analyzed using IBM SPSS version 20.0. Nutrient analysis was done using Micro diet version 3.0. Data was summarized using means and percentages. Chi-squared test was used to test for associations and statistical significance set at $p < 0.05$.**Results:** The prevalence of stunting, underweight and wasting was reported as 28%, 16% and 13% respectively. Girls were more stunted and wasted compared to boys. Mean haemoglobin concentration was 10.12 ± 2.77 g/dl. Mild, moderate and severe anaemia were reported in 14.2%, 41.1% and 12.5% of the children respectively. Apart from carbohydrates, less than 50% of the children were able to meet their requirements for the other nutrients[†].**Conclusions:** Our findings reveal high level of malnutrition among the children receiving ARV. There is the need for targeted nutrition interventions to improve the nutritional status of the children.

1. Introduction

In spite of recent gains made in combating malnutrition, high prevalence of childhood morbidity and mortality still persists. Childhood malnutrition is a major risk factor for childhood morbidity and mortality, causing about half of childhood deaths globally [1]. Food insecurity, poverty and the presence of infections such as HIV/AIDS are among the underlying factors for childhood malnutrition [2]. Globally, close to 2.6 million children less than 15 years have been infected with the HIV virus and a malnutrition prevalence rate of between 40- 64% in children with HIV/AIDS have been reported [3, 4, 5]. Furthermore, an average of almost a third (31%) of children in sub-Saharan Africa admitted to nutrition rehabilitation centers are diagnosed with HIV [6]. In Ghana, about 8.8% of the people living with HIV/AIDS were children as at the year 2018 [7].

Several factors put children with HIV infection at risk of malnutrition [2]. HIV/AIDS infection increases the risk of recurrent infections such as diarrhea and tuberculosis, which commonly lead to malnutrition [8]. Furthermore, infection with the HIV virus also results in growth failure and stunting [9, 10]. There is also an increase in the basal metabolic rate as a result of inflammation, opportunistic infections, viral replication and oxidative stress resulting in higher use of vitamins and minerals leading to their subsequent depletion [10]. Since HIV infected children may lose one or both parents, they become vulnerable to food insecurity, coupled with inadequate care and support, aggravating their risk of developing malnutrition [9].

Although initiation of antiretroviral drugs (ARV) improves the body's defense mechanism and enables these children to fight infections, it may not be sufficient for them to recover adequately from an already compromised nutritional state [11]. Moreover, the ARV's themselves can lead to malnutrition through the side-effects of drugs such as zidovudine,

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lamivudine, abacavir and stavudine, which cause nausea, vomiting, diarrhea and stomatitis [12]. Early nutritional intervention can slow down the progression, morbidity and mortality associated with HIV/AIDS in infected children, however, it needs to be associated with effective monitoring of nutritional status to enable the children who are most affected to be targeted and to evaluate the effects of the intervention [13]. Therefore, it has been strongly recommended that HIV-infected children should be routinely assessed for nutritional status, particularly after initiation of ARV [14].

Nutritional assessment is a critical component of the management of every child infected with HIV. Nutritional deficiencies are detected this way so that the level of nutritional support for HIV-infected children can be guided by their current nutritional status as well as by the presence of risk factors for malnutrition [15].

In Ghana and elsewhere, children with HIV infection are placed on ARV after diagnosis and they report routinely at special clinics for monitoring. As part of the monitoring, their nutritional status is assessed regularly to guide treatment. It is essential for health professionals to know how treatment is impacting on the nutritional status of these children. However, information on the effect of ARV's on nutritional status and the outcome of nutritional interventions in these children in Ghana is limited. Furthermore, there is lack of information on the full range of nutritional problems affecting Ghanaian children with HIV and the best way to identify and target them. Therefore, in this study we aimed at assessing the nutritional status of HIV infected children on ARV using anthropometric, haemoglobin concentration and dietary methods.

2. Methods

2.1. Study design and area

The study design was cross sectional carried out at the Department of Child Health, Korle-Bu Teaching Hospital and the Special Clinic for HIV Management of the Princess Marie Louise Hospital. These two health facilities were selected because they are both referral hospitals. Princess Marie Louise hospital is one of the few specialist children's hospitals in West Africa. It is an 81 bed capacity children's hospital and has the largest facility for treating children with severe malnutrition in Ghana [16]. The hospital attends to cases referred from other Greater Accra region hospitals and other parts of the country. The services provided by the Special clinic include: HIV testing, counseling and support services. Korle-Bu Teaching hospital is the premier and leading national referral/tertiary hospital in Ghana and the second largest teaching hospital in West Africa. The hospital has 2000 beds and has a child health department which specializes in handling medical and surgical cases of children under 13 years.

2.2. Study population

We recruited HIV infected children between the ages of 6–12 years, on ARV and enrolled on the HIV management programme in the selected health facilities. The age range 6–12 years was chosen because this period is described as the school going age where optimal nutrition is critical and has great influence on cognitive development and growth. Additionally, this age group is one of the least studied in the country. These children were attending the special clinics for HIV infected children for routine medical checkups and collection of ARV medications which are provided free of charge. Parents and other caregivers of all such children were approached and invited to be part of the study. Those who provided consent were recruited into the study. Consent was deemed to have been given when parent or caregiver signs or thumbprints the consent form after being fed with information on the project.

2.3. Sampling and sample size determination

A purposive sampling approach was employed where all caregivers/parents of potentially eligible participants were approached and briefed about the study. Caregivers/parents who consented were recruited into the study. HIV infected children without feeding disabilities, on antiretroviral drugs, within the ages of 6–12 years, enrolled on the HIV management programme in the health facilities and provided consent were included in the study. HIV infected children with feeding disabilities, not on antiretroviral drugs or those whose parents or caregivers refuse to consent were excluded. The expected sample size calculated with a confidence interval of 95% and an allowable error of 5% was 118 children.

$$\frac{Z_{1-\alpha/2} P(1-p)}{d^2}$$

$$= \frac{1.96^2 \times 0.084(1 - 0.084)}{0.05^2}$$

$$= 118$$

where; $Z_{1-\alpha/2}$ = standard normal variate at 5% type 1 error.

p = expected proportion in population based on previous studies

d = absolute error or precision.

Estimated sample size is **118 participants**.

However, this sample size could not be met during the stipulated data collection period because after a month, the same patients who had already been recruited kept coming. Therefore, a total of 100 HIV infected children were finally included in the data analysis 50 from each hospital.

2.4. Measurements

Data collection was undertaken by two research assistants. The research assistants received training on how to take anthropometric measurements and dietary assessment. They were also trained on how to administer the questionnaire for this study.

2.4.1. Background information

A semi-structured questionnaire was used to obtain demographic data including: age, gender, level of education of the child and level of education of parent/caregiver.

2.4.2. Anthropometric assessment

The weight and height of participants were measured using a digital weighing scale (Seca 770, Germany) and a stadiometer (Seca, Germany) respectively. Their height-for-age z-scores, weight-for-height z-scores and weight-for-age z-scores were assessed and compared with WHO (2007) child growth standards, to determine the prevalence of stunting, wasting and underweight respectively. Children whose height-for-age z-scores, weight-for age z-scores and weight-for-height z-scores were below -2 standard deviations of the WHO (2007) reference population were categorized as stunted, underweight and wasted respectively.

2.4.3. Dietary intake assessment

Energy and nutrient intakes were assessed using a 24-hour dietary recall. Parents and caregivers were aided with household measures to recall and estimate the quantities of foods eaten by their children over the past 24-hours. The estimated quantities were converted into grams and entered into the Micro diet version 3.0 nutrient analysis software. Nutrients and energy intakes were analyzed using the nutrient analysis software Micro diet version 3.0 which was incorporated with some Ghanaian foods.

2.4.4. Biochemical assessment

Data on haemoglobin concentration was obtained from the patient's folders and used as a proxy for biochemical measure of iron deficiency. Children who had haemoglobin concentrations less than 11.5 g/dl were categorized as having anaemia according to WHO classification of anaemia in children. The children were deemed to have mild, moderate and severe anaemia if they had haemoglobin concentrations between 11–11.4 g/dl, 8–10.9 g/dl and <8 g/dl respectively [17].

2.5. Data analysis

The Z-scores were calculated using WHO anthroplus calculator (version 1.0.4). The data obtained was analyzed using SPSS version 23.0. Categorical variables were summarized using frequencies and percentages and reported using tables. Statistical inference was made using Chi-squared to test for associations between anthropometric indices, anaemia categories and gender. T-tests were used to test for differences between means of nutrient intakes among boys and girls. Statistical significance was set at p-value <0.05.

2.6. Ethical considerations

Ethical approval was obtained from the Ethics and Protocol Review committee of the Korle-Bu Teaching Hospital and the School of Biomedical and Allied Health Sciences (SBAHS/10425986/AA/AD). Permission to conduct the research in the various hospitals was granted by the Medical Directors in charge of the hospitals. Participation was voluntary. Confidentiality and anonymity were ensured and written informed consent by way of obtaining signature or thumbprint was secured from parents or caregivers before each interview. The data was kept confidential and coded such that the final result could not be traced to individual patients.

3. Results

3.1. Background of children

Altogether, 100 children with HIV infection on ARV's were recruited for the study. These children included 55% males and 45% females. About two thirds of the children were in the age group, 9–10 years and 11–12 years (Table 1). Majority (36%) of the respondents were first-born children of the caregivers. Among the caregivers, 60% were married (Table 1). About 75% of the children were living with their actual parents.

3.2. Energy and nutrient intakes of children

The mean energy and nutrient intakes of the children are reported in Table 2. Results obtained suggests that nutrient intakes were widely distributed. The adequacy of their nutrients when compared to the Estimated Average Requirements (EAR) is reported in Table 3. More than fifty percent of the children met their required intake for carbohydrate and vitamin B₁₂. Intake of vitamin C and folate was rarely met.

3.3. Haemoglobin concentration and anthropometric indices of children

Table 4 provides a summary of the nutritional status of the study subjects based on anthropometry and haemoglobin status. Prevalence of malnutrition based on stunting, underweight and wasting was 28%, 16% and 13% respectively. There were no significant differences in anthropometric measurements among gender but girls were found to be more stunted than boys. Data on haemoglobin was available for 56 of the children because it was retrieved from their folders. The mean haemoglobin concentration was 10.12 ± 2.77 g/dl. About 67.9% of the children were found to be anaemic based on low haemoglobin status of <11.5 g/dl.

Table 1. Background information of the children (N = 100).

Variable	Frequency	Percent
Age		
6–8	32	32.0
9–10	34	34.0
11–12	34	34.0
Gender		
Male	55	55.0
Female	45	45.0
Birth order of Child		
First born	36	36.0
Second born	31	31.0
Third born	19	19.0
Fourth born	8	8.0
Fifth born	4	4.0
Sixth born	2	2.0
Marital status of Caregiver		
Single	23	23.0
Married	60	60.0
Divorced/separated	4	4.0
Educational level of caregiver		
None	20.0	20.0
Primary	17	17.0
Secondary	52	52.0
Tertiary	11	11.1
Relationship of caregiver to child		
Mother	62	62.0
Father	13	13.0
Grandmother	25	25.0

4. Discussion

Malnutrition is one of the common complications of the HIV infection. This study assessed the nutritional status and dietary intake adequacy in a group of HIV infected children living in Ghana. The overall prevalence of stunting, wasting and underweight was 28%, 13% and 16% respectively. These figures are much higher than the national average of 19%, 5% and 11% for stunting, wasting and underweight respectively as reported in the last Ghana Demographic Health survey [18]. The reason for this disparity can be attributed to the fact that nutritional requirements increase significantly in HIV. Caloric requirements increase to about 150% and micronutrients to about 5 times more in HIV positive children compared to HIV negative children. Additionally, HIV children are more prone to coinfections and chronic diarrhea as a result of HIV enteropathy [19]. The findings of this study are similar to those reported in other studies among Tanzania and Nigerian HIV infected children [11, 20]. In Tanzanian, stunting, underweight and wasting were reported to be 36.6%, 22.1% and 13.6% respectively while in Nigeria 23.7% and 20.2% were underweight and stunted respectively. In a related study in southern India, Padmapriyadarsini and colleagues [21] found a higher prevalence of stunting (58%), wasting (16%) and underweight (63%). The disparities may be explained by the fact that the Ghanaian children in this study were on ART while in the other studies the children were not on ART's. Although we do not have the pre-treatment anthropometric measurements, it appears that in this instance ART has proven to be protective and this could have been due to a decrease in the degree of disease progression by increasing immunity thereby decreasing morbidity. However, the administration of the ART alone was not enough to curb malnutrition in these children since some of them were malnourished as has been demonstrated by this present study and other studies [11].

An earlier systematic review and meta-analysis reported boys being more stunted compared to girls [22]. This study however reported

Table 2. Energy and nutrient intakes among the children.

Nutrients	Boys Mean (SD)	Girls Mean (SD)	Total Mean (SD)	EAR/Day	P- Value
Protein (g)	39.23 (24.97)	42.26 (23.45)	40.59 (24.23)	0.76 g/ kg/d	0.53
Fat	30 (18)	32 (17)	31 (18)	-	0.61
Carbohydrate (g)	227 (116)	226 (72)	227 (99)	100	0.94
Energy (kcal)	1325 (661)	1310 (449)	1318 (573)	1600* 2000	0.89
Calcium (mg)	397 (324)	413 (302)	404 (313)	800* 1,100	0.80
Iron (mg)	13.1 (9.5)	18.7 (33.1)	15.6 (23.3)	4.1* 5.9	0.24
Zinc (mg)	7.1 (7.5)	8.2 (16.0)	7.6 (12.1)	4.0* 7.0	0.65
Iodine (µg)	19 (19)	16 (15)	17 (17)	65* 73	0.42
Vitamin (B1) (mg)	0.68 (0.84)	0.56 (0.24)	0.63 (0.65)	0.5* 0.7	0.36
Vitamin (B2) (mg)	0.5 (0.8)	0.4 (0.5)	0.5 (0.7)	0.5* 0.8	0.85
Vitamin B6 (mg/ d)	0.4 (1.1)	0.24 (0.2)	0.3 (0.8)	0.5* 0.8	0.24
Vitamin B12 (µg)	5.6 (18.2)	6.6 (16.7)	6.1 (17.4)	1* 1.5	0.77
Vitamin C (mg)	57 (54)	46 (47)	52 (51)	22* 39	0.28
Niacin (mg)	7 (4)	7 (6)	7 (5)	6* 9	0.41
Folate (µg)	37 (35)	37 (34)	37 (34)	160* 250	0.96
Total Vitamin A	623 (303)	536 (653)	584 (880)	275* 445	0.62

* EAR for children < 9 years.

Table 3. Proportion of children who met their nutrient intakes.

Nutrients	Boys n = 55 n (%)	Girls n = 45 n (%)	Total = 100 n (%)
Energy (kcal)	2 (3.6)	2 (4.4)	4 (4.0)
Protein(g)	9 (16.4)	6 (13.3)	15 (15.0)
Carbohydrate (g)	48 (87.2)	43 (95.5)	91 (91.0)
Calcium (mg)	4 (7.3)	3 (6.7)	7 (7.0)
Iron (mg)	29 (52.7)	20 (44.4)	49 (49.0)
Thiamine (B1) (mg)	6 (10.9)	7 (15.6)	13 (13.0)
Riboflavin (B2) (mg)	8 (14.5)	2 (4.4)	20 (20.0)
Vitamin B6 (µg)	12 (21.8)	8 (17.8)	20 (20.0)
Vitamin B12 (µg)	36 (65.5)	27 (60.0)	63 (63.0)
Vitamin C (mg)	0 (0.0)	0 (0.0)	0 (0.0)
Folate (µg)	0 (0.0)	0 (0.0)	0 (0.0)
Total Vitamin A (µg)	19 (34.5)	20 (44.4)	39 (39.0)

otherwise, where girls were found to be more stunted than boys. The earlier studies attribute the results of their findings to boys being more susceptible to infections and therefore impacting negatively on their nutrition. In this study, one may raise the likelihood of girls being discriminated against by virtue of their sex as is common in several African countries and therefore not receiving the required nutrition compared to the boys. This is an assertion that needs further investigation to ascertain particularly in the population studied.

We found that, only a few met their energy requirement and the mean energy intake based on the 24-hour dietary recall was 1318 (573) kcal. Therefore, special measures are needed to address this deficiency in energy intake. This can be done by encouraging caregivers to give their

Table 4. Prevalence of stunting, underweight, wasting and anaemia status among the children.

Variable	Boys (n = 55) n (%)	Girls (n = 45) n (%)	Total (n = 100) n (%)	P- value
Anthropometry				
Height-for-age (Stunting)	12 (21.8)	16 (35.6)	28 (28.0)	0.110
Weight-for-age (Underweight)	9 (16.4)	7 (15.6)	16 (16.0)	0.771
Weight-for-height (Wasting)	5 (9.1)	8 (17.8)	13 (13.0)	0.232
Anaemia				
	Boys (n = 28)	Girls (n = 28)	Total (n = 56)	
Mean (10.12 ± 2.77 g/dl)				
Total anaemia (Hb < 11.5 g/dl)	23 (41.1)	15 (26.7)	38 (67.8)	0.230
Mild anaemia (Hb 11.0–11.4)g/dl	4 (7.1)	4 (7.1)	8 (14.2)	
Moderate anaemia (Hb 8–10.9) g/dl	14 (25.0)	9 (16.1)	23 (41.1)	
Severe anaemia (Hb < 8) g/dl	5 (8.9)	2 (3.6)	7 (12.5)	

children high caloric meals such as palm nut soup, groundnut soup, palava sauce, and okro stew, served with rice, yam, cassava etc.

The average protein intake in this study was however higher than what was reported in a similar study in Malawi [23]. The nutritional requirement, particularly with regards to protein, increases among children infected with HIV because it is needed to maintain muscle mass [23]. Thus, encouraging HIV infected children to incorporate various sources of protein such as eggs, legumes, fish, meat, poultry and nuts in their diet is essential in maintaining health in this and other similar settings. It is also important to target children who are failing to meet their protein requirement.

Micronutrients generally aid the body in fighting opportunistic infections. Majority of children in this study had inadequate intakes of micronutrients particularly folate and vitamin C which could be attributed to several factors. The inadequate intake could be attributed to poverty, lack of knowledge and anorexia or malabsorption from recurrent diarrhea which sometimes affects children with this condition [12]. Micronutrients play a vital role in the growth and immunity of children living with HIV/AIDS. Thus, it is imperative that measures be put in place to provide this population with the recommended requirements for these nutrients for growth and good disease prognosis. In addition to the general nutrition advice given to these children more emphasis can be given to foods containing vitamin C and folate. Further investigation using a more representative sample size is needed so that if the same micronutrients are consistently deficient, vitamin C and folic acid supplementation could be considered in this setting.

Iron is essential in the diet of children due to their rapidly expanding blood volume and growth. Forty nine percent of the children met their iron requirements. Anaemia classified by low haemoglobin status less than 11.5 gm/dl was prevalent in 67.8% of the 56 children whose haemoglobin records were obtained. Although sickle cell thalassaemia or alpha thalassaemia could yield similar results, this finding is worrying and needs further investigation. In two separate studies in Uganda, anaemia prevalence in HIV infected children was reported to be 91.7% and 57.6% respectively [24, 25]. In another report from India, anaemia prevalence of 45.5% among the children was observed [26]. A study by Shet et al., reported 66% prevalence for iron deficiency anaemia with majority having mild anaemia [27]. However majority of patients in this study rather had moderate anaemia. The aetiology of anaemia in HIV infection in children is multi-factorial [28]. This includes malnutrition and malabsorption of nutrients, suppression of erythropoiesis, increased metabolic demands and HIV associated malignancies [27, 28]. In

addition to malabsorption and infections contributing to anaemia among these children, opportunistic infections affecting the bone marrow mainly due to the chronic nature of the disease, the drugs used in the treatment of HIV have also been implicated as a cause of anaemia in people on ART. Drugs such as zidovudine have been reported to affect synthesis of haemoglobin [12]. This is hypothesized to be as a result of zidovudine suppressing red blood cell formation or inhibiting erythroid stem cells and so ensuring red cell aplasia.

It is well established that anaemia in children produces not only short-term effects such as fatigue and apathy but has long-term impacts including poor cognitive development in children. The need to address malnutrition including anaemia in HIV infected children is critical because of its effect on disease progression as well as its impact on school performance and physical growth which tends to affect the prognosis and economic impact of the disease [25]. Additionally, the high burden of anaemia and malnutrition among West African children further emphasizes the need for targeted nutrition interventions for children living with HIV/AIDS in this setting. To improve nutritional status and health, the intake of a healthy diet that provides the body with all the essential macro and micronutrients needed for development is necessary. However; this should be either done in combination with micronutrient supplementation, via dietary means or through supplements taken with the ARV's. This is why it is important for periodic nutritional assessments using multiple methods so that specific nutrient deficiencies can be identified and targeted interventions applied and evaluated from time to time.

This study provides essential information to all stakeholders such as dietitians, nutritionists, doctors, nurses and parents/caregivers in ensuring good nutrition in HIV infected children. It also provides stakeholders with baseline information on the nutrition situation of HIV infected children in Ghana.

There are some limitations of the present study that should be noted. Firstly, the non-probability sampling used and not meeting the targeted sample size limits the generalization of the findings of this study. Secondly, the use of the 24-hour dietary recall which largely depends on memory could introduce some recall biases. Additionally, using recalls for multiple days could have provided a better estimate of their dietary intakes.

Furthermore, absence of data on CD4 count and HIV viral load of participants also limits the extent to which one can generalize the contribution of nutrition in the management of HIV/AIDS among the children studied. Authors recommend a repetition of the study to enable evaluation of outcomes of interventions and target specific patients for treatments.

5. Conclusion

While the use of ART's may improve the nutritional status of children infected with HIV, this study revealed a higher prevalence of stunting, underweight and wasting among these children compared to country statistics. Dietary assessment also revealed inadequate caloric and micronutrient intake, particularly folate, vitamin C and iron deficiency were highly prevalent in the majority of the children. Since these micronutrients are needed for physical growth, cognitive development and a better disease prognosis, there is an urgent need for targeted nutrition sensitive and specific interventions to improve the nutritional status of this vulnerable population. Further studies involving more patients are needed in this and similar settings to guide the process of incorporating nutrition sensitive and specific interventions for HIV/AIDS infected children.

Declarations

Author contribution statement

Freda D. Intiful: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Hikmatu Abdulai: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Ruth Nyarko: Analyzed and interpreted the data; Wrote the paper.

Edem Tette, Matilda Asante: Conceived and designed the experiments; 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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