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Concurrent *Plasmodium* infection, anemia and their correlates among newly diagnosed people living with HIV/AIDS in Northern Ethiopia

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ABSTRACT

The magnitude of concurrent malaria infection and the impact it has on hematological abnormalities, such as anemia in people living with HIV/AIDS, is not well studied in Ethiopian set up. In this cross sectional study, therefore, we assessed the prevalence of concurrent malaria infection and anemia among highly active anti-retroviral therapy (HAART) naive people living with HIV/AIDS between October, 2012 to May, 2013 in Northern Ethiopia. After obtaining consent, socio demographic, clinical, immunological and behavioural data was obtained. The overall prevalence of concomitant malaria infection was 17.4%. Rural residents and low to middle income class clients were more frequently co-infected with malaria ($p < 0.0001$). Utilization of insecticide treated nets ($p = 0.0002$) and co-trimoxazole intake ($p = 0.006$) were protective factors against *Plasmodium* infection. The overall prevalence of anemia was also high (43%), being significantly higher (91.3%) in malaria positive people living with HIV/AIDS compared to malaria free HIV patients (32.8%) ($p < 0.0001$). Female gender ($p = 0.011$), history of opportunistic infections ($P = 0.0027$) and late HIV stages (III and IV) ($p = 0.0001$) were also significantly associated with anemia in HIV patients. In conclusion, concurrent malaria represents a common condition and there was a significant difference in the odds of anemia between malaria positive and negative people living with HIV/AIDS in Northern Ethiopia indicating a need for routine screening of people living with HIV/AIDS living in malaria endemic-areas and close monitoring of co-infected patients. Indeed utilization of ITNs, malaria prophylaxis and early HIV diagnosis are highly encouraged in people living with HIV/AIDS.

1. Introduction

Despite continued efforts of control measures, HIV and malaria remained among important health concerns of our time. In 2015, malaria alone contributed to 584 000 deaths globally (WHO, 2015b) and HIV for 1.2 million deaths (WHO, 2014) which means both malaria and HIV contribute to over 1.7 million deaths worldwide annually. Malaria and HIV infections are both highly prevalent in Sub-Saharan Africa and remained significant deadly diseases that are often brought together by overlapping geographic distributions. Sub-Saharan Africa carries a disproportionately high share of the global malaria burden. In 2015, 88% of malaria cases and 90% of malaria deaths occurred in this region (WHO, 2015b). Likewise, Sub-Saharan Africa hosted around 25.8 million people living with HIV/AIDS in 2014 and 70% of new HIV cases (WHO, 2014).

HIV/AIDS patients who have a concomitant malaria infection are at high risk of developing severe malarial disease (Cohen et al., 2005; Patnaik et al., 2005), recrudescing malaria symptoms (Grimwade et al., 2004), and experiencing treatment failure of malaria (Kamya et al., 2006). Additionally, acute malaria is associated with an increase in HIV viral load (Van Geertruyden et al., 2006) and a steeper decline in CD4 cell count (Kublin et al., 2005). Moreover, viral load and CD4 count changes can take several weeks to recover after successful malaria therapy (Kublin et al., 2005). A reduction in CD4T cells below 200 cells/μL makes the host highly susceptible to opportunistic infections (Samet et al., 2001) includ-

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ing malaria (Morgan et al., 2002) and increases overall AIDS related morbidity and mortality. These interactions favor spread of both diseases, and hence early detection of co infection and identifying factors associated with it is of paramount importance for better management of co infected patients and ultimately reduce disease burdens from dual infections.

Anemia is one of the HIV related hematological abnormalities and is the most common hematological complication of HIV infection that has a significant impact on the quality of life and clinical outcomes (Moore, 1999). It is estimated that, up to 90% of adults and children develop anemia during HIV infection (Semba and Gray, 2001). There is also evidence of correlation between low hemoglobin concentration and depletion of CD4+ lymphocytes in late clinical stage of AIDS (Ferede and Wondimeneh, 2013). Correlations between anemia and established HIV infection and faster progression to AIDS stage and death (Lau et al., 2005; Mocroft et al., 1999) have been also documented.

Malaria and HIV are able to cause anemia one independent of the other (Grimwade et al., 2004) and changes in haematological indices. These hematological changes could be understood in light of the mechanisms by which malaria and HIV individually impact: HIV can result in a general myelossupressive effect, while malaria could impact hematological parameters through its hemolytic effect on red blood cells as well as its immunoinflammatory effects on white blood and platelet cell counts. People living with HIV/AIDS who are concurrently infected with *Plasmodium* are rather at higher risk of being anemic (Erhabor et al., 2006) and or severely anemic (Saracino et al., 2012; Davenport et al., 2010) compared to malaria free HIV/AIDS patients. However, a study suggested malaria to have no significant effect on haematological parameters such as on haemoglobin, CD4 cells, WBCs, RBCs and platelets in HIV infected patients (Tchinda et al., 2012).

Given, high prevalence of both HIV and malaria in sub-Saharan Africa, co-infections are often common in a given population. But only few studies have been conducted on the magnitude of co-infections so far. A high prevalence of malaria co-infection (29.4%) in Cameron (Nkuo-Akenji et al., 2008), 11.75% in Ghana (Tay et al., 2015), 32% in Jos, Nigeria (Goselle, 2009) was reported. In these studies, the co-infection was shown to be a predictor of anemia. Because of the geographic overlap between high-prevalence areas for malaria and HIV infection, there is growing evidence that the two infections may synergistically intensify each other, increasing incidence and complicating treatment efforts.

Despite recent changes in the epidemiology of HIV infection and malaria, and major improvements in their control, these diseases remain amongst the most important infectious diseases in Ethiopia. The current national prevalence of malaria in Ethiopia is about 1.3% (USAID, 2013) and that of HIV is 1.1% (WHO, 2015a), but reaching up to 6% in some regions. While few cross sectional studies in Ethiopia (Ferede and Wondimeneh, 2013; Assefa et al., 2015; Enawgaw et al., 2015; Gedefaw et al., 2013; Mihiretie et al., 2015) have attempted to characterize anemia and its correlates in people living with HIV/AIDS who harbor HIV infection alone, there is a dearth of information on the joint impact of HIV and malaria co-infection on anemia in the HAART naïve people living with HIV/AIDS. Understanding the burden of co-infection with HIV and malaria in settings where both diseases are common aids in determining approaches to treatment and prevention. It would also help health care staff improving current diagnostic, therapeutic and follow up guidelines of HIV-infected patients presenting with concurrent malaria infection and hematological abnormalities. Therefore, the main aim of this study was to determine the prevalence of concurrent malaria, anemia and associated factors among adult people living with HIV/AIDS coming for initial CD4+ T cell evaluation, in Northern Ethiopia.

2. Methods

2.1. Study area and design

A cross sectional study was conducted from October, 2012 to May 2013 at Bahirdar Felegehowot Referral Hospital (FHRH); the only referral hospital of the town, Northern Ethiopia. It was selected as it is the only public referral hospital of the town where HIV diagnosis and care is provided. Bahirdar is the capital city of Amhara National Regional State (ANRS) and it is located 562 km from Addis Ababa. This general service public institution provides this service (CD4 counting) as one part of the HIV/AIDS care and treatment services to monitor disease progression and hence check eligibility for initiation of ART.

According to available information, residents in the study area were found to be at higher risk of malaria than those living in other regions of Ethiopia (Ayele et al., 2012). Bahir dar is also among HIV affected towns in Ethiopia. From a total of 1.5 million people living with HIV/AIDS in Ethiopia, about 5–7% live in and around Bahir Dar and its neighbouring areas. However, the exact magnitude of concurrent malaria infection in people living with HIV/AIDS remained elusive for years.

2.2. Sample size and study population

In intent to obtain maximum sample size we assumed 50% prevalence rate of concurrent malaria in people living with HIV/AIDS as there was no data. We also considered anemia prevalence in HAART naive adult people living with HIV/AIDS to be 0.35 (Ferede and Wondimeneh, 2013), a previous report in North west Ethiopia. With the following assumptions (95% confidence limit, 5% margin of error and allowance for 10% non-response) and taking a 10% contingency, a total of 528 people living with HIV/AIDS above 18 years old had been included. All adult (>18 years old) newly diagnosed HIV patients coming for an initial CD + T cell evaluation, i.e. ART naïve, who were consecutively admitted to the ART clinic of FHRH, Bahir Dar, Northern Ethiopia were enrolled. HIV positive patients who were on antiretroviral therapy and pregnant women were excluded. Pre-ART HIV patients who were on medication such as antibiotics, history of anti- malarial intake, vitamin supplements and tuberculosis treatments were also excluded.

2.3. Data collection

To collect socio-demographic data, participants were interviewed using a standardized structured questionnaire. Data was collected on predefined sets characteristic of newly diagnosed people living with HIV/AIDS. These include, age, sex, residence, marital status, education, employment status, income, WHO clinical stage of AIDS, CD4 count, utilization of insecticide treated nets (ITNs), cotrimoxazole intake, history of opportunistic infections, and body mass index (BMI). We obtained BMI by measuring the patients' weight and height and employing the following formula: weight (kg)/height $(m)^2$. BMI <18.5 kg/m^2, assumed to be under nutrition.

2.4. Specimen collection and processing

A drop of blood, 3–5 mm in diameter was put on a slide and spread with the corner of another slide to form a thin blood smear. The smear was thoroughly allowed to dry, fixed with methanol and stained with Giemsa stain for about 15 min. The stained smear was washed with running tap water, allowed to dry in air and examined microscopically under 100X oil immersion objective for the presence of malaria parasites. A slide was considered negative when no parasites were seen after examining 100 oil immersion fields. An immunochromatography-based rapid diagnostic test (ICT) kit,

SD BIOLINE Malaria Pf/Pv Kit (SD Bio Standard Diagnostics Pvt. Ltd., India), was used for detecting antibodies against malaria surface protein (MSP) of both *P. falciparum* and *P.vivax*. Haemoglobin concentration was measured using a portable spectrophotometer (HemoCue Hb 301 System, Sweden), and anemia was defined according to WHO (WHO, 2011a,b) definition (hemoglobin <13 g/dL for men and <12 g/dL for non pregnant women). Severity of anemia was also graded as follows: hemoglobin levels of less than 8 for both men and women, 8–13 for men and 8–12 for represent severe and mild to moderate anemia respectively.

2.5. Data processing and analysis

Data were entered into an Excel spreadsheet and analyzed using the SPSS version 21 software. The statistical tests performed included the Pearson's Chi-square for the group comparison of categorical variables, the Student's T-test to compare group means in people living with HIV/AIDS with malaria co-infection versus malaria free HIV mono infected patients. A multivariate analysis was performed to identify predictor variables. Statistical significance was set at $p < 0.05$.

2.6. Ethical consideration

The current study was approved by Institutional Ethics Committee/IEC of College of Medicine and Health Sciences, Bahir Dar University. A written informed consent was obtained from study subjects who were able to read and write and for those who were illiterate study participants; the data collectors inform each respondent and confirmed the willingness by signing on the informed consent sheet. To maintain the confidentiality of the patients' data, staff nurses working at the respective ART clinics were preferred to collect the data. Name and other personal identifiers had not been written on the questionnaire.

3. Results

3.1. Socio-demographic characteristics

Initially, 572 adult non pregnant people living with HIV/AIDS who visited FHRH were reviewed, but 44 of them were excluded from the study, some due to denial of consent, incomplete data and intake of anti malarial drugs. Therefore, a total of 528 subjects were included in this study of whom 250 (47.3%) were males and 278 (52.7%) were females. The age of respondents was approximately normally distributed with mean of 33.69 years old and standard deviation of 9.08. Four hundred and twenty three of respondents (79.2%) are residents of Bahirdar and the remaining are from outside Bahirdar town (see Table 1 for more details).

Table 1
Socio-demographic characteristics of people living with HIV/AIDS, Bahir Dar, Northern Ethiopia.

Variables	Categories	Frequency	Percent
Sex	Male	250	46.8
	Female	284	53.2
Age in quartile categories	<27 years	139	26.5
	27.00–31.99 years	141	26.9
	32.0–39.74 years	113	21.6
	>=39.75	131	25.0
Ethnicity	Amhara	488	91.4
	Agew Awi	20	3.7
	Tigrie	11	2.1
	Oromo	10	1.9
	Others	5	0.9
Religion	Orthodox	410	77.1
	Muslim	88	16.5
	Protestant	24	4.5
	Catholic	10	1.9
Marital status	Never married	97	18.3
	Married	295	55.6
	Divorced	89	16.8
	Whose spouse has died	45	8.5
	Widowed	5	0.9
Residence	Bahirdar	423	79.2
	Out of Bahirdar	111	20.8
Formal educational status	No formal education	82	15.4
	Some education up to 2^0 education	303	56.7
	Certificate, diploma and above	149	27.9
Occupation	Farmer	36	6.7
	Merchant	142	26.6
	Government employee	168	31.5
	Housewife	84	15.7
	Private employee	49	9.2
	Daily laborer	55	10.3
Estimated monthly average income	<500 ETB	118	22.1
	500–999 ETB	147	27.5
	1000–1499 ETB	125	23.4
	1500–1999 ETB	79	14.8
	>=2000 ETB	65	12.2

3.2. Prevalence of malaria in people living with HIV/AIDS and associated factors

At HIV diagnosis, 92 (17.4%) of the total adult people living with HIV/AIDS were found positive for malaria. *P. falciparum, P. vivax* and mixed infections of the two occurred in 57%, 40% and 3% of all malaria positive cases, respectively. The socioeconomic and clinical characteristics of HAART naive people living with HIV/AIDS were compared between those with concurrent malaria infection and their malaria negative counterparts. Female people living with HIV/AIDS were more frequently co-infected with malaria (19%) compared to males, although the difference was not significant. Similarly we observed a significant association between risk of malaria infection versus rural residence, low income status and non use of ITNs. Reported intake of co-trimoxazole was associated with protection of malaria. CD4+ T cell count as a whole, regardless of malaria co-infection, showed right skewed distribution with range of 1308; the maximum CD4 count being 1313 and the minimum 5 per μLof blood and an inter-quartile (IQR) range of 290–110. HIV patients who had an initial CD4+ T count of less than 200 cells/μL constitute 317/528 (60%). And 303 (57.4%) were at clinical AIDS stage III and IV (Table 2).

After analyses for potential associated variables, age 18–27 years old [(OR = 3.05), 95% CI = (1.63, 5.69)], residence outside Bahirdar City [(OR = 3.14), 95% CI = (1.93, 5.11)], low economic status [(OR = 3.22), 95%CI = (1.96, 5.29)] were significantly associated with malaria infection in HIV/AIDS patients. ITN use [(OR = 3.5), 95% CI = (2.00, 6.10)] and co-trimoxazole intake [(OR = 2.63), 95%CI = (1.31, 5.27)] were however, protective factors against malaria infection in HIV patients. However, there was no a statistically significant association observed with regard to gender, CD4+ T cell count and HIV clinical stage (Table 2).

3.3. Prevalence of anemia

The overall prevalence of anemia in this study for people living with HIV/AIDS was 227/528 (43%). The overall, haemoglobin concentration ranged from 4.7 g/dL to 16.8 g/dL with mean (SD) of 8.3 g/dL (1.7) in those patients with concurrent malaria infection and 5.3 g/dL to 18 g/dL with mean (SD) = 11.6 g/dL (2.1) in malaria negative people living with HIV/AIDS.

Table 2
Comparison of socio demographic, clinical and behavioral attributes between *Plasmodium*-positive and *Plasmodium*-negative people living with HIV/AIDS, in Northern Ethiopia.

Variables	Category	Malaria$^+$ (%)	OR(95%CI)	P value
Gender	Male	39/250(15.6)	1	
	Female	53/278(19%)	1.27(0.80, 2.00)	0.295
Age range (in years)	18–27	26/139(18.7)		
	27–31.99	30/141(21.3)		
	≥32	36/244(14.75)		
Residence	Bahir Dar City	56/423(13.2)	1	
	Outside Bahir Dar	36/111(39)	3.14(1.93, 5.11)	<0.0001
Average monthly income (ETB)	Low(<1000)	67/265(25)	3.22(1.96,5.29)	<0.0001
	Middle(1000–1999) to High(≥2000	25/263(9.5)	1	
CD_4^+Tcount (cell/μL)	<200	49/317(15.5)	0.71(0.45,1.12)	0.145
	≥200	43/211(20.3)	1	
WHO clinical stage	Stage I	11/79(13.9)	1	
	Stage II	36/146(24.7)	2.02(0.96, 4.23)	0.061
	Stage III	40/265(15)	0.54(0.53, 2.25)	0.797
	Stage IV	5/38(13)	0.85(0.31,2.31)	0.753
ITN utilization	Yes	17/210(8)	1	
	No	75/318(23.6)	3.5(2.00, 6.10)	0.0002
CXL	Yes	10/111(9)	1	
	No	82/396(20.7)	2.63(1.31, 5.27)	0.006

ETB Ethiopian Birr, CXL Co-trimoxazole, OR Odds ratio, WHO World Health Organization.

Table 3
Severity of anemia among HIV positive patients with and without concomitant malaria infection.

Anemia grade	Malaria$^-$(n = 436)		Malaria$^+$(n = 92)		X^2	P value
	Frequency	%	Frequency	%		
Severe	12	2.75	25	27.2	17.713	0.000026
Mild to Moderate	131	30	59	64.1		
Total	143	**32.75**	84	**91.3**		

Among malaria co-infected patients, the prevalence of anemia was 91.3% (84/92), and among malaria negative HIV patients it was 32.8% (143/436). According to the WHO classification of anemia severity, an overall 37 (7%) and 190 (36%) of the study participants had severe and mild to moderate anemia respectively. In malaria co-infected HIV patients, the prevalence of severe and mild to moderate anemia was 27.2%, and 64.1% respectively, compared to 2.75% severe anemia and 30% mild to moderate anemia in malaria negative counterparts, and this difference was statistically significant (Table 3).

3.4. Factors associated with anemia in people living with HIV/AIDS

Using chi-square computation, we showed risk factors associated with anemia in HIV patients. Female gender (p = 0.011), the presence of concomitant malaria infection, (p < 0.0001), late clinical presentation (HIV clinical stage III–IV) (p = 0.0001), history of any HIV associated opportunistic infection at first visit or within 6 months of the first HIV test prior data collection (p = 0.0027) and low income (0.0001) were associated with anemia (Table 4).

Table 4
Factors associated with anemia in HAART naive people living with HIV/AIDS, Northern Ethiopia.

Variables	Category	Number anemic (%)	P value
Gender	Male	93/250(37)	
	Female	134/278(48.2)	0.011
Age(in years)	18–31.99	116/280(41.4)	
	≥32	111/244(45.5)	0.349
Malaria co- infection	Yes	84/92(91.3)	<0.0001
	No	143/436(32.8)	
Residence	Bahir Dar city	171/423(40.2%)	
	Outside Bahir Dar	56/111(50.4)	0.058
BMI(Kg/m^2)	<18.5	147/317(46.4)	0.055
	≥18.5	80/211(37.9)	
WHO clinical stage	Stage I/II	42/225(18.7)	
	Stage III/IV	185/303(61)	0.0001
CXL intake	Yes	53/111(47)	
	No	174/396(43.9)	0.210
Previous OIs (history of malaria included)	Yes	57/101(56.4)	0.0027
	No	170/427(39.8)	

BMI: Body Mass Index, OIs: Opportunistic Infections, CXL: Co-trimoxazole.

4. Discussion

In this study we assessed the prevalence of symptomatic malaria, anemia and their correlates in adult HIV/AIDS patients. We observed high rates of concurrent malaria infection in HIV/AIDS patients. A high prevalence of anemia in HIV/AIDS patients was also seen regardless of malaria co-infection. However, a significantly higher overall prevalence of anemia and severe anemia were seen in malaria co-infected HIV patients compared to malaria negative HIV patients. Rural residence and low income were factors associated with malaria co-occurrence; in contrary ITN utilization and co-trimoxazole intake were protective factors against malaria infection. Female gender, recent history of opportunistic infections, presence of malaria co-infection and late HIV stage (clinical stage III and IV) were identified as risk factors for anemia.

The malaria co-infection rate reported in current study (17.4%) was relatively lower compared to prevalence rates reported elsewhere (Iliyasu et al., 2013; Akinbo et al., 2009; Saracino et al., 2012) and only slightly lower compared to a report from Northern Ethiopia (19.4%) (Wondimeneh et al., 2013). But it was higher compared to prevalence from Asia (7.6%) (Shankarkumar et al., 2011) Tanzania (4.5%) (Manyanga et al., 2014) and Ghana (11.75%) (Tay et al., 2015). The observed differences in prevalence rates of malaria and HIV co-infection might be attributable to prevalence variation of both diseases, whether HIV patients are taking

co-trimoxazole chemoprophylaxis for opportunistic infections, in which cases malaria infection in HIV could be very low (Saracino et al., 2012), and level of practice of malaria control measures as well as methodological discrepancies.

Co-trimozaxole intake was associated with low likelihood of concomitant malaria in HIV patients. Similar results were reported in Ethiopia (Alemayehu et al., 2015), Nigeria (Iliyasu et al., 2013), Mozambique (Saracino et al., 2012) and Tanzania (Manyanga et al., 2014). Moreover, HIV patients who slept under ITNs in the last six months prior to data collection had lower odds of being malaria positive. Reports on protective role of ITNs against malaria are immense (Manyanga et al., 2014; Iliyasu et al., 2013).

Results from the present study revealed a high prevalence of anemia (43%) in people living with HIV/AIDS. This was lower compared to anemia prevalence reported in Ghana (67%) (Tay et al., 2015), Benin city, Nigeria (60.61%) (Omoregie et al., 2009), North east Nigeria (49.5%) (Denue et al., 2013), Uganda (47.8%) (Kyeyune et al., 2014) and China (51.9%) (Yinzhong et al., 2013). In relation to previous studies done in Ethiopia such as that of Ferede and Wondimeneh (2013) on HIV patients, our overall anemia prevalence rate was relatively higher, but similar to that of Assefa et al. (2015). The reason for higher prevalence of anemia in our case compared to many other studies in Ethiopia could be due to the fact that a higher proportion (60%) of the HIV patients included in our study being immunosuppressed, having CD4 cell <200/μL, all participants being HAART naïve, and some presenting with malaria co-infection. Study designs, socioeconomic and nutritional status, geographical set up, HAART status and sample size do also matter. Moreover, the complexity and the multifactorial etiology of anemia among HIV infected people in sub-Saharan Africa, including HIV/AIDS itself, malaria, protein and micronutrient deficiency and endemic diseases like hookworm and schistosomiasis (Algoe and Gable, 2009) play their role in contributing for anemia.

In line to some previous findings (Nkhoma et al., 2012; Manyanga et al., 2014; Erhabor et al., 2006), people living with HIV/AIDS and having a concurrent malaria infection, were considerably at higher risk of being anemic compared to those free of malaria infection. In the current study, the vast majority of the study subjects (91%) with concurrent malaria infection were anemic. Similarly a study done in 2008 in Doula, Cameroon, where malaria HIV co-infection was high (29.4%), reported anemia as the most prominent hematological disorder (Nkuo-Akenji et al., 2008). A 90.9% and 94.4% of anemia prevalence in males and female subjects respectively was reported in Ghana (Tay et al., 2015), and a slightly higher anemia prevalence rate than our was reported in Tanzania which is 94.7% (Manyanga et al., 2014).

The magnitude of severe anemia reported in this study in malaria infected people living with HIV/AIDS was much higher compared to malaria negative patients in both sexes. Reports from Ghana (Orish et al., 2013) and Lagos, Nigeria (Sanyaolu et al., 2013) showed a similar scenario. In these studies, dual infection of malaria and HIV increased severe anemia in patients including the pregnant patients. In another study by Tagoe and Boachie (2012), none of the HIV mono-infected showed severe anemia compared with 18.2% of the HIV and malaria co-infected cases. These evidences suggest a strong link between HIV-malaria and severity of anemia, though the overall anemia prevalence was not significantly differed between malaria positive and malaria negative HIV patients. This might be due to the fact that HIV could cause anemia independently of other co-morbidities.

In this study, the odds of people living with HIV/AIDS being anemic was higher in patients with CD4T cell count less than 200 cells/μL of blood compared to those having greater than 200 CD4 cells, though we could not observe a statistically significant association. Studies elsewhere however, showed a significant correlation between declining CD4 cells and likelihood of anemia (Mata-Marín et al., 2010; Ferede and Wondimeneh, 2013; Kyeyune et al., 2014; Mihiretie et al., 2015; Tay et al., 2015). The differences could be due to the variation in CD4 count grading, below which the risk of anemia is correlated among other factors. An exact cutoff CD4 count below which is a significant predictor of anemia therefore remains elusive.

In this study, anemia was present in 61% of people living with HIV/AIDS at clinical stage III and IV combined and 18.7% (in stage I plus II). HIV clinical stage III–IV was rather a significantly associated with anemia in people living with HIV/AIDS. A study done in Tanzania (Manyanga et al., 2014) reported similar result. Anemia has been consistently associated with the progression of HIV disease as measured by diagnosis of an AIDS-defining opportunistic illness and measurement of a CD4 count of 200 cells/μl. This association is most likely explained by the increasing viral burden as HIV disease progresses, which could cause anemia by increased cytokine mediated myelosuppression which impair erythropoietin. Also, several opportunistic microorganisms such as *Mycobacterium tuberculosis*, *Histoplasma, Cryptococcus, Coccidiodes, Pneumocystis carinii,* and *Leishmania* have been shown to infiltrate the bone marrow and disrupt erythropoiesis (Hambleton, 1996). But some reports that still contradict with link between late HIV stage and prevalence of anemia (Enawgaw et al., 2015). Difference, in study subjects, design, study setting, presence or number of opportunistic infections present and other factors to be explored may justify this difference.

5. Conclusion

In view of our findings, concurrent malaria infection in people living with HIV/AIDS was high. While to reside in rural areas is associated with malaria, both co-trimoxazole intake and bed net utilization protected against the infection in HIV/AIDS patients. The overall prevalence of anemia in the cohort of people living with HIV/AIDS despite malaria co-infection was substantial and a significantly higher severity of anemia was observed in HIV/AIDS patients who were simultaneously infected with malaria. The presence of malaria co-infection, WHO stage III and IV, female gender and history of opportunistic infections were identified as factors associated with occurrence of anemia in adult people living with HIV/AIDS. This is therefore, an implication for a need to implement anti malaria prophylaxis and heightened utilization of ITNs in HIV/AIDS patients. Measures such as early diagnosis and timely initiation of anti-retroviral treatment, as well as early detection of malaria in people living with HIV/AIDS could be of benefit to prevent co-morbidities and associated anemia. This study is an observational one, and hence we could not establish any causal relationships. Furthermore, the complexity and multiple etiologies of anemia warrant highly controlled future studies. Further longitudinal research is therefore needed to evaluate the impact of malaria infection on HIV and anemia to help formulate reliable management strategies during malaria infection in people living with HIV/AIDS.

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