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Anaemia among Pregnant Women Attending Antenatal Care in Kyenjojo and Kole Districts in Uganda: Prevalence and Associated Factors

James Ssekitooleko[1*], Tinuola Femi Rufus[2], Denis Mubiru[3], Catherine Nyakakye[3], Paul Kibikyabu[4]

[1]*PhD in Public Health, Texila American University, Uganda*
[2]*Federal University, Gusau Zamfara State, Nigeria*
[3]*Malaria Consortium, Juba, South Sudan*
[4]*Kyenjojo District Local Government, Kyenjojo, Uganda*

Abstract

Anemia during pregnancy is a major public health problem, with a global prevalence of 41.8%. It is associated with high morbidity and mortality. Information on the prevalence of anemia and associated factors among pregnant women in the study area is limited. This study aimed at determining the prevalence and predictors of anemia among pregnant women attending antenatal clinics (ANC) in Kyenjojo and Kole Districts, Uganda. Cross-sectional study was conducted among randomly selected pregnant women. Quantitative data was collected using a structured questionnaire that captured demographic and obstetric characteristics. Haemoglobin concentration (Hb) was determined using HemoCue 201+. The study outcome was the prevalence of anaemia (Hb <11 g/dl). Chi-square, odds ratio, and logistic regression were used to test for associations. Of the total 760 pregnant women who participated in this study, 20.1% were anaemic. The prevalence varied from 13.4% in Kyenjojo to 26.9% in Kole District. Of 153 anaemic women, 121 (97%) were mildly anaemic, 27 (18%) moderately anemic, and 5(3%) severely anemic. Malaria infection [AOR: 0.46, 95% CI (0.26 – 0.83)], primigravida [AOR: 0.52, 95% CI: 0.29-0.93], and residing in Kole [AOR: 0.50, 95% CI: 0.32-0.76] were significant predictors of low haemoglobin concentration. This study highlighted the high prevalence of anaemia in our settings and the significant association between anaemia and malaria among pregnant women. Therefore, routine screening of pregnant women for anemia, malaria, and other risk factors during their first ANC visit is recommended to identify those at risk and prompt management provided to curb their negative consequences.

Keywords: *Antenatal care, Anaemia in pregnancy, Malaria infection, Pregnant women, Uganda.*

Introduction

Anaemia is a global public health problem and most times under-unrecognized as it is overshadowed by the normal physiological condition during pregnancy [1]. It is a risk factor in pregnancy and is a major cause of morbidity and mortality among pregnant women low-income and negative consequences to fetus including premature births, low birth weight and death [2]. According to 2008 World Health Organization report, the highest rate of anaemia during pregnancy was found in the Sub-Saharan region, with over 17.2 million mothers were estimated to be anaemic and accounting for 30% of global cases [2, 3]. In Africa, more than three percent of maternal mortality are attributed to maternal anaemia [4]. In the East-African region, the prevalence of anaemia among pregnant women varies from 23.36% in Rwanda, 38.2% in Uganda, 57.1% in Tanzania, and 57-61% in Kenya [5, 6, 7, 8]. According to Uganda's Demographic and Health Surveys report 2016, the prevalence of anemia among pregnant

Corresponding Author: j.k.ssekitooleko@gmail.com

women was 38% in 2016 but with regional variations from 39.3% in Lago region Northern Uganda, 29.4% in Tooro region Mid-Western Uganda, and 16.9% in Kigezi region [9].

The cause of anemia during pregnancy is multifactorial. It includes nutritional deficiencies of minerals (like iron, folate, and vitamin B12), and parasitic diseases (like malaria and hookworm), and chronic infections (like tuberculosis and HIV). The contribution of each of these risk factors to anaemia during pregnancy varies greatly by location, season, and dietary [10]. In the literature, wealth index, maternal education, maternal age, parity, area of residence, occupation, iron intake, source of water, and marital status were factors associated with anemia in pregnancy [11, 12].

Though there are pieces of evidence in Uganda regarding the anaemia prevalence and the risk factors associated with it, none of these indicated the overall burden and risks among pregnant women in Kole and Kyenjojo Districts. And knowing the prevalence is useful in the intervention mix to lessen the case burden of anaemia and importantly, aid in monitoring the progress made in reproductive health. Thus, the objective of this study was to determine the prevalence and factors associated with anemia among pregnant women who sought antenatal care (ANC) in the Kole (Northern Uganda) and Kyenjojo (Midwestern Uganda) District in Uganda. The findings are vital in the design of policies and strategies aimed at reducing the burden of anemia during pregnancy and hence lowering the maternal mortality ratio in the Ugandan context.

Materials and Methods

Study Setting

We conducted a multi-centre facility-based study among pregnant women attending their first antenatal care clinics in Alito HC III and Bala HC III located in Kole District, Northern Uganda, and in Katooke HC III and Butunduzi HC III located in Kyenjojo District mid-western Uganda. Kole District is in Northern Uganda, with a population estimate of 297,479. It has 19 health facilities. In 2020, 14,458 and 21,716 pregnant women attended their first ANC visit in Kole and Kyenjojo Districts, respectively.

Design

A cross-sectional quantitative research design was adopted. A structured questionnaire was used to collect data from pregnant women. Laboratory samples were collected to estimate haemoglobin level and test for the presence of malaria parasites and HIV.

Sample Size Determination and Sampling Technique

The sample size of this study was calculated by using the Kish Leslie formula. We considered 95% confidence interval, 5% margin of error, and 45% and 64% prevalence of anaemia for Kole (Northern Uganda) and Kyenjojo (Mid-Western Uganda), respectively [9]. A factor of 10% non-response rate was added. The four facilities were purposively sampled due to the high volume/patient load in each of the 2 districts. A total sample size of 760 pregnant woman were selected using a systematic random sampling technique to avoid selection bias. The national HMIS form 071: integrated antenatal register was used as the sampling frame. After randomly selecting the start point, thereafter every third unit in the list was included until the required sample size was attained.

Data Collection

A pre-tested structured questionnaire was administered by trained midwives to obtain information on maternal characteristics such as age, education level, occupation, marital status, HIV status, gravidity, gestational age, history of abortion, and use of malaria prevention methods (IPTp-SP and ITNs). Gestation age was estimated using the date of the last normal menstrual period. Study variables included in the questionnaire were guided by previous studies in Uganda [12-14]. Finger pricked blood samples were taken to measure haemoglobin concentration using HemoCue® 201 machine,

detect the presence of malaria parasite, and HIV testing by trained Phlebotomist. Pregnant women with a haemoglobin concentration of less than 11.0 g/dl were categorised as anaemic using the WHO classification [15]. Anaemia was considered severe when haemoglobin concentration was less than 7.0 g/dL, moderate when haemoglobin was between 7.0 and 9.9 g/dL, and mild from 10 to 10.9 g/dL.

Data Management and Analysis

Quantitative data was collected using ODK software, exported to Microsoft Excel, and then transferred to STATA version 15 statistical package for further analysis. The outcome variable for this study was anaemia (low Hb concentration). The independent variables include socio-demographic factors (age, marital status, educational status, and occupational status); obstetric factors (gravidity, parity, trimester of pregnancy, history of abortion); health-related conditions (malaria infection, HIV); and malaria prevention measures (ITN ownership and use). Descriptive statistics were done to explain the study population in relation to relevant variables. Both bi-variate and multi-variate logistic regressions were used to assess the association. Odds ratios generated were used to reflect the likelihood of risk factors to anaemia prevalence in pregnant women.

Ethical Approval

Mildmay Uganda Institutional Review Committee (REF 0209-2020), Uganda National Council for Science and Technology, and University Ethical committee Texila American University Guyana approved the study. Written informed consent was obtained from all study participants. Data collected from each participant and results of laboratory tests were kept confidential.

Results

A total of 760 pregnant women (379 in Kole and 381 in Kyenjojo) were included in this study, with a response rate of 99%. The age of the participants ranged from 15 to 46 years with a median age of 23, the majority (41.1%) of them between 20–24 years. The majority (94.5%) of the women were married, and about 77% of the women completed their primary and secondary level education, and 97% were farmers. Sixty-nine percent of the mothers were multigravidae, 50.36% of them were in their second trimester for their first ANC visit. Over 85% of pregnant women owned at least one ITN (Table 1).

Table 1. Sociodemographic and Obstetric Characteristics of Study Participants

Characteristics	**Kole (N=379)**		**Kyenjojo (N=381)**		**Total (N= 760)**	
	Frequency	**Percent (%)**	**Frequency**	**Percent (%)**	**Freq**	**Percent (%)**
Age						
Median	-	-	-	-	23	-
Min	15	-	15	-	15	-
Max	46	-	40	-	46	-
Mean	24	-	25	-	24	-
Age Group						
≤19	88	23.2	58	17.9	156	20.5
20 – 24	153	40.4	159	41.6	312	41.1
25 – 29	80	21.1	76	20.0	156	20.5
30 – 34	36	9.5	48	12.6	84	11.1
≥35	22	5.8	30	7.9	52	6.8
Occupation						
Farmers	368	97.1	323	84.8	691	90.9
Traders/Professional	11	2.9	30	7.8	41	5.4

Unemployed	0	0.0	28	7.4	28	3.7
Education Level						
None	90	23.7	86	22.6	176	23.2
Primary	266	70.2	228	59.8	494	65.0
Secondary or Higher	23	6.1	67	17.6	90	11.8
Marital status						
Not married	4	1.1	38	10.0	42	5.5
Married	375	98.9	343	90.0	718	94.5
Gravidity						
Primigravidae	142	37.5	91	23.9	233	30.7
Multigravidae	237	62.5	290	76.1	527	69.3
Trimester						
1st	186	49.1	126	33.1	312	41.0
2nd	168	44.3	214	56.2	382	50.3
3rd	25	6.6	41	10.7	66	8.7
ITN ownership						
Owned At least 1 ITN	337	89	316	83	653	86
Did not own any ITN	42	11	65	17	107	14

Prevalence of Anaemia among Pregnant Women

A total of 153 (20.1%) pregnant women were anaemic. The prevalence of anemia in Kole was 26.9% (102/379), and that in Kyenjojo was 13.4% (51/381). Of 153 anaemic women; 121 (97%) were mildly anaemic, 27 (18%) moderately anemic, and 5(3%) severely anemic. The prevalence of mild, moderate, and severe anaemia in Kole was 21%, 5%, and 0.8% respectively, and in Kyenjojo 11%, 2%, and 0.5%, respectively. Anaemia was more prevalent in the younger age (15 – 19 years) decreased with increasing age (Figure.1).

The error bars in Figure 1 represent 95% confidence intervals. Mild anaemia (Hb = 10–10.9g/dL), Moderate anaemia (Hb = 7–9.9g/dl), Severe anaemia (Hb < 7g/dL).

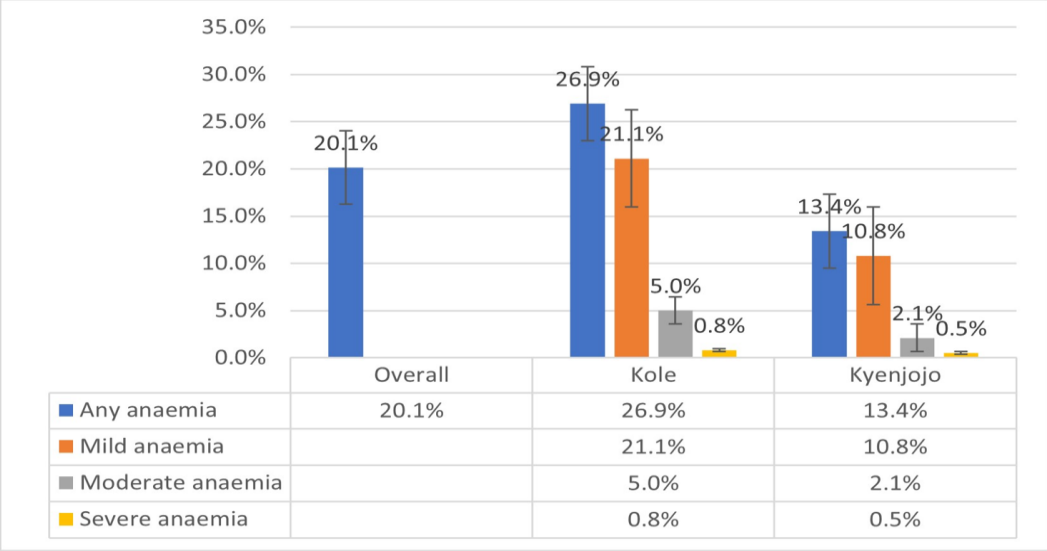

Figure 1. Overall Prevalence and Severity of Anaemia among Pregnant Women

Bi-variate Analysis of Factors associated with Anaemia among Pregnant Women

Anaemia was significantly associated with the mother's age, gravidity, gestation age, presence of malaria parasites, not using ITN, and place of residence. Other variables (including marital status, educational level attained, occupation, owning an ITN, or HIV status) yielded no significant association (Table 2 and Table 3).

Table 2. Bivariate analysis for socio-demographic factors associated with Anaemia among pregnant women

Socio-demographic characteristics	**Total**		**Kole District**		**Kyenjojo District**	
	Anaemia		**Anaemia**		**Anaemia**	
	Positive	**p-value****	**Positive**	**p-value****	**Positive**	**p-value****
	N (%)		**N (%)**		**N (%)**	
Age group (years)						
≤19	47 (30.13)	*P*=0.003	36 (40.91)	*P*=0.002	11 (16.18)	*P*=0.937
20 – 24	57 (18.27)		36 (23.53)		21 (13.21)	
25 – 29	33 (12.15)		23 (28.75)		10 (13.16)	
30 – 34	10 (11.90)		5 (13.89)		5 (10.42)	
≥35	6 (11.54)		2 (9.09)		4 (13.33)	
Age (years)						
Adolescents (15-19)	47 (30.1)	*P*<0.001**	36 (40.91)	*P* <0.001**	11 (16.18)	*P*=0.456
Adults (≥20)	106 (17.6)		66 (22.68)		40 (12.78)	
Residence/District						
Kole	102 (26.91)	*P*<0.001**	-	-	-	-
Kyenjojo	51 (13.39)		-	-	-	-
Marital status						
Not married	8 (19.1)	*P=0.857*	1 (25.00)	*P=0.706*	7 (18.42)	*P=0.32*
Married	145 (20.2))		101 (26.93)		44 (12.83)	
Educational level						
No education	29 (16.48)	*P=0.293*	20(22.22)	*P=0.41*	9 (10.47)	*P=0.635*
Primary level	107 (21.66)		74 (27.82)		33 (14.47)	
Secondary & higher	15 (17.86)		7 (35.00)		8 (12.5)	
Occupation						
Farmer	142 (20.55)	*P=0.635*	100 (27.17)	*P=0.734*	42 (13.00)	*P=0.775*
Traders/Professional	7 (17.07)		2 (18.18)		5 (16.67)	
Unemployed	4 (14.29)		0 (0.00)		4 (14.29)	

Note: Row percent used, ** Pearson's chi square test at alpha = 0.05, N values are weighted

Table 3. Bivariate Analysis for Obstetric and Health-Related Factors Associated with Anaemia among Pregnant Women

Obstetric Characteristics	Total		Kole District		Kyenjojo District	
	Anaemic		Anaemic		Anaemic	
	Yes N (%)	p-value**	Yes N (%)	p-value**	Yes N (%)	p-value**
Gravidity						
Primigravidae	71 (30.47)	*P*<0.001	52 (36.62)	*P*=0.001	19 (20.88)	*P*=0.016
Multigravidae	82 (15.56)		50 (21.10)		32 (11.03)	
Gestation period						
First Trimester	77 (24.68)	*P*<0.022	55 (29.57)	*P=0.452*	22 (17.46)	*P=0.025*
Second Trimester	62 (16.23)		42 (25.00)		20 (9.35)	
Third Trimester	14 (21.21)		5 (20.00)		9 (21.95)	
HIV serostatus						
Positive	2 (25.00)	*P*<0.665	2 (25.00)	*P=0.631*	-	-
Negative	151(20.08)		100 (26.95)		-	
Malaria infection						
Positive	36 (42.86)	*P*<0.001**	26 (44.83)	*P=0.001*	10 (38.46)	*P*<0.001
Negative	117 (17.31)		76 (23.68)		41 (11.55)	
ITN ownership						
Yes	133 (20.37)	*P*=0.689	90 (26.71)	*P*=0.797	43 (13.61)	*P*=0.779
No	20 (18.69)		12 (28.57)		8 (12.31)	
Number of ITN owned						
None	20 (18.69)	*P=0.099*	12 (28.57)	*P*=0.033	8 (12.31)	*P*=0.193
One	70 (24.73)		48 (34.53)		22 (15.28)	
Two	35 (16.28)		26 (24.53)		9 (8.26)	
Three & more	28 (18.06)		16 (17.39)		12 (19.05)	
ITN Use						
Yes	117 (18.31)	*P*=0.016	77 (24.84)	*P*=0.009	40 (13.61)	*P*=0.53
No	16 (34.04)		13 (48.15)		3 (15.00)	

Note: Row percent used, ** Pearson's chi square test at alpha = 0.05, N values are weighted

Multi-variate Analysis of Factors associated with Anaemia among Pregnant Women

Multiple logistic regression analysis was performed to identify independent predictors of anaemia among pregnant women. Eight explanatory variables that were associated with anaemia in bivariable analyses at 10% level of significance were entered into multiple logistic regression models. Area of residence, gravidity, and malaria infection showed significant association with anaemia. Accordingly, staying in Kyenjojo district had a 50% (AOR: 0.50, 95% CI: 0.32-0.76) protected effect against being anaemic compared to pregnant women in the Kole district. Multigravidae 48% (AOR: 0.52, 95% CI: 0.29-0.93) less likely to be anaemic compared to Primigravidae while women with malaria parasite had a 54% (AOR: 0.46, 95% CI: 0.25-0.82) chance of suffering from anaemia compared to those without parasitemia. Anemia was rampant among young pregnant women aged ≤19 years. Pregnant women aged 20 years or more were less likely to be anaemic compared to young pregnant women aged ≤19 years of age. Although older women were less likely to be anaemic, such an association did not reach a statistically significant level (Table 4).

Table 4. Multi-variate Analysis for determinant factors associated with Anaemia among Pregnant Women

Factors	Crude Estimates			Adjusted Estimates		
	OR	**95%CI**	**p-value**	**aOR**	**95%CI**	**p-value**
Age in years						
Adolesents (15-19)	1	-	-	-	-	-
Adults (>20 yrs)	0.49	0.33 - 0.74	*P*<0.001	-	-	-
Location						
Kole	1	-	-	1	-	-
Kyenjojo	0.42	0.29 – 0.61	*P*<0.001	0.50	0.32 – 0.76	*P*=0.001**
Gravidity						
Primigravidae	1	-	-	1	-	-
Multigravidae	0.42	0.29 - 0.61	*P*<0.001	0.52	0.29 – 0.93	*P*=0.026
Gestation period						
First Trimester	1	-	-	1	-	-
Second Trimester	0.59	0.41 – 0.86	*P*=0.006	0.83	0.54 – 1.28	*P=0.*403
Third Trimester	0.82	0.43 – 1.56	*P*=0.55	1.51	0.71 – 3.25	*P*=0.286
Malaria infection						
Positive	1	-	-	1	-	-
Negative	0.28	0.17 – 0.45	*P*<0.001	0.46	0.26 – 0.83	*P=0.*01
ITN Use						
Yes	1	-	-	1	-	-
No	2.16	1.14 – 4.08	*P*=0.018	1.74	0.89 – 3.41	*P*=0.103

Note: Row percent used, ** Pearson's chi square test at alpha = 0.05, N values are weighted

Discussion

Anemia is the commonest medical complication in pregnancy, affecting up to an estimated 40% of pregnant women compared to 29% of all women of reproductive age globally [1, 16]. Despite anemia being a public health concern, women in low developed countries are disproportionately affected. In 2011, WHO reported that Africa had the highest prevalence of anemia of 37.6% [2]. Thus, this study assessed the prevalence and determinants of anemia among pregnant women in Kyenjojo and Kole Districts in Uganda. In our study, the overall prevalence of anaemia was 20.1 % which indicates that anemia among pregnant women is a major public health problem in Uganda. This finding agrees with findings in Uganda, Kenya, Ethiopia, and Nigeria, [13, 17, 18, 19]. However, this finding was lower than those reported from the systematic review and meta-analysis in Uganda [12, 20] and in East Africa [5], other studies in the region [9, 21], and the WHO estimate of 40–60 % in developing countries [1]. The prevalence in this study was higher than the studies conducted in Uganda [9, 14, 22], Ethiopia [23], and Saudi Arabia [24]. The variations in the prevalence of anaemia were attributed to differences in the socioeconomic status of the different populations studied, a factor that determines nutrition and health-being. In addition, the variation can be explained by the range of interventions employed to address anaemia in pregnancy vary in different settings [25]. Importantly, the prevalence of mild, moderate, and severe anemia was 15.9%, 3.6% and 0.7%, respectively. The low prevalence of severe anemia is consistent with earlier reports [13]. The prevalence of anaemia was significantly higher in Kole than in Kyenjojo (P < 0.001). Kole district fall in region in Northern Uganda that was ravaged by the civil war that

left most of the social services in the region in ruins and a large majority of its population in poverty [26]. The above is collaborated by the findings from the 2016 Uganda Demographic and Health Surveys [9], which showed 43% of the population in Acholi region were in the lowest wealth quartile compared to 6.4% in Tooro region. A Study reported an association of anaemia and wealth with mothers in lowest wealth quartile at higher risk, this finding can explain why anaemia prevalence was more in Kole [17]. In addition, the observed difference in prevalence can be explained by high hookworm infection in Northern Uganda [27].

The causes of anemia in pregnancy are complex, and several predisposing factors have been implicated. In this study, we found an association between anemia and area of residence, parity, and the presence of malaria parasites. In the multi-variate logistic analysis, pregnant women who had been infected with malaria were more likely to be anemic (AOR: 0.46, 95% CI: 0.25-0.82). The association is supported by a systematic review [28, 29, 30] and other studies in Uganda [31], Ethiopia [32], Ghana [33], and Sudan [34]. The study findings add evidence to further support the association of malaria with anemia during pregnancy. Malaria in pregnancy may causes anemia through hemolysis of infected and uninfected red blood cell, increased splenic clearance of erythrocytes, and reduced red blood cell production. Malaria-associated maternal anemia is the leading cause of maternal and fetal morbidity and mortality [35]. Malaria transmission in Uganda is perennial, with two peaks following rainy seasons. The data collection for this study was done during the high malaria transmission season. Therefore, this might contribute to the association of malaria with anemia.

In this study, being multigravidae was associated with lower odds of anemia in pregnancy (AOR: 0.52, 95% CI: 0.29-0.93). In addition, the prevalence of anaemia decreased with increasing parity. These findings contradict results from studies elsewhere. For example, in Ethiopia, Kibret et al. 2021 documented an increased odds of anaemia associated with high gravidity [17]. Other studies in Uganda [21], Sudan [34], Ethiopia [23], and Iran [36] also found an increased risk of anaemia with parity four or more. The timing of ANC initiation is critical for commencement of interventions and services routinely offered to pregnant women at ANC clinics to prevent anaemia, such as folic acid supplementation, provision of LLINs, and IPT dosing as well as laboratory investigations to diagnose early anaemia in pregnancy and offer early treatment. In our study, 50% of the mothers initiated their ANC in their second trimester, and the prevalence of anaemia was more among mothers in their 1st and 3rd trimester. However, this yielded no association with anaemia. These results contradict findings from Uganda, Tanzania, Kenya, and South Africa that found the odds of having anaemia in pregnancy were significantly higher among pregnant women who initiated ANC 2nd and 3rd trimester [6, 7, 17, 21].

Limitations

The results of this study ought to be interpreted in light of the following shortfalls; a) We did not investigate other causes of anemia like nutritional factors, soil-transmitted helminthes infection, and hereditary conditions such as sickle cell disease, b) Other demographic factors such as body mass index, smoking and wealth index were not elucidated, and c) cross-sectional study like ours, does not provide inform on whether the pregnant mothers had anemia before conception; on this basis, we presumed that the anemia diagnosed was pregnancy-related.

Conclusion

Two in 10 pregnant women (20%) seeking their first antenatal care were anaemic making anaemia in pregnancy a public health problem in the study districts. The prevalence of anaemia in pregnant women in Kole was higher than in Kyenjojo. Mother's parity, place of residence, and malaria infection had significant association

with anaemia in pregnancy. Routine screening for anemia, malaria, and other risk factors should be part of ANC to identify those at risk and prompt management provided to curb their negative consequences.

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Conflict of Interest

The authors declare no conflicts of interest in this work.

References

[1] McLean E et al., 2009. Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993–2005, *Public Health Nutrition*, vol. 12, no. 4, pp. 444–454.

[2] WHO 2008. Worldwide Prevalence of Anaemia 1993-2005: WHO Global Database on Anaemia, *World Health Organization*, Geneva Available from: http://whqlibdoc.who.int/publications/2008/9789241596657_eng.pdf.

[3] Susan T and Blackburn D.O, 2007. Maternal, Fetal, & Neonatal Physiology, Clinical Perspective. *Qualitative Health Research*, vol. 11, no. 6, pp. 780–794. Available from: https://www.elsevier.com/books/maternal-fetal-and-neonatal-physiology/blackburn/978-0-323-44934-2.

[4] UNICEF WHO, Maternal Mortality in 2005: Estimates Developed by WHO, UNICEF, UNFPA and World Bank, *WHO, Geneva*, Switzerland. Available from: https://apps.who.int/iris/handle/10665/43807.

[5] Liyew A.M, et al., 2021. Prevalence and determinants of anemia among pregnant women in East Africa; A multi-level analysis of recent Demographic and Health Surveys. *PLoS One*. 16(4): e0250560. doi: 10.1371/journal.pone.0250560. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8078763/.

[6] Nyamu G.W et al., 2020. Prevalence and risk factors associated with asymptomatic Plasmodium falciparum infection and anemia among pregnant women at the first antenatal care visit: A hospital-based cross-sectional study in Kwale County, Kenya. *PLoS One*. 15(10): e0239578. doi: 10.1371/journal.pone.0239578.

[7] Mlugu E.M, et al., 2020. Prevalence and Correlates of Asymptomatic Malaria and Anemia on First Antenatal Care Visit among Pregnant Women in Southeast, Tanzania. *International Journal Environmental Research and Public Health*. 17(9):3123.30. doi: 10.3390/ijerph17093123.

[8] Okube, O.T, et al., 2016. Prevalence and Factors Associated with Anaemia among Pregnant Women Attending Antenatal Clinic in the Second and Third Trimesters at Pumwani Maternity Hospital, Kenya. *Open Journal of Obstetrics and Gynecology*, 6, 16-27. http://dx.doi.org/10.4236/ojog.2016.61003.

[9] UDHS. Uganda Bureau of Statistics (UBOS) and ICF. 2016. Uganda Demographic and Health Survey 2016. Kampala, Uganda, and Rockville, Maryland, USA: UBOS and ICF; 2016. Available from: https://dhsprogram.com/pubs/pdf/FR333/FR333.pdf.

[10] Baker SJ and DeMaeyer EM, 1979. Nutritional anemia: it's understanding and control with special reference to the work of the world health organization. *The American Journal of Clinical Nutrition*; 32(2):368–417. https://doi.org/10.1093/ajcn/32.2.368.

[11] Asrie F, et al., 2017. Prevalence of anemia and its associated factors among pregnant women receiving antenatal care at Aymiba Health Center, northwest Ethiopia. *Journal of blood medicine*, 8, 35–40. https://doi.org/10.2147/JBM.S134932.

[12] Bongomin F, et al., 2021. Anemia in Ugandan pregnant women: a cross-sectional, systematic review and meta-analysis study. *Tropical Medical Health*. 49: 19. Available from: https://tropmedhealth.biomedcentral.com/articles/10.1186/s41182-021-00309-z.

[13] Obai G, et al., 2016. Prevalence of anaemia and associated risk factors among pregnant women

attending antenatal care in Gulu and Hoima Regional Hospitals in Uganda: A cross-sectional study. B*MC Pregnancy Childbirth*.;16(1):1–7. https://bmcpregnancychildbirth.biomedcentral.com/track/pdf/10.1186/s12884-016-0865-4.pdf.

[14] Ononge S, et al., 2014. Campbell O, Mirembe F. Haemoglobin status and predictors of anaemia among pregnant women in Mpigi, Uganda. *BMC research notes*, 7, 712. Available from: https://pubmed.ncbi.nlm.nih.gov/25304187/.

[15] WHO catalogue of indicators for health monitoring. SCHI Unit. Division of Epidemiological Surveillance and Health Situation and Trend Analysis. World Health Organization; Geneva: 1996. April 1993. Available from: https://apps.who.int/iris/handle/10665/63030.

[16] Goonewardene M, et al., 2012. Anaemia in pregnancy. *Best practice & research. Clinical obstetrics & gynaecology*, 26(1), 3–24. Available from: https://pubmed.ncbi.nlm.nih.gov/22138002/.

[17] Kibret K.T, et al., 2019. Spatial distribution and determinant factors of anaemia among women of reproductive reproductive age in Ethiopia: a multilevel and spatial analysis. *BMJ Open*. e027276. doi: 10.1136/bmjopen-2018-027276. Available from: https://pubmed.ncbi.nlm.nih.gov/30948614/.

[18] Buseri, F. I, et al., 2008. Prevalence and risk factors of anaemia among pregnant women in Nigeria. *Open Journal of Hematology*, vol. 2, pp. 14–19. Available from: https://benthamopen.com/ABSTRACT/TOHJ-2-14.

[19] Alem M, et al., 2013. Prevalence of Anemia and Associated Risk Factors among Pregnant Women Attending Antenatal Care in Azezo Health Center Gondar Town, Northwest Ethiopia. *Journal of Interdisciplinary Histopathology*. 1(3): 137-144 doi: 10.5455/jihp.20130122042052. Available from: https://www.bibliomed.org/?mno=31063.

[20] Nankinga, O and Aguta, D. 2019. Determinants of Anemia among women in Uganda: further analysis of the Uganda demographic and health surveys. *BMC Public Health* 19, 1757. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-8114-1.

[21] Mahamoud N.K, et al., 2020. Prevalence of anemia and its associated socio-demographic factors among pregnant women attending an antenatal care clinic at kisugu health center IV, Makindye Division, Kampala, Uganda. *Journal of blood medicine*. 11:13–8. Available from: https://pubmed.ncbi.nlm.nih.gov/32021527/.

[22] Okia C.C, et al., 2019. Prevalence, Morphological Classification, And Factors Associated with Anaemia Among Pregnant Women Accessing Antenatal Clinic at Itojo Hospital, Southwestern Uganda. *Journal of blood medicine*, 10, 351–357. Available from: https://pubmed.ncbi.nlm.nih.gov/31695541/.

[23] Kassa, G. M. et al., 2017. Prevalence and determinants of anemia among pregnant women in Ethiopia; a systematic review and meta-analysis. *BMC hematology*, 17. https://doi.org/10.1186/s12878-017-0090-z. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5646153/.

[24] Mahfouz A., et al., 1994. Anemia among pregnant women in the Asir region, Saudi Arabia: an epidemiologic study. *The Southeast Asian journal of tropical medicine and public health*, 25(1), 84–87. Available from: https://pubmed.ncbi.nlm.nih.gov/7825031/.

[25] Balarajan Y et al., 2011. Anaemia in low-income and middle-income countries. *Lancet*.;378 (9809):2123–2135. doi:10.1016/S0140-6736(10)62304-5. Available from: https://pubmed.ncbi.nlm.nih.gov/21813172/.

[26] Economic Development Policy and Research Department. Poverty status report 2014: Structural Change and Poverty Reduction in Uganda. Kampala: Ministry of finance, planning and economic development; 2014. https://www.ug.undp.org/content/uganda/en/home/library/human_development/TheUgandaPovertyStatusReport2014.html.

[27] Apili F, et al., 2020. Hookworm Infection among Pregnant Women at First Antenatal Visit in Lira, Uganda: A Cross-Sectional Study. *International Journal of Reproductive Medicine*. doi: 10.1155/2020/8053939. Available from: https://www.hindawi.com/journals/ijrmed/2020/8053939/.

[28] Desai M, et al., 2007. Epidemiology and burden of malaria in pregnancy. The Lancet. Infectious diseases, 7(2), 93–104. https://doi.org/10.1016/S1473-3099(07)70021-X.

[29] Shulman C.E, et al., 2002. Malaria as a cause of severe anaemia in pregnancy. *Lancet*.; 360:494. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(02)09662-9/fulltext.

[30] Shulman C.E and Dorman E.K, 2003. Importance and prevention of malaria in pregnancy. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 97(1):30-5. https://pubmed.ncbi.nlm.nih.gov/12886801/.

[31] Muhangi L et al., 2007. Associations between mild-to-moderate anaemia in pregnancy and helminth, malaria, and HIV infection in Entebbe, Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *101*(9), 899–907. https://doi.org/10.1016/j.trstmh.2007.03.017.

[32] Kare A.P and Gujo A.B, 2021. Anemia among Pregnant women attending Ante Natal Care Clinic in Adare General Hospital, Southern Ethiopia: Prevalence and Associated Factors. *Health Services Insights.* 14: doi: 10.1177/11786329211036303. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8327009/.

[33] Fondjo L.A, et al., 2020. A multicenter study of the prevalence and risk factor of malaria and anaemia among pregnant women at first antenatal care visit in Ghana. *PLoS One*. 15(8): e0238077 doi: 10.1371/journal.pone.0238077. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7444479/.

[34] Adam I, Ibrahim Y and Elhardello O, 2018. Prevalence, types, and determinants of Anaemia among pregnant women in Sudan: a systematic review and meta-analysis. *BMC Hematology*. doi: 10.1186/s12878-018-0124-1. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6225563/.

[35] White N. J. 2018. Anaemia and malaria. *Malaria Journal*, 17(1), 371. https://doi.org/10.1186/s12936-018-2509-9. Available from: https://malariajournal.biomedcentral.com/track/pdf/10.1186/s12936-018-2509-9.pdf.

[36] Sadeghian, M., Fatourechi, A., Lesanpezeshki, M., & Ahmadnezhad, E. 2013. Prevalence of anemia and correlated factors in the reproductive-age women in rural areas of tabas. *Journal of family & reproductive health*, 7(3), 139–144. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4064781/.