

Association of Anemia with Health-Related Quality of Life Among HIV-Infected Individuals in Meru, Kenya

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Abstract

Anemia is a prevalent hematological complication in HIV patients, significantly impacting their health-related quality of life, morbidity, disease progression, and mortality. Despite its importance, there is a lack of information specifically focused on the impact of anemia on the health-related quality of life (HRQoL) of HIV-infected individuals in Meru County, Kenya. This cross-sectional study aimed to determine the prevalence of anemia, identify its predisposing factors, and assess its impact on HRQoL among HIV-infected individuals attending Meru Teaching and Referral Hospital (MeTRH). A total of 354 adult participants (76.1% women, 24.9% men) were enrolled for the study at MeTRH between May and August 2022. Demographic and clinical data were collected using a standardized questionnaire. Hemoglobin levels were analyzed using an automated hemoglobin analyzer, and anemia was defined according to WHO criteria (hemoglobin <11.5 g/dL for non-pregnant women, <12.5 g/dL for men). HRQoL was assessed using the WHOQOL-BREF tool across physical, psychological, social, and environmental domains. To identify factors associated with anemia, logistic regression was used. Linear regression was used to analyze the relationship between mean HRQoL scores and anemia status. The prevalence of anemia in the study population was 12.4%, 11.4% in men, and 12.8% in women. The level of education was the only sociodemographic factor significantly associated with anemia status. Among the clinical factors, period of HIV positivity and CD4 count were found to be significantly associated with anemia status. The mean HRQoL score in the physical domain was statistically significantly different between the anemic and non-anemic groups. Furthermore, we found that anemia status was significantly associated with the physical domain of HRQoL after adjusting for period of HIV positivity, level of education, and CD4 count ($p = 0.02$). Anemia impacts the physical HRQoL in HIV patients, emphasizing the importance of comprehensive management strategies. Implementing a holistic approach to enhance physical well-being for these individuals is crucial in Meru County and similar resource-limited settings.

Keywords: Anemia, HIV-infected individuals, Health-Related quality of life, AIDS

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1. Introduction

HIV remains a significant global health problem, with sub-Saharan Africa bearing the highest burden. In 2022, an estimated 39 million people worldwide were living with HIV (UNAIDS, 2023). By the end of 2022, Southern and Eastern Africa had an estimated 20.8 million HIV-positive individuals (UNAIDS, 2023). Although a decline in the incidence of HIV infection has been observed, the number of people living with HIV (PLWHIV) is at an all-time high. This is

due to increased access to antiretroviral therapy, which has improved survival (Kharsany & Karim, 2016). Hematological complications have been identified as a significant problem among PLWHIV worldwide, negatively affecting their quality of life and disease progression (Melese et al., 2017; Cao et al., 2022a; Getu et al., 2023; Sah et al., 2020; Sahle et al., 2017). In Africa, the prevalence of anemia in PLWHIV ranges between 16.2% to 69% (Ikolango et al., 2023; Zenebe et al., 2019). The main causes of anemia in PLWHIV include nutrient deficiencies, anorexia, medication-related gastrointestinal disturbances, wasting, and malabsorption (Gardner & Kassebaum, 2020; Geletaw et al., 2017; Kumar et al., 2022).

Anemia affects the overall functional status and well-being of PLWHIV, leading to symptoms such as fatigue, vertigo, dyspnea, and cardiovascular problems (Hoshino et al., 2020; Melese et al., 2017; Zuñiga et al., 2020). The introduction of antiretroviral treatment (ART) significantly changed the trajectory of HIV, transforming it from a rapidly progressive illness to a chronic disease with reduced mortality and fewer opportunistic infections (Aynalem et al., 2020; Harding et al., 2020; Katemba et al., 2018; Melese et al., 2017). However, there has been insufficient attention to other health aspects, such as emotional, psychological, financial, and physical well-being, that may result in poor quality of life for many patients (Algaralleh et al., 2020; Tesemma et al., 2019; Zenebe et al., 2019; Zou et al., 2022). Health-related quality of life encompasses health status, functional status, psychological well-being, and overall life satisfaction (Algaralleh et al., 2020; Osei-Yeboah et al., 2017; Tesemma et al., 2019; WHO, 2016).

There is limited research, specifically focused on Meru County, hindering the understanding of the local dynamics of HIV and anemia and their impact on the quality of life of PLWHIV. By addressing this gap, tailored interventions and strategies can be developed to improve outcomes for HIV positive patients in Meru County. Therefore, there is a pressing need for in-depth research to inform targeted interventions to address anemia among HIV-positive individuals, particularly in underserved regions, to enhance their overall well-being and quality of life. This study investigated the association between anemia and health-related quality of life (HRQoL) among PLWHIV in Meru County. The four aspects of HRQoL, including physical, social, environmental, and psychological, were assessed.

2. Methodology

2.1 Study population

The cross-sectional study involved adult HIV positive patients attending Meru Teaching and Referral Hospital (MeTRH) in Meru, Kenya, between May and August 2022. A total of 354 HIV-Infected adults older than 18 years were recruited from the HIV Clinic at MeTRH. Ethical approval for the study was granted by Meru University Institutional Research Ethics Review Committee (MIRERC) and the MeTRH Ethics Review Committee. The eligibility criteria for participants in the study were: HIV-positive adults aged 18 years and older who consented to participate. Pregnant HIV positive women, children below 18 years, and HIV positive adults who had been recently transfused (less than 6 months) were not eligible to take part in this study.

2.2 Data collection

Questionnaires were administered to participants to collect socio-demographic data, including age, sex, marital status, employment, residence, income, and education level. Medical records from the MeTRH HIV clinic provided clinical information, including HIV status, period under ART regimen, period of HIV positivity, CD4 level, TB diagnosis, and WHO stage of HIV infection. The World Health Organization Quality of Life BREF (WHOQOL-BREF) questionnaire, a shorter version of WHOQOL-100, was also administered to assess the health-related quality of life of the respondents under physical health, psychological health, social relationships, and environmental

health domains (WHO, 2012). The physical health domain contains seven items that explore sleep, rest, pain, discomfort, energy, and fatigue. The psychological health domain contains six items that evaluate individuals' perceptions of self-esteem, body image and appearance, positive and negative feelings, memory, learning, concentration, and thinking. The social relations domain encompasses three items: social support, personal relationships, and sexual activity. The environment domain comprises eight items assessing safety and security, finances, access to health and social services, the home and physical environment, and activities, including education, training, and leisure. Each item is rated on a 5-point Likert scale, with a low score of 1 and a high score of 5. To calculate the mean score for each domain, the mean item score for that domain is determined and then multiplied by 4 to make it comparable to the WHOQOL-100. The domain mean scores are then transformed to a 0-100 scale by the formula $(\text{mean domain score} - 4) \times (100/16)$.

Venous blood was drawn from the participants by a trained licensed lab technologist and placed in EDTA tubes. Hemoglobin levels were measured using an automated hematology analyzer. Quality control measures were implemented. Anemia was defined according to WHO criteria (hemoglobin <11.5 g/dL for non-pregnant women, <12.5 g/dL for men).

2.3 Statistical analysis

Descriptive statistics were used to summarize the characteristics of the study population, including socio-demographic and clinical information. Categorical data were represented by absolute and relative frequencies, while continuous variables were represented by mean and standard deviation. A comparison of factors between the anemic and non-anemic groups was performed using the Pearson Chi-square test, the Z-test, and univariate logistic regression. Multivariable linear regression was performed to assess the relationship between anemia status and the mean HRQoL score for each of the four domains, adjusted for potential confounders. The analysis was performed using R version 3.6.3 (R Core Team, 2021). The level of significance was set at $p < 0.05$ to determine statistical significance.

3. Results

3.1 General Characteristics of the Study Population

A total of 354 HIV positive individuals, comprising 266 (75.1%) females and 88 (24.9%) males, were recruited for the study. The mean age of the participants was 44.7 years, with a range between 20 and 77 years (Table 1). The majority of participants (55.1%) had primary education, the highest level of education (Table 1). The mean hemoglobin level in the study population was 16.2 g/dL (6-29.9 g/dL), with a mean of 16.4 g/dL (7.7-27.9 g/dL) in men and 16.1 g/dL (6-29.9 g/dL) in women (Figure 1). The prevalence of anemia in the study population was 12.4%, with 11.4% prevalence in men and 12.8% in women.

Among the socio-demographic factors assessed, we observed a statistically significant association between level of education and anemia status (univariate logistic regression, p -value = 0.02). The odds of anemia in individuals with no education and training were found to be 3.33 times higher compared to those with a primary level of education (crude OR=3.33) (Table 1). Age, gender, marital status, residence, and monthly income were not significantly associated with anemia status (p -value > 0.05) (Table 1). Among the clinical factors assessed, CD4 count showed a statistically significant association with anemia status (logistic regression, p value=0.002). Individuals with CD4 levels greater than 400 c/mL had 0.35 decreased odds of being anemic as compared to individuals with CD4 levels less than 400 c/mL (Table 2).

Other clinical characteristics, including period of HIV positivity, WHO stage, TB diagnosis, and period under ART treatment, were not significantly associated with anemia status (p -value

> 0.05) (Table 2).

In general, the non-anemic group had higher mean HRQoL scores than the anemic group across all domains except the social relations domain (Table 3). Some participants reported very low HRQoL mean scores of less than 20 in the social relations domain (Figure 2). We observed that only the mean HRQoL scores in the physical health domain differed significantly between the anemic and non-anemic groups (p-value = 0.004) (Table 3, Figure 2). No significant differences in mean scores between the groups were observed in the psychological health, environment, and social relations domains (p values>0.05) (Table 3, Figure 2).

We further investigated factors, in addition to anemia, that may be associated with HRQoL. The period of HIV positivity was statistically significantly associated with the physical and psychological health domains; education level was significantly associated with the psychological and environmental domains; and CD4 level was significantly associated with all domains except the physical domain (univariable linear regression, p value <0.05) (Table 4). These significantly associated factors were further adjusted for in multivariable logistic regression to assess the association between anemia status and each specific health domain.

Anemia status was observed to be statistically significantly associated with the physical health domain after adjusting for period of HIV positivity, level of education, and CD4 count (multivariate logistic regression, p value = 0.02) (Table 5). The study revealed that individuals with anemia had a lower mean physical health HRQoL score of 2.80, on average, compared to non-anemic individuals, adjusted for period of HIV positivity, level of education, and CD4 count (Table 5). Psychological health, social relations, and environmental domains were not significantly associated with HRQoL mean scores.

Table 1: Socio-demographic characteristics according to anemia status

Variables		Non- Anemic n=310 (87.6)	Anemic n=44 (12.4)	Odds Ratio	95% Confidence Interval	P value
Age (years)	45.7 (20-77)	46.04 (20-77)	43.09 (20-72)		7.34-1.45	0.13
Gender (%)	Female	232 (87.2)	34 (12.8)	REF		
	Male	78 (83.0)	10 (17.0)	0.87	0.39-1.79	0.73
Marital Status (%)	Divorced	58 (91.8)	3 (8.2)	0.33	0.08-0.96	0.07
	Married	176 (84.3)	28 (15.7)	REF		
	Single	33 (74.3)	2 (25.7)	0.38	0.06-1.35	0.20
	Widowed	43 (94.4)	11 (5.6)	1.61	0.72-3.41	0.23
Education Level (%)	No formal education/ training	15 (90.9)	7 (9.1)	3.33	1.17-8.77	0.02
	Primary	171 (85.6)	24 (14.4)	REF		
	Secondary	84 (88.2)	9 (11.8)	0.76	0.32-1.66	0.51
	Tertiary	40	4 (47.1)	0.71	0.20-1.97	0.55
Residence (%)	Rural	83 (88.7)	14 (11.3)	REF		
	Suburban	116 (89.5)	17 (10.5)	0.87	0.41-1.88	0.72
	Urban	111 (80.6)	13 (19.4)	0.69	0.31-1.56	0.38
Monthly income	<10,000	41 (85.7)	8 (14.3)	1.41	0.57-3.15	0.43

(%)	10,000-19,999	231 (85.6)	32 (14.4)	REF		
	≥ 20000	38 (86.2)	4 (13.8)	0.78	0.21-2.05	0.62

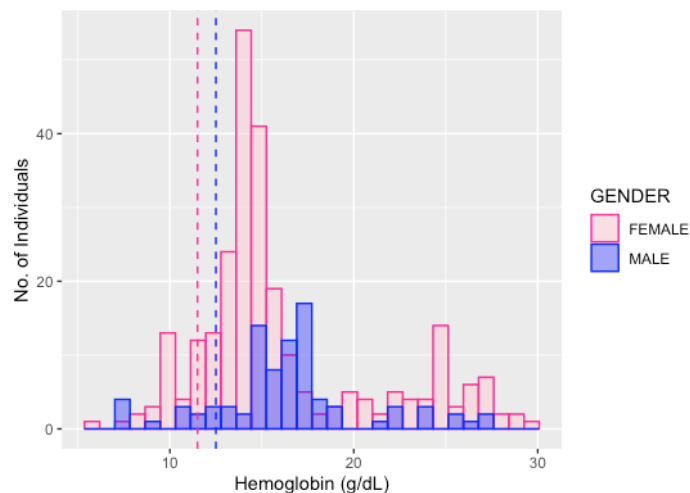


Figure 1: Distribution of hemoglobin level in the study population

The frequency distribution of hemoglobin levels in men is indicated by blue bars, and the distribution in females is indicated by pink bars. Anemia was defined by hemoglobin level cutoffs indicated by vertical dashed lines at 11.5g/dL (pink) and 12.5g. dL (blue) in non- pregnant women and men, respectively.

Table 2: Clinical characteristics according to anemia status

Variables		Anemia		Odd Ratio	95% CI	P value
		No (n=310) (87.6%)	Yes (n=44) (12.4%)			
Period of HIV positivity	≤1	11 (68.8)	5 (31.2)	4.84	1.02-26.98	0.05
	>1 - 5	32	3	REF		
	>5-10	112	16	1.52	0.47-6.84	0.52
	>10	155	20	1.38	0.44-6.09	0.78
WHO Stage	I	209	26	REF		
	II	99	16	1.30	0.66-2.51	0.44
CD4 Count (c/ml)	≤400	79	22	REF		
	>400	215	21	0.35	0.18-0.67	0.002
TB Diagnosis	Positive	61	9	1.05	0.45-2.21	0.90
	Negative	249	35	REF		
Period under ART treatment (Years)	0	3	1	2.38	0.11-19.98	0.46
	>1-5	36	4	0.79	0.22-2.35	0.69
	>0-1	14	4	2.04	0.53-6.60	0.25
	≥10	150	20	0.95	0.47-1.97	0.89
	>5-10	107	15	REF		

Table 3: Comparison of HRQoL mean scores between anemic and non-anemic group

Group	Mean scores of HRQoL domains			
	Physical Health	Psychological Health	Social Relations	Environment
Anemic mean(sd)	53.08±7.69	55.02±9.10	50.37±18.93	47.72±13.01
Non-Anemic mean(sd)	56.75±7.14	55.25±9.26	48.65±18.26	49.78±11.79
P value	0.004	0.87	0.57	0.33

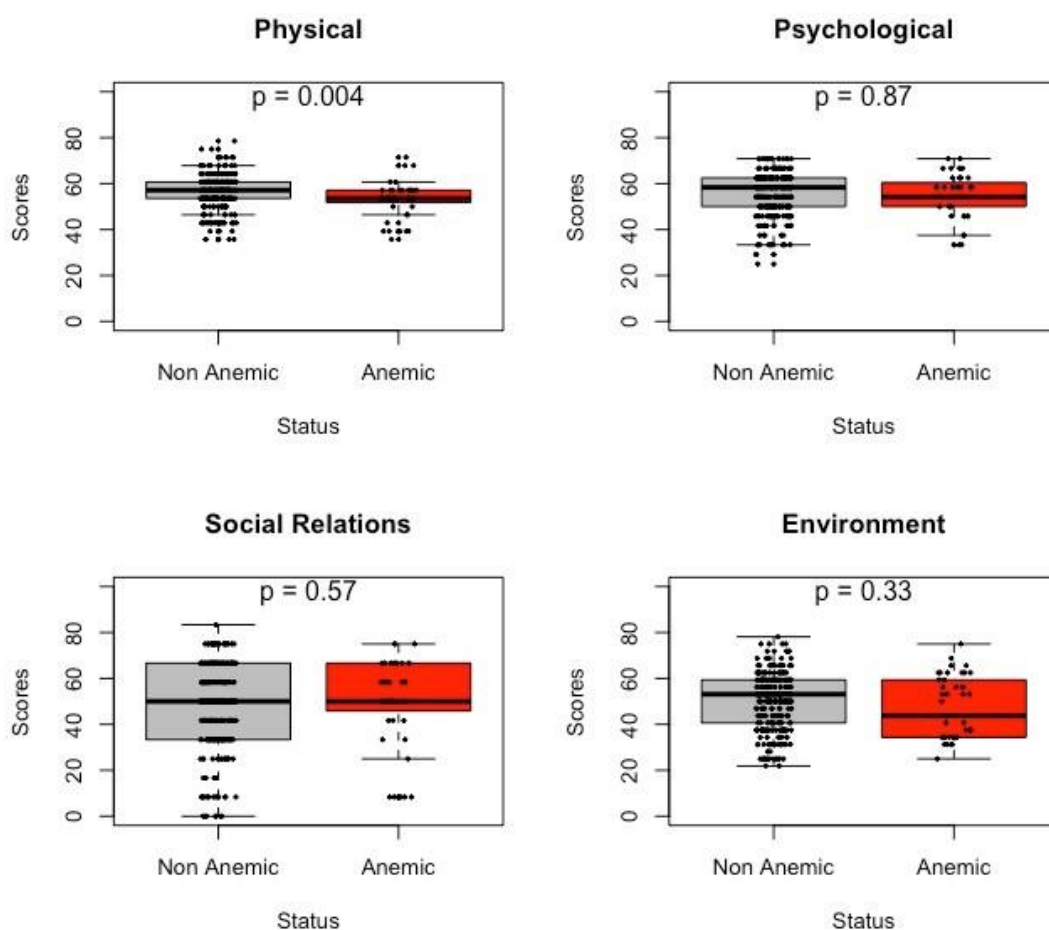


Figure 2: Distribution of mean HR-QoL scores of participants by anemia status

Box plot showing distribution of mean HR-QoL scores of anemic participants in black and anemic participants in red under the physical health (top left), psychological health (top right), social relations (bottom left), and environment (bottom right) domains. P values are indicated within each plot.

Table 4: Socio-demographic and clinical factors other anemia showing significant association with HRQoL mean scores for the four domains by univariable linear regression analysis

Variable		Domain	Coef	95% CI	P value
Period of HIV positivity in years	≤1	Physical	-0.60	-0.12-0.09	0.09
	>1 - 5		REF		
	>5-10		-0.55	-0.98-4.16	0.01
	>10		-0.44	-0.87- -0.22	0.04
Level of education	No Education	Psychological	-0.005	0.53-1.87	0.99
	Primary		REF		
	Secondary		0.58	1.25-2.55	0.001
	Tertiary		1.07	1.83-4.66	<0.001
Period of HIV positivity (years)	≤1	Psychological	-1.00	-1.53- -0.46	<0.0001
	>1 - 5		REF		
	>5-10	Psychological	-1.00	-1.53- -0.46	<0.0001
	>10		-0.54	-1.06- -0.02	0.04
CD4 count (c/ml)	≤400		REF		
	>400	Psychological	-1.20	-1.52- -0.89	<0.001
	>400	Social relations	-2.04	-2.68- -1.39	<0.001
	>400	Environment	-1.36	-1.77- -0.95	<0.001
Level of education	No Education	Environment	-0.55	-1.38 - 0.28	0.20
	Primary		REF		
	Secondary		0.13	-0.34- 0.60	0.58
	Tertiary		1.00	0.37 - 1.61	0.002

Table 5: Multivariate analysis of association between anemia status and HR-QoL mean score for the four domains adjusting for period of HIV positivity, level of education and CD4 count.

Domain	Coefficient	95% CI	P value
Physical Health	-2.80	-5.16 - 0.43	0.02
Psychological Health	-0.90	-3.56 - 1.76	0.51
Social Relations	-2.10	-7.87 - 3.67	0.48
Environmental	-3.57	-7.13 -0.02	0.05

4. Discussion

Anemia, a condition characterized by a decrease in the number of red blood cells or a reduction in hemoglobin levels, is a prevalent global health concern that impacts millions of individuals across various age groups (Cao et al., 2022b; Fekene et al., 2018; Hoshino et al., 2020; Katemba et al., 2018). While the physical consequences of anemia, such as fatigue, weakness, and impaired oxygen delivery, are well-documented, its broader implications on the overall health-related quality of life have gained increasing attention in recent years (Aksu & Ünal, 2023; Zuñiga et al., 2020). The association between anemia and health-related quality of life (HRQoL) has become a focal point of research, as it holds the potential to uncover significant insights into the multifaceted impacts of this condition on individuals' well-being (Akbarpour et al., 2022; Durandt et al., 2019). Our study provides an in-depth analysis of the prevalence and determinants of anemia among HIV-positive individuals, as well as the impact of anemia on health-related quality of life (HRQoL). The findings are significant, especially in the case of resource-limited settings such as Kenya, where both HIV and anemia pose considerable public health challenges.

The overall prevalence of anemia in our study population was 12.4%, with a slightly higher prevalence in women (12.8%) than in men (11.4%), which contrasts with higher prevalence rates reported in several other studies. For instance, Melese et al. (2017) reported a prevalence of 23% in Debre-Tabor Hospital, Ethiopia, and Wendie and Mengistu (2022) found a prevalence of 41.3% among HIV-positive patients. The study by Sah et al. (2020) found an even higher prevalence of 66.7% in Nepal, indicating significant geographic and demographic variability (Aynalem et al., 2020; Melese et al., 2017; Wendie & Mengistu, 2022). This variability can be attributed to several factors, including differences in study populations, methodologies, healthcare settings, and the criteria used to define anemia.

Level of education emerged as a significant socio-demographic factor associated with anemia status in our study. The role of education in anemia among HIV-positive patients is notable. Studies such as Gebremedhin & Haye (2019) and Zenebe et al. (2019) have reported that lower educational attainment is associated with a higher risk of anemia. Individuals with lower educational attainment may have limited access to health information, which can affect their understanding of anemia management and nutritional needs. This is supported by the finding from Zenebe et al. (2019) that the inability to read and write was a significant predictor of

anemia, suggesting that educational interventions could play a crucial role in the prevention and management of anemia (Gebremedhin & Haye, 2019; Zenebe et al., 2019).

Among clinical factors, CD4 count was significantly associated with anemia. Individuals with CD4 counts greater than 400 cells/mL had a lower likelihood (OR = 0.35) of being anemic compared to non-anemic. Studies consistently show that as CD4 count decreases, the prevalence of anemia increases. Sah et al. (2020) reported anemia prevalence rates of 5.71%, 12.85%, and 48.09% among patients with CD4 counts >500, 200–499, and <200 cells/mm³, respectively. This relationship highlights the importance of maintaining adequate immune function to mitigate the risk of anemia (Sah et al., 2020). However, other clinical variables such as the duration of HIV positivity, WHO stage, TB diagnosis, and duration of ART did not show a significant association with anemia status in our study.

Our investigation into the relationship between anemia and HRQoL revealed that anemia significantly impacts the physical health domain. Anemic individuals reported lower physical health HRQoL mean scores compared to their non-anemic counterparts, after adjusting for period of HIV positivity, education level, and CD4 count. This finding is critical as it highlights the tangible impact of anemia on daily functioning and overall well-being of HIV- positive individuals.

Interestingly, while anemia was significantly associated with physical health, it did not show a significant relationship with psychological, social, or environmental domains of HRQoL. This suggests that the physical manifestations of anemia, such as fatigue and reduced physical capacity, are more immediately perceptible to patients compared to its effects on other aspects of life. This findings correspond to the findings of studies carried out in different settings. A study carried out in US and Brazil is consistent with our study and indicates the role anemia has on the health-related quality of life (Hoshino et al., 2020). Another study carried out in Ethiopia also concurred with the findings of our study which stated that risk factors such as low CD4 count, opportunistic infections and anemia contribute negatively to the health-related quality of life among HIV positive patients (Osei-Yeboah et al., 2017).

The associations between anemia, education level, and CD4 count emphasize the need for integrated care approaches that address both clinical and socio-economic determinants of health. Routine screening for anemia in HIV-positive individuals, particularly those with lower CD4 counts or lower educational attainment, should be prioritized. Furthermore, interventions aimed at improving educational opportunities and health literacy could play a role in reducing the burden of anemia. The significant impact of anemia on physical HRQoL emphasizes the importance of early detection and management of anemia to improve overall health outcomes and quality of life in HIV-positive populations. This could involve nutritional interventions, iron supplementation, or adjustments in ART regimens to minimize hematologic toxicity.

Despite the robust findings, our study has some limitations. The cross-sectional design limits the ability to infer causality between anemia and HRQoL. Longitudinal studies are needed to further explore these associations over time. Additionally, our study was conducted in a specific geographical and socio-economic context, which may limit the generalizability of the findings to other settings. Future research should aim to identify specific causes of anemia in HIV-positive individuals, such as nutritional deficiencies, chronic infections, or ART-related side effects. Investigating these factors could provide more targeted strategies for anemia prevention and management.

5. Conclusion

This study investigated the prevalence of anemia and its association with health-related quality of life (HRQoL) among HIV-infected individuals attending Meru Teaching and Referral Hospital in Meru County, Kenya. The findings revealed that anemia remains a notable health concern among people living with HIV, with a prevalence of 12.4% in the study population. Although this prevalence is lower than in some studies conducted in other regions, it remains an important clinical condition that may negatively affect patients' well-being.

The study identified education level and CD4 count as significant factors associated with anemia among HIV-positive individuals. Participants with lower educational attainment were more likely to experience anemia, suggesting that socio-economic and knowledge-related factors may influence health outcomes in this population. Additionally, individuals with higher CD4 counts demonstrated a lower likelihood of being anemic, highlighting the importance of immune status in mitigating hematological complications associated with HIV infection.

Importantly, the study demonstrated that anemia significantly affects the physical health domain of HRQoL. Anemic participants reported lower physical health scores compared to non-anemic individuals, indicating that anemia contributes to reduced physical functioning, fatigue, and diminished overall well-being. However, anemia did not show a statistically significant association with psychological, social, or environmental domains of HRQoL.

6. Recommendations

Based on the findings, the study made several recommendations. Healthcare facilities providing HIV care should implement routine screening for anemia among people living with HIV. Early detection and timely management of anemia can help prevent deterioration in physical health and improve patient quality of life. Healthcare providers should incorporate comprehensive anemia management into HIV care programs. This may include nutritional assessment, iron supplementation where appropriate, treatment of underlying infections, and monitoring of antiretroviral therapy that may contribute to hematological complications. Educational interventions should be integrated into HIV care services to improve patients' understanding of anemia, nutrition, and adherence to treatment. Improving health literacy may help reduce the risk of anemia, particularly among individuals with lower levels of formal education. Health institutions and policymakers should strengthen nutritional support programs for people living with HIV. Adequate dietary intake of essential micronutrients, particularly iron, folate, and vitamin B12, can play a key role in preventing anemia.

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