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Prevalence and Factors Associated with Anemia among People Living with Human Immunodeficiency Virus Followed at the Outpatient Treatment Centre of Panzi General Referral Hospital in Eastern Democratic Republic of Congo

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Abstract

Introduction: Anemia in people living with human immunodeficiency virus (PLHIV) is a major health problem. Although anemia often responds to combination antiretroviral therapy, many patients remain anemic despite treatment, and such persistent anemia continues to adversely affect prognosis, regardless of drug response. Scientists have identified some of the factors involved. However, the mechanisms put in place have not been effective in overcoming them. Examples include the withdrawal of zidovudine from antiretroviral treatment lines, iron and folate supplementation, etc. Anemia is still a major concern in HIV-positive patients. The aim of this study is to assess the prevalence of anemia and its associated factors among PLHIV followed up at the outpatient treatment centre (CTA) of the Panzi General Reference Hospital (HGR) in South Kivu, Democratic Republic of Congo (DRC). **Method:** We conducted a cross-sectional, comparative study of 276 HIV-infected

adults on antiretroviral therapy (ART) followed up at the CTA of Panzi HGR. Socio-demographic and nutritional parameters were collected using a survey questionnaire, and clinical assessment and nutritional status were performed at the centre. Hemoglobin, seric albumin and viral load determinations were performed at the HGRP laboratory. We constructed univariate and multivariate logistic regression models to assess factors associated with anemia in people living with HIV/AIDS. **Results:** We found a prevalence of anemia of 39.4%, including 4.1% severe anemia, 17.7% moderate anemia and 17.5% mild anemia. After multivariate adjustment, the factors associated with anemia in our PLHIV were: moderate undernutrition (aOR = 1.26; 95% CI: 1.50 - 4.20; p = 0.001), severe undernutrition (aOR = 115.4; 95% CI: 2.04 - 164.52; p = 0.021), hypoalbuminemia (aOR = 2.11; 95% CI: 1.87 - 5.10; p = 0.004) and the lower degree of dietary diversity (aOR = 1.56; 95% CI: 1.10 - 4.32; p = 0.034). **Conclusion:** The prevalence of anemia in PLHIV on ART is high. This greatly affects quality of life and increases the need for care. Early detection tools and management algorithms are essential in the follow-up of PLWHIV.

Keywords

Anemia, HIV/AIDS, Undernutrition, PANZI Hospital

1. Introduction

People infected with HIV or AIDS are more likely than the general population to develop anemia. Anemia in HIV is a morbidity and mortality factor that adds to the global burden of all-cause anemia. PLHIV with anemia are at greater risk of early mortality compared with those who do not develop anemia [1].

There is a certain similarity between the pathophysiology of anemia in HIV/AIDS infection and that of anemia in chronic inflammatory diseases. This can be explained by some mechanisms. Firstly, there is an overall shortening of the lifespan of red blood cells due to hemophagocytosis by macrophages, but also to early apoptosis induced by the presence of free radicals and inflammatory cytokines. Erythropoiesis is impaired by reduced erythropoietin (EPO) production and marrow reactivity to EPO. In addition, inflammatory cytokines can impair erythroid proliferation and differentiation through radical formation and/or induction of apoptosis. Iron metabolism is altered by an increase in hepcidin, which inhibits iron absorption and recycling, leading to iron sequestration [2]. HIV itself is thought to have a direct effect on hematopoietic progenitor cells and erythropoietin reactivity [3].

Empirical studies have shown the multifactorial origin of anemia in HIV/AIDS infection. Patients with factors such as high viral load, low CD4 count < 200 cells/mm^3, BMI less than 18.5 and the presence of opportunistic infections prior to initiation of ART were at greater risk of anemia. ART improved patients' haematological parameters during the first year of ART, except for pa-

tients receiving Zidovidine-based therapy [4] [5]. The existence of co-infections such as HIV-Tuberculosis, hepatitis C (HCV), Epstein barr virus (EBV) and the presence of parasitic infections such as malaria, toxoplasmosis and schistosomiasis were associated with the severity of anemia and increased mortality [6]. Studies have also reported that anemia-related morbidity and mortality were higher in PLHIV who were deficient in micronutrients such as iron, folate, and vitamin B12. Anemia is then considered a sign of disease progression [7].

Although ART and cotrimoxazole prophylaxis have restored haematological parameters in most cases, publications over the last five years show that anaemia remains frequent in PLHIV despite treatment worldwide. Apart from treatment with nucleoside reverse transcriptase inhibitors (NRTIs), notably zidovudine, few studies have investigated the reasons for the persistence of anemia in people living with HIV on ART. The present study aims to assess the prevalence of anemia and its associated factors in PLHIV followed up at the outpatient treatment centre (CTA) of Panzi General Referral Hospital (HGR).

2. Materials and Methods

The study took place at the CTA of Panzi HGR. The CTA of PANZI HGR provides outpatient care for PLHIV. HGR Panzi is in the eastern region of the Democratic Republic of Congo, in South Kivu province in Bukavu town. Since it was set up in 2004, the Panzi CTA has registered a total of almost 3,500 patients, and currently some 2500 patients regularly keep their appointments, the remainder having either been lost to follow-up or having died. In order to ensure smooth running and to support patients throughout the care process, an appointment system has been adopted for clinically stable patients. Medication is supplied monthly or every two to three months. Patients with health problems consult the infectiologist on an outpatient basis or go to the emergency room in the event of seriousness. In addition, dozens of patients come to the Centre every working day for a variety of reasons: medication supply, participation in awareness-raising workshops, clinical follow-up (vital parameters, etc.).

We carried out a comparative cross-sectional study to compare the differences between two categories of the study population: on the one hand, PLHIV with anemia and, on the other, PLHIV without anemia. We should point out that this study was carried out as part of a large-scale study to assess the clinical situation of PLHIV on ART for more than 6 months. Data collection took place from 01/12/2021 to 31/03/2022. Patients who presented to the centre during the data collection period were selected if they met the criteria. The formula used to calculate the sample size is: $n = \frac{t_p^2 \times P(1-P) \times N}{t_p^2 \times P(1-P) + (N-1) \times y^2}$ with: n: sample size; N: size of target population 2500 PLWH regularly monitored. P: Estimated proportion of the population presenting the characteristic (anemia). As it is unknown, we considered a rate of 25% based on the approximately prevalence of anemia among PLHIV described by other researchers. tp: sampling confidence

interval: t_p = 1.96 for the 95% confidence interval; y: margin of sampling error: y = 5% [8]. Calculating the sample size yielded 258 patients, and adding a margin of 10% gave us 283 patients, *i.e.* 141 with anemia and 141 without. As the haemoglobin levels of the patients were not known in advance, we included patients who met the selection criteria as and when they came to the centre for their usual appointments. In order to reach this number of patients with the desired criteria and characteristics, we collected data from a total of 422 patients. Of these 422 PLHIV, 11 patients were automatically eliminated due to poorly completed questionnaires, while 62 patients completed the questionnaire correctly but did not complete all the blood tests. A total of 139 patients with anemia had all the data. We randomly selected 137 patients out of the 210 without anaemia whose data were complete for comparison. The process for selecting study participants is shown in Figure 1.

2.1. Inclusion Criteria

PLWHA aged 18 or over who have been taking ARVs for more than six (6) months; present at the CTA for a regular appointment (clinical monitoring and ARV supply) during the recruitment phase of our study and who consent to participate in the study. The diagnosis of HIV infection must first be confirmed by a double serological test of the "DETERMINE HIV-1/2" type; in the case of an undetermined test, confirmation is obtained by the Western blot test.

2.2. Exclusion Criteria

Excluded from the study are critically ill patients whose clinical condition requires urgent hospital care or PLHIV treated in hospital during the harvest period, pregnant women, PLHIV without ATR treatment or who have been on treatment for less than 6 months, HIV-infected patients who have not given their consent, and patients who have not completed all the steps required for the study.

2.3. Data Collection Process

We worked with the CTA's usual team of providers of outpatient care for PLWHA.

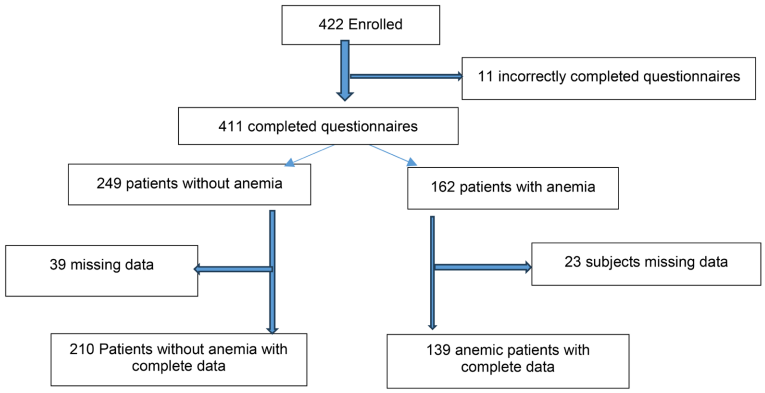

Figure 1. The process for selecting study participants.

Their daily activities consisted of screening for HIV infection, therapeutic education, listening to patients' complaints, taking vital parameters, referring patients to doctors and delivering ARVs as prescribed. To facilitate the task, clinically stable patients received medication for 2 - 3 months and had one clinical evaluation per quarter.

We reinforced this CTA team with two other nursing staff (A2 nurses) to avoid disrupting the normal work rhythm by the additional activities linked to this research. All the interviewers were trained beforehand on each stage to be observed during the collection of data from each patient; the training was reinforced by a few interview sessions with them in the form of simulation. As part of the study, the role of the providers was to talk to the patients about the study, present the survey questionnaire, help them to understand it and fill it in if they were illiterate, and take the patients' parameters: weight, height and blood sample. On average, ten or so patients who met the criteria were included each day, among those who came for their usual visit. Biological analyses were carried out in the HGRP's large laboratory.

Socio-demographic and health data were collected using a structured questionnaire in paper format, designed by the researchers based on standardized and pre-tested models. Participants who could not read or write were assisted by the providers in completing the questionnaire. The participant's presence at the centre for data collection was required only once; he or she could be called back in the event of missing data. This was done to manage time rationally and avoid additional expenses for participants.

2.4. Operational Definitions of Variables

Anemia, the dependent variable of the study, is defined on the basis of the value of the hemoglobin concentration according to the WHO, hemoglobin concentration below 13 g/dl for adult men and below 12 g/dl for non-pregnant adult women [9]. The study's independent variables were: sociodemographic parameters such as age, sex, marital status, level of education. Food consumption is assessed by the food consumption score (FCS), calculated based on the frequency of consumption of different food groups in the patient's household during the 7 days preceding the study. It is an acceptable proxy for measuring caloric intake and diet quality at household level, giving an indication of household food security status if combined with other household food access indicators. Interpretation: FCS poor < 28; borderline 28.5; 42 Acceptable > 42 [10].

Dietary diversity represents the number of different foods or food groups consumed by the patient during a given period, usually a 24-hour recall; designed to check the adequacy of micronutrient intakes (SDAM). The score has a value between 0 and 12: the number of food groups consumed in the 24 hours preceding the survey. Interpretation: low score < 3; medium score between 4 and 5; and high score > 6 [11]. Coping strategy (r CSI): households are food secure if they can meet their essential food needs without resorting to atypical coping strategies [10]. The nutritional status of PLHIV was first assessed by anthropo-

metric measurements, including weight and height. Patients were examined in light clothing and without shoes. Body mass index (BMI) is the ratio of weight (kg) to height squared (m) = P/T^2. Normal BMI between 18.5 and 25 and undernutrition when BMI < 18.5. Anthropometric measurements were supplemented by seric albumin levels. From these variables we calculated the nutritional risk index (NRI) = 1.519 × albuminemia (g/l) + 0.417 × (current weight/usual weight) × 100. NRI interpretation: above 97.5%: normal nutritional status, between 83.5 and 97.5%: moderate undernutrition and below 83.5%: severe undernutrition [12]. Digestive problems: lack of appetite, mouth sores, dysphagia, vomiting, diarrhea. History of opportunistic diseases such as toxoplasmosis, Kaposi's disease, tuberculosis, shingles and digestive candidiasis, and viral load.

2.5. Data Management and Analysis

Data were collected using a well-structured questionnaire in paper format and then the data were entered into Microsoft Excel 2016, then transferred to Stata SE 14.0 (Stata Corp LP, College Station, Texas, USA) for cleaning and analysis.

To describe the data, we calculated means and their standard deviations (SD), as well as medians with interquartile ranges (IQR) for continuous variables, where appropriate. Categorical variables were summarized in frequencies and percentages. To compare two means, we used the Student's t-test. To compare proportions, we used Pearson's Chi-square test or Fisher's exact test for proportions less than or equal to 5.

We constructed univariate and multivariate logistic regression models to assess factors associated with anemia in people living with HIV/AIDS. The odds ratio and their 95% confidence intervals were calculated to measure the strength of the association between the explanatory variables and the dependent variable (anemia or normal). To integrate the final model, we considered values of $p<0.2$ and 0.05. All p-values were two-tailed, and we used a p-value of less than 0.05 as the significance level.

2.6. Ethical Considerations

The study was conducted in strict compliance with the Helsinki principles. All participants gave their free consent to take part in the study. The information collected was managed with strict respect for discretion, confidentiality, and anonymity. Patients were reassured that their participation in the study would not adversely affect their care at the CTA. The study was authorized by the National Health Ethics Committee, South Kivu Provincial Directorate.

3. Results

We analysed and compared the results of 276 patients, 139 with anemia and 137 without. Of a total of 411 PLHIV, 162 had anemia, corresponding to a prevalence of 39.4%.

3.1. Socio-Demographic Profiles and Anemia in PLHIV

Most of participants are women 77.9% of whom 78.4% have anemia p = 0.834. The age range 31 - 50 years is more represented 52.5% and among them 54% have anemia p = 0.307. Married people represent 43.5% with 43.2% anemia p = 0.721. The majority of PLHIV have secondary education 56.5% with 54.7% anemia p = 0.273. No significant statistical association between demographic data and anemia in PLHIV (Table 1).

3.2. Comparison of Mean Hemoglobin Levels by Gender

We compared the mean hemoglobin levels by gender, finding a high mean hemoglobin level in men (124.34 ± 22.96 vs. 117.65 ± 20.15 in women) with a statistically significant difference p = 0.027 (Table 2).

3.3. Food Consumption Parameters and Anemia in PLHIV

We found anemia in 9.4% of patients with poor FCS, 28.8% with borderline FCS and 61.9% with acceptable FCS but with no statistically significant association between anemia and FCS as presenting p-values greater than 0.05. Nevertheless, we found a strong statistically significant association between the degree of dietary diversity and anemia in PLHIV (p < 0.001) (Table 3).

Table 1. Sociodemographic profiles and haemoglobin status in PLVIH+.

Parameters	Total (n = 276)	Hemoglobin status		p-Value
		Anemia	Normal	
		N = 139	N = 137	
Gender				0.834
Woman	215 (77.9)	109 (78.4)	106 (77.4)	
Men	61 (22.1)	31 (21.6)	31 (22.6)	
Age group (years)	42.09 ± 11.77			0.307
18 - 30	55 (19.9)	31 (22.3)	24 (17.5)	
31 - 50	145 (52.5)	75 (54.0)	70 (51.1)	
51 - 70	76 (27.5)	33 (23.7)	43 (31.4)	
Civil status				0.721
Single	48 (17.4)	27 (19.4)	21 (15.3)	
Divorced	22 (8.0)	12 (8.6)	10 (7.3)	
Married	120 (43.5)	60 (43.2)	60 (43.8)	
Widowed	86 (31.2)	40 (46.5)	46 (33.6)	
Study level				0.273
Literacy (reading and writing)	3 (1.1)	2 (1.4)	1 (0.7)	
No	24 (8.7)	15 (10.8)	9 (6.6)	
Primary	72 (26.0)	32 (23.0)	40 (29.2)	
Secondary	156 (56.5)	76 (54.7)	80 (58.4)	
University	21 (7.6)	14 (10.1)	7 (5.1)	

Table 2. Comparison of mean haemoglobin levels by sex.

Parameters	Mean ± SD	P-value
Gender		
Woman	117.65 ± 20.15	0.027
Men	124.34 ± 22.96	
Total	119.13 ± 20.95	

In this table, we found a high mean hemoglobin level in men (124.34 ± 22.96 vs. 117.65 ± 20.15 in women) with a statistically significant difference p = 0.027.

Table 3. Parameters related to food consumption and hemoglobin status in PLHIV.

Parameters	Total (n = 276)	Albumin status		p-Value
		Anemia	Normal	
		N = 139 (%)	N = 137 (%)	
State FCS	48.38 ± 17.30			
Acceptable	158 (57.2)	86 (61.9)	72 (52.6)	0.214
Limit	93 (33.7)	40 (28.8)	53 (38.7)	
Poor	25 (9.1)	13 (9.4)	12 (8.8)	
In the last 30 days, has there ever been nothing to eat at all in your house?				0.441
No, never	169 (61.2)	84 (60.4)	85 (62.0)	
Rarely (1 - 2 times)	100 (36.2)	53 (53.0)	47 (34.3)	
Sometimes (3 - 10 times)	7 (2.5)	2 (1.4)	5 (3.6)	
Over the past 30 days, has your household ever gone to bed hungry?				0.725
No, never	183 (66.3)	90 (64.7)	93 (67.9)	
Sometimes (3 - 10 times)	5 (1.8)	2 (1.4)	3 (2.2)	
Rarely (1 - 2 times)	88 (31.8)	47 (33.8)	41 (29.9)	
In the last 4 weeks, have you asked your household for food aid?				0.667
No	256 (92.8)	128 (92.1)	128 (93.4)	
Yes	20 (7.2)	11 (7.9)	9 (6.6)	
Degree of dietary diversity				<0.001
Weaker	96 (34.8)	30 (21.5)	66 (48.2)	
Average	158 (57.3)	87 (62.5)	71 (51.8)	
High	22 (7.9)	22 (15.7)	0 (0.0)	

3.4. Clinical Parameters and Anemia in PLWHA

We found no statistically significant association between appetite, digestive disorders, and anemia in PLHIV (p > 0.05). However, we did find a significant association between dysphagia and anemia in PLWH (p = 0.041) (Table 4).

Table 4. Clinical parameters and hemoglobin status of PLHIV+.

Parameters	Total (n = 276)	Hemoglobin status		p-Value
		Anemia	Normal	
		N = 139 (%)	N = 137 (%)	
Appetite				0.916
No	47 (17.0)	24 (17.3)	23 (16.8)	
Yes	229 (83.0)	115 (82.7)	114 (83.2)	
Digestive disorders				0.555
No	158 (57.3)	82 (59.0)	76 (55.5)	
Yes	118 (42.5)	57 (41.0)	61 (44.5)	
Frequency of digestive disorders (n = 118)				
Less than 2 weeks	64 (54.3)			
More than 2 weeks	50 (42.3)			
Frequently	4 (3.4)			
Symptoms/Nausea	N = 118	N = 63	N = 55	0.063
No	34 (28.8)	21 (36.8)	13 (21.3)	
Yes	84 (71.2)	36 (63.2)	48 (78.7)	
Vomiting				0.277
No	56 (47.4)	30 (52.6)	26 (42.6)	
Yes	62 (52.6)	27 (47.4)	35 (57.4)	
Diarrhea				0.402
No	72 (61.1)	37 (64.9)	35 (57.4)	
Yes	46 (38.9)	20 (35.1)	26 (42.6)	
Dysphagia				0.041
No	111 (94.1)	51 (89.5)	60 (98.4)	
Yes	7 (5.9)	6 (10.5)	1 (1.6)	
Oral wounds				0.169
No	97 (82.2)	44 (77.2)	53 (86.9)	
Yes	21 (17.8)	13 (22.8)	8 (13.1)	

3.5. Data Related to Nutritional Status and Anemia in PLHIV

We noted a statistically significant association between NRI and anemia $p < 0.001$, and between hypoalbuminemia and anemia $p < 0.001$ in PLHIV (Table 5).

3.6. Medical History of PLWHIV and Anemia in PLWHIV

There isn't statistically significant association between having had opportunistic diseases such as toxoplasmosis, Kaposi's disease, tuberculosis, candidosis, and herpes zoster with anemia in PLWH (Table 6).

Table 5. Data relating to nutritional status and haemoglobin status in PLHIV.

Parameters	Total (n = 276)	Hemoglobin status		p-Value
		Anemia	Normal	
		N = 139 (%)	N = 137 (%)	
NRI status				<0.001
Normal state	88 (31.9)	29 (20.9)	59 (43.1)	
Moderate undernutrition	165 (59.8)	92 (66.2)	73 (53.3)	
Severe undernutrition	23 (8.3)	18 (12.9)	5 (3.6)	
BMI				0.111
Undernutrition	32 (11.5)	21 (15.1)	11 (8.1)	
Normal state	180 (65.2)	93 (66.9)	87 (63.5)	
Mild obesity	8 (2.9)	4 (2.8)	4 (2.9)	
Moderate obesity	1 (0.3)	1 (0.7)	0 (0.0)	
Morbid obesity	1 (0.3)	0 (0.0)	1 (0.8)	
Overweight	54 (19.5)	20 (14.3)	34 (24.8)	
Albumin status				<0.001
Hypoalbuminemia	138 (50.0)	92 (66.2)	46 (33.6)	
Normal	138 (50.0)	47 (33.8)	91 (66.4)	

Table 6. Medical history of PLHIV and haemoglobin status of PLHIV.

Parameters	Total (n = 276)	Hemoglobin status		p-Value
		Anemia	Normal	
		N = 139 (%)	N = 137 (%)	
Toxoplasmosis				0.192
No	146 (94.8)	71 (97.3)	75 (92.6)	
Yes	8 (5.1)	2 (2.7)	6 (7.4)	
Kaposi				0.054
No	150 (97.4)	73 (100.0)	77 (95.1)	
Yes	4 (2.6)	0 (0.0)	2 (4.9)	
Tuberculosis				0.284
No	66 (42.8)	28 (38.4)	38 (46.9)	
Yes	88 (57.2)	45 (62.6)	43 (53.1)	
Oral or genital candidiasis				0.761
No	126 (81.8)	59 (80.8)	67 (82.7)	
Yes	28 (18.2)	14 (19.2)	14 (17.3)	
Zona				0.254
No	144 (93.5)	70 (95.9)	74 (91.4)	
Yes	10 (6.5)	3 (4.1)	7 (8.6)	

3.7. Viral Load and Hemoglobin Status of PLWHIV

We found more anemia in patients with uncontrolled viral load than in those with undetectable viral load, but the difference was not statistically significant p = 0.119 (Table 7).

3.8. Univariate and Multivariate Logistic Regression of Factors Associated with Anemia in PLHIV

To establish the strength of the association between the different variables and anemia, after univariate logistic regression: we found no association between clinical data (nausea, vomiting, mouth sores, dysphagia, diarrhea) and anemia.

The factors associated with anemia that we have found are:

- moderate undernutrition (aOR = 1.26; 95% CI: 1.50 - 4.20; p = 0.001),
- severe undernutrition (aOR = 115.4; 95% CI: 2.04 - 164.52; p = 0.021),
- hypoalbuminemia (aOR = 2.11; 95% CI: 1.87 - 5.10; p = 0.004),
- lower degree of dietary diversity (aOR = 1.56; 95% CI: 1.10 - 4.32; p = 0.034) (Table 8).

Table 7. Viral load and haemoglobin status of PLHIV.

Parameters	Total (n = 276)	Hemoglobin status		p-Value
		Anemia	Normal	
		N = 139 (%)	N = 137 (%)	
Viral load				0.119
Uncontrolled	74 (26.8)	43 (30.9)	31 (22.6)	
Undetectable	202 (73.2)	96 (69.1)	106 (77.4)	

Table 8. Univariate and multivariate logistic regression of factors associated with anemia in PLHIV.

Parameters	COR (95% CI)	p-Value	aOR (95% CI)	p-Value
Nausea				
No	1 (reference)		1 (reference)	
Yes	0.46 (0.20 - 1.04)	0.065	0 (0.47 - 2.96)	0.721
Vomiting				
No	1 (reference)		1 (reference)	
Yes	0.46 (0.32 - 1.38)	0.277	1.09 (0.26 - 4.49)	0.895
Diarrhea				
No	1 reference)		1 (reference)	
Yes	0.46 (0.20 - 3.11)	0.065	0.43 (0.09 - 1.93)	0.277
Dysphagia				
No	1 (reference)		1 (reference)	
Yes	7.05 (0.82 - 60.57)	0.075	6.16 (0.40 - 94.26)	0.721

Continued

Oral wounds				
No	1 (reference)		1 (reference)	
Yes	1.95 (0.74 - 5.14)	0.175	2.28 (0.37 - 13.88)	0.370
NRI				
Normal state	1 (reference)		1 (reference)	
Moderate undernutrition	2.56 (1.49 - 4.40)	<0.001	1.26 (1.50 - 4.20)	0.044
Severe undernutrition	7.32 (2.47 - 21.69)	<0.001	115.4 (2.04 - 164.52)	0.021
Albuminemia				
Hypoalbuminemia	3.87 (2.35 - 6.37)	<0.001	2.11 (1.87 - 5.10)	0.004
Normal	1 (reference)		1 (reference)	
Degree of dietary diversity				
Weaker	2.69 (1.58 - 4.59)	<0.001	1.56 (1.10 - 4.32)	0.034
Average	-	-	-	-
High	1 (reference)		1 (reference)	

COR = Crudes odds ratios; **aOR = Adjusted odd ratios.

4. Discussion

Overall, we found a prevalence of anemia of 39.4%, including 4.1% severe anemia, 17.7% moderate anemia and 17.5% mild anemia. We can clearly see that the prevalence of anemia remains high in our study population. This prevalence is slightly higher than that of Temesgen Anjulo Ageru in Ethiopia in 2019, who found a prevalence of 36.5% [13].

Andrew D Kerkhoff and colleagues found in 2014 in South Africa a prevalence of anemia of 26.8% of any severity with only 8.2% of moderate/severe anemia after 12 months of ART whereas before ART the prevalence of anemia was 70.5% including 42.5% of moderate and severe [4]. Compared with her results after treatment initiation, we can see that the prevalence of anemia is high in our group. Predictors of anemia in his population are severe anemia at ART initiation and a Zidovudine-based regimen. We did not analyse data relating to hemoglobin levels in our patients prior to ART, due to the lack of a structured database. We also know that zidovudine can no longer be incriminated, as it has not been used in our region for around 7 years. If we base ourselves on the results of the study by Mr. Akilimali and his collaborators, who found in Goma a prevalence of anemia of 69% before ART. After 12 months' follow-up, they observed a mean increase in hemoglobin concentration of 1.2 g/dl ($p < 0.001$), with differences depending on the treatment regimen. Patients receiving zidovudine (AZT) gained less than those not receiving AZT (0.99 g/dl vs. 1.33 g/dl; $p < 0.001$). Among patients with anemia at baseline, 33% (147/445) had their condition resolved [5].

We found no association between the various socio-demographic attributes

and anemia in PLHIV. About gender, we found no association between gender and anemia, as the mean hemoglobin of men was higher than that of women in the 2 groups. This corroborates the data in the literature. Fausto and colleagues in 2020 in Malawi and Mozambique found that female sex was associated with undernutrition [14]. Batool and colleagues in 2019 in Tanzania found a high risk of anemia-related mortality in men [15]. Shen and colleagues in 2013 in China found an association between anemia and advanced age in people newly diagnosed with HIV/AIDS [16]. We found no association between anemia and the marital status of PLHIV, nor between anemia and their level of education.

About food consumption, we found no statistical association between FCS and anemia in PLHIV, but we did find a high probability of anemia in PLHIV with a low degree of dietary diversity. This issue was not addressed by the authors of the papers we consulted. We link this association to insufficient intake of nutrients essential for red blood cell production, due to a less diversified and less rich diet.

Regarding digestive disorders, we found an association between anemia and dysphagia $p = 0.041$. Dysphagia prevents patients from eating properly, which has a negative impact on dietary intake, at the root of nutritional deficiencies. Amanda Marchionatti and Mariana Migliorini Parisi highlighted the predominance of nutritional deficiencies in PLWH with digestive disorders. Vitamin B12 deficiency was found in 30% of PLWH [17]. Temesgen Anjulo Ageru and colleagues found an association between anemia and the presence of parasitic digestive infections in PLHIV [13].

We found a correlation between undernutrition and anemia. PLWHA with hypoalbuminemia and those with a moderate and severe nutritional risk index have greater risk of anemia. An association between anemia and a BMI < 18.5 was found in Ethiopia by Temesgen Anjulo Ageru [13]. For Minke HW Huibers and colleagues in Malawi, BMI < 20 was associated with anemia in PLHIV [6]. In this situation, anemia is of deficiency origin, linked to the unavailability of sufficient quantities of nutrients essential for the renewal of red blood cells.

We found no association between a history of opportunistic infections and anemia. We can justify this result by the fact that only a small number of PLHIV are concerned, but also because patients are assumed to be cured of these conditions at the time of the survey. Minke HW Huibers in Malawi found a statistically significant association between anemia and HIV-TB and EBV co-infection. [6]. Amanda Marchionatti and Mariana Migliorini Parisi found an association between infection with mycobacterium tuberculosis, fungi such as Histoplasma spp. and Cryptococcus spp. and parasites such as Leishmania spp. and Plasmodium falciparum with anemia [17]. These pathogens are at the root of an inflammatory state of variable duration and expression that can cause anemia, but we also know that some of them are at the root of the destruction of red blood cells by hemolysis (as in the case of Plasmodium).

We found more cases of anemia in the group of PLHIV with uncontrolled viral load than those with controlled load, but with no significant statistical associa-

tion. Amanda Marchionatti and Mariana Migliorini Parisi in their literature review published in 2021 found an association between high viral load and aregenerative anemia. The role of HIV in disrupting the bone marrow microenvironment is further emphasized [17]. We mentioned in the introduction the harmful effects of inflammation factors and hepcidin in erythropoiesis and iron homeostasis respectively [2] and [3].

We were interested in knowing patients' clinical and biological parameters before starting treatment, and to what extent these parameters had changed over time during treatment, but this was not possible. In many patient files, data such as blood count, viral load or CD4 count were missing, which is why we carried out these analyses in the course of our study.

5. Conclusion

The prevalence of anemia among PLHIV on ART is high. This greatly affects quality of life and increases the need for care. It is possible to eradicate anemia in PLHIV by acting on the various risk factors. Periodic screening of haematological parameters and routine monitoring of nutritional status are therefore essential. It is essential to make available the tools needed for the early diagnosis of anemia, and the concrete actions to be taken if necessary. It is highly desirable that patients benefit from nutritional education and support.

Authors' Contributions

Study design and implementation: Marlene Abedi Zalufa

Methodology: Marlene Abedi Zalufa, Aline Byabene, Marie Hatem, Jean Paulin Mbo Mukonkole, Nicolas Vignier.

Data collection and entry: Sadiki Michel, Claudien IRAGI.

Data analysis and interpretation: Claudien IRAGI, Omari Mukanga Lampard.

Laboratory analysis: Balthazar MUHIGIRWA, Eric Mungu Akonkwa, Maombi, validation of laboratory analysis by Chasinga Baharanyi Tchass.

Validation and addition of data: Omari Mukanga Lampard.

Final editing: Marlene Abedi Zalufa, Omari Mukanga Lampard, Marie Hatem.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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