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ISSN 2766-7820

Research Article

Open Access, Volume 2

Morphological patterns of anemia among under five children on Prevention of Mother-To-Child Transmission (PMTCT) programmes in Masogo sub-county hospital, Kisumu county, Kenya

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Received: Feb 08, 2021
Accepted: Apr 12, 2021
Published: Apr 14, 2021
Archived: www.jcimcr.org
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Keywords: Morphological patterns; anaemia; under-five children; Prevention of Mother-To Child Transmission (PMTCT).

Abstract

Background: Anaemia during childhood adversely affects mental, physical and social development of the children, therefore morphological patterns of anaemia in under- five children are considered essential for classification, diagnosis and management.

Aim: This study aimed at assessing morphological patterns, the prevalence and associated factors of anaemia among under-five children on Prevention of Mother-To-Child Transmission (PMTCT) programmes in Masogo sub-county hospital, Kisumu County, Kenya.

Method: A cross-sectional health facility-based study was conducted among 175 children aged 6 to 59 months who attended clinic for the PMTCT programme for the period of January 2020 to December 2020. Pretested and structured questionnaires were used to collect socioeconomic and demographic characteristics of the family and child. Capillary blood sample was collected from each child for malaria parasite and Peripheral Blood Film (PBF) examination.

Result: Complete blood counts indicate that microcytic pattern was the most common, representing 30 (42.3%) followed by microcytic hypochromic pattern 20 (28.2%), normocytic normochromic pattern with 11 (15.5%) and lastly dimorphic pattern with 10 (14.0%). High prevalence of anaemia was observed in children who were urban dwellers (50.0%), in children whose mothers aged 18-27 years (44.0%) and had no formal education (48.1%). Besides, the high prevalence rate of anaemia was found among children with a family monthly income of less than 500 Ksh. (46.9%), early (<6 months) introduction of complementary foods (71.4%).

Conclusion: This study has revealed that the prevalence of anaemia in children less than five years is high and is a severe public health problem in the study area. Therefore, the policymakers should make a strategy that can reduce poverty and increase the awareness to women on breastfeeding, nutrition, and other associated factors to reduce anaemia.

Citation: Awuor SO, Eric OO, Musyoki S, Daud II, Nyangaresi RO, et al. Morphological patterns of anemia among under five children on Prevention of Mother-To-Child Transmission (PMTCT) programmes in Masogo sub-county hospital, Kisumu county, Kenya. J Clin Images Med Case Rep. 2021; 2(2): 1048.

Introduction

Anaemia can be defined as a reduction in Hemoglobin (Hb) concentration, hematocrit, or a number of red blood cells per litre below the reference interval for healthy individuals of similar age, sex, and race, under similar environmental conditions [1]. According to the World Health Organization (WHO), for under-five children, the threshold Hb level for being anemic is less than 110 g/l [2]. Anaemia is a global public health problem which affects 1.62 billion (24.8%) people world-wide. It occurs at all stages of the life cycle but is more prevalent in under-five years old children. Globally, 293.1 million (47.4%) under-five year's children are anemic and 67.6% of these children live in Africa [3,4]. In Kenya, 57% of children age 6–59 months were documented to be anemic according to the Kenya 2019 Demographic and Health Survey (KDHS) report [5]. This therefore raises a pertinent concern that calls for proper measures to be put in place to reduce such cases.

Several factors have been found to be contributing to the occurrence of anaemia and nearly half of (43%) the anaemia cases in childhood are due to iron deficiency [6]. The deficiency may result from inadequate dietary intake of iron, malabsorption of iron, and increased iron demand during rapid growth in children and chronic blood loss. Other causes of anaemia include folate and vitamin B12 and A deficiencies, Malaria, intestinal helminths, viral infections, chronic disease, hemoglobinopathies, hemolysis, and bone marrow disorders [7-10]. For instance, *H. pylori* has been documented to absorption of iron and its hypothesize that gastritis and disturbance in pH increase levels of neutrophil-derived lactoferrin, and since *Helicobacter pylori* has a lactoferrin-binding protein receptor, the infection would result in increased iron losses related to bacterial turnover [39]. Different studies also claimed that factors such as age, sex, residence, early initiation of complimentary food, under-nutrition, maternal health status, maternal education, and poor socioeconomic status are significantly associated with anaemia [11-13].

Anaemia on childhood adversely affects mental, physical, and social development of the children in short- and long-term outcome; it causes abnormalities of immune function, poor motor and cognitive development, poor school performance, and reduced work productivity in the life of the children, thereby decreasing earning potentials and negatively affect national economic growth [14-17]. Anaemia is also an important cause of morbidity and mortality in African children where resources to determine the underlying etiology remain poor [18].

Based on the morphology of RBCs and blood cell indices, anaemia is classified into normocytic normochromic, microcytic hypochromic, macrocytic and dimorphic anaemia. Each type suggests specific aetiological factors, so an evaluation of the morphology of RBCs and clinical features among under five could help in the diagnosis and management of patients. Even though the national and regional prevalence of anaemia in under five years children are available in Kenya, data on the magnitude of anaemia and its risk factors in specific settings are scarce. Studying the specific aetiology and prevalence of anaemia in each setting and population group is very important to prevent or treat anaemia [2]. Therefore, this study is aimed to assess the morphological patterns of anaemia and its associated factors among children under-five years of age in Masogo sub-county hospital, Kisumu county, Kenya.

Materials and methods

Study site

The study was conducted at Masogo Sub-County Hospital (0.1566^0 S, 35.1984^0 E) in Kisumu County (East to Chemelil Sugar Company). Masogo Sub-County Hospital is a Government a 20 bed capacity health facility located in Masogo centre, Muhoroni sub county in Kisumu county.

Study design

This was a cross-sectional study conducted at Masogo sub-county hospital, Kisumu county from January 2020 to December 2020. One hundred and seventy-five women with under five children attending PMTC clinics in the hospital were included, after fulfilling specific selection and exclusion criteria, in which only those mother who are living with HIV having under-five children and having ccc number with the facility will be consider in the study.

Sample size

Data collection on socio demographics: Pretested and structured questionnaires were used to collect socioeconomic and demographic characteristics of the family and child, feeding practice and other risk factors by interviewing mother/caregivers of the child. The questionnaire was adapted from previous similar literatures [12].

The questionnaire was pretested in Nyakoko health centre that was not included in the actual study area on 10% of the sample size. Based on the pilot study result, certain revisions were made for the questionnaire before the actual study. The interview was conducted by two trained clinical nurses in the local language (Dholuo).

Determination of the nutritional status: Data on nutritional status were collected by measuring the weight and height of children below age 5 during the clinic visit based on WHO recommendations [19]. The length was measured for children aged 6-23 months in a recumbent position and standing height was measured for children aged 24-59 months using the measuring board. The weight of the children was measured by a Salter scale as used before [19]. Briefly, the children were requested to remove shoes and any other heavy clothing prior to their weight measurement. Each measurement was collected twice and the mean value of the two measurements was recorded on the questionnaire.

Laboratory analysis

Venous blood collection: Venous blood was collected by use of well-established standard protocols as used before [20] by a well-trained phlebotomist. The vein was identify and the site was clean using 70% Alcohol, by used of 10 ml syringe nine mL of venous blood was collected and divided into three containers:

Ethylene Diamine Tetra Acetic Acid (EDTA), lithium heparin and Plain containers.

Determination of presence of anaemic blood parameters

Complete blood counts: The complete blood count was measured using Sysmex KX20 automated analyser, manufacturer by Sysmex Corporation, September 2015 (Bellport, New York, United States), and direct peripheral smears were taken to be compared with Ethylene Diamine Tetra-Acetic Acid (EDTA) smears; both thin and thick smears were stained with Gemsa stain and examined under the microscope for RBC morphological classification using already established standard protocols [20].

Haemoglobin concentration determination: Two ml of blood in the plain tube were used to determine haemoglobin concentration using HemoCue Hb 201 analyzer as used before. This analyzer uses HemoCue cuvettes Hb-201+ cuvettes which contains sodium deoxycholate dried reagent that lyses red blood cells to release free Hb and form a stable azide-methemoglobin that is detected at 570 nm and 880 nm. One drop of blood was carefully collected in a micro cuvette from the sample on the plain container. The filled micro cuvette was loaded in the cuvette holder of calibrated HemoCue Hb201analyser and after few seconds the haemoglobin measurement displayed. Then the results were recorded on the questionnaire. Standard operating procedure and manufacturers instruction were strictly followed [20,21].

Data analysis procedures: All collected data were entered into Ms Excel and exported to SPSS version 20.0 statistical software for analysis. Normally distributed and continuous variables expressed as mean±SD, and non-normally distributed variables were presented as medians (quartiles 25 and 75%). Chisquare (×2) test was used to compare proportions. Multivariate logistic regression was used to calculate adjusted Odds Ratios (OR) and the corresponding 95% Confidence Intervals (CI). A pvalue < 0.05 was used to indicate statistical significance.

Ethical considerations

Confidentiality and privacy were strictly adhered to and no names of individuals were recorded or made known in the collection or reporting of information. The study was granted ethical clearance by Kisumu County ministry of health department and from the sub county MOH office (MSC/KSM/3421/20). The participants consented for taking part in the study and they consented to have the results of this research work published.

Result

Sociodemographic characteristics

A total of 175 under-five children participated in the study from January 2020 to December 2020. The mean age of the children who participated in the study was 23.1 ± 14.4 months (median: 20 months, range: 6 to 58 months). Half of the children were below two years of age 97 (55.4%), 127 (72.5%) of the children came from the rural part of the study area. Majority 91 (52.0%) of caregivers/mothers of the children were aged between 18–27 years old, followed by 81 (46.3%) age 28-38 years and lastly 3 (1.7%) age 39-40 years. On education 104 (57.4) had no formal education followed with 47 (26.9%) with primary level and 24 (13.7%) had secondary and above. On occupation 132 (75.5%) were Housewives with mean (±SD) mothers/caregivers age of 27.1 (± 5.3) years. Majority 131 (74.7%) of the mothers had one child aged under five years, and 136 (77.7%) of the studied children had first birth order. The median (interquartile range) monthly income of the families of the studied children was 800 (600-1050) Kenya shillings (Ksh), and 101 (57.7%) had a monthly income between 750 and 1500 ETB (Table 1).

Table 1: Socio-demographic characteristics of children under five years and mothers attending Masogo sub-county Hospital PMTC, (n=175).

Characteristics		Frequencies	Percent (%)
Child sex	Male	87	49.7
	Female	88	50.3
Child age	6-11 months	49	28
	12-23 months	48	27.4
	24-35 months	36	20.6
	36-47 months	22	12.6
	48-59 months	20	11.4
Residence	Urban	48	27.5
	Rural	127	72.5
Mothers age	18-27 years	91	52
	28-38 years	81	46.3
	39-40 years	3	1.7
Mothers education	Non-formal	104	59.4
	Primary	47	26.9
	≥ Secondary	24	13.7
Mothers occupation	Housewife	132	75.5
	Small-scale business	7	4
	Government employee	1	0.5
Family's monthly income	Farmer	35	20
	<500 Ksh	64	36.6
	500-1500 Ksh	101	57.7
	>1500 Ksh	10	5.7
Birth order	1st	136	77.7
	2nd	24	13.7
	3rd	11	6.3
	4th and above	4	2.3
Number of children aged <5 years	0	6	3.5
	1	131	74.7
	≥2	38	21.8

Key: KSH: Kenya shillings.

Nutritional status of children

Regarding nutritional status, 93 (53.1%) of the children were underweight, 63 (36%) were wasted in which 27 (15.4%) were moderate while 36 (20.1%) were sever, and 93 (53%) were stunted, where 34 (19.4%) were moderate while 59 (33.3%) were severe. Only 14 (7.8%) of the children had started complementary foods before 6 months of their age. The blood sample for malaria parasite investigations showed that 72 (41.1%) of children suffered from malaria infestations (Table 2).

Table 2: Anthropometric status and Malaria parasite infection of children under five years attending at Masogo sub-county hospital, (n=175).

Characteristics		Frequencies	Percent (%)
Introduction of complementary foods Underweight	< 6 months	14	7.8
	> 6 months	161	92.2
	Not underweight	82	46.9
	moderate	41	23.4
	severe	52	29.7
Wasted	Not wasted	112	64.5
	moderate	27	15.4
	severe	36	20.1
Stunted	Not stunted	82	46.9
	moderate	34	19.4
	severe	59	33.7
Low MUAC	Yes	127	72.6
Malaria parasite	No	48	27.4
	positive	72	41.1
	negative	103	58.9

Key: MUAC: Mid-Upper Arm Circumference.

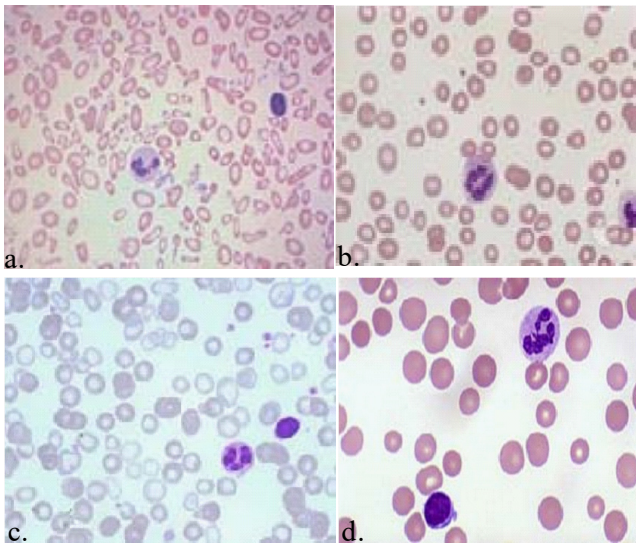

Figure 1: Photos of morphological patterns of anaemia, Masogo sub-county hospital, January 2020 to December 2020. (Plate a) Hypochromic microcytic, (Plate b) normochromic normocytic, (Plate c) dimorphic pattern and (Plate d). Macrocytic pattern.

Haemoglobin concentration

Haemoglobin concentration below 5 g/dl was high among the female 37 (19.5%) and male of 34 (19.5%), whereas the concentration of 5-10 g/dl female were 35 (20%) and male were 23 (13.1%) and lastly the concentration of >10 g/dl male were 30 (17.1%) and female were 16 (9.1%) as summarize in table 3.

Anaemia parameters

Complete blood counts: Complete blood counts did indicate that microcytic pattern was the most common, representing 30 (42.3%) followed by microcytic hypochromic pattern 20 (28.2%), normocytic normochromic pattern with 11 (15.5%) and lastly dimorphic pattern with 10 (14.0%) as shown in plates below (Figure 1). The general distribution of the blood cells is also summarized in Figure 2 below

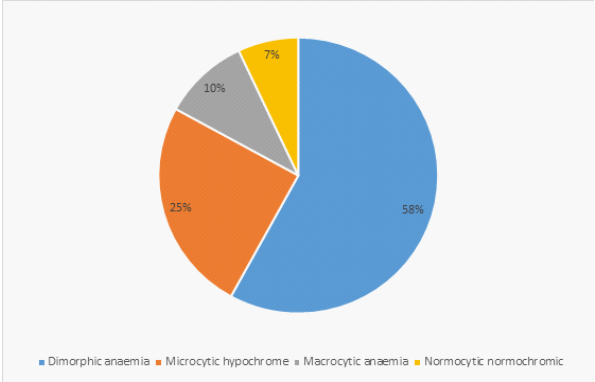

Figure 2: The general distribution of morphological patterns of anaemia, Masogo sub-county hospital, January 2020 to December 2020.

Table 3: Haemoglobin concentration among children under five years attending Masogo subcounty hospital.

Characteristics		Frequency (n=175	Percentage (%)
<5 g/dl	Male	34	19.5
	Female	37	21.2
5-10 g/dl	Male	23	13.1
	Female	35	20
>10 g/dl	Male	30	17.1
	Female	16	9.1

Anaemia prevalence: High prevalence of anaemia was observed in children who were urban dwellers (50.0%), in children whose mothers aged 18-27 years (44.0%) and had no formal education (48.1%). In addition, the high prevalence rate of anaemia was found among children with a family monthly income of less than 500 Ksh. (46.9%), early (<6 months) introduction of complementary foods (71.4%) (Table 4).

Table 4: Prevalence of anaemia among children under five years attending Masogo sub-county hospital.

Characteristics		Anaemia		P- value*
		No n (%)	Yes n (%)	
Child sex	Male	53 (60.4)	34 (39.6)	0.572
	Female	51 (57.7)	37 (42.3)	
Child age	6-11 months (n=49)	28 (57.1)	21 (42.9)	<0.001
	12-23 months (n=48)	25 (52.1)	23 (49.9)	
	24-35 months (n=36)	23 (63.9)	13 (36.1)	
	36-47 months (n=22)	18 (84.0)	4 (16.0)	
Residence	Urban (n=48)	24 (50.0)	24 (50.0)	0.033
	Rural (n=127)	79 (62.2)	48 (37.8)	
Mothers age	18-27 years (n=91)	46 (50)	44 (48.4)	0.001
	28-38 years (n=81)	56 (69.1)	25 (30.9)	
	39-40 years (n=03)	1 (33.3)	2 (66.7)	
Mothers education	Non-formal (n=104)	54 (51.9)	50 (48.1)	<0.001
	Primary (n=47)	30 (63.3)	17 (36.7)	
	≥ Secondary (n=24)	20 (83.3)	4 (16.7)	
Mothers occupation	Housewife (n=132)	75 (56.8)	57 (43.2)	0.29
	Small-scale business (n=07)	4 (57.1)	3 (42.9)	
	Government employee (n=01)	1 (100.0)	0 (0.0)	
	Farmer (n=35)	51 (64.6)	8 (35.4)	
Family's monthly income	<500 Ksh. (n=64)	34 (53.1)	30 (46.9)	0.006
	500-1500 Ksh. (n=101)	61 (60.4)	40 (39.6)	
	>1500 Ksh. (n=10)	9 (90.0)	1 (10.0)	
Birth order	1st (n=136)	77 (56.6)	59(43.4)	0.481
	2nd (n=24)	16 (66.7)	8 (33.3)	
	3rd (n=11)	7 (63.6)	4 (36.4)	
	4th and above (n=4)	3 (75.0)	1 (25.0)	
Number of children aged <5 years	0 (n=06)	4(66.7)	2 (33.3)	0.058
	1 (n=131)	111 (84.7)	20 (15.3)	
Wasted	No (n=112)	69 (61.6)	43 (38.4)	0.171
	Yes (n=93)	50 (53.8)	43 (46.2)	
Stunted	No (n=82)	48 (58.5)	34 (41.5)	0.93.0
	Yes (n=127)	75 (59.1)	52 (40.9)	
Introduction of complementary foods	<6 months (n=14)	4 (28.6)	10 (71.4)	<0.001
	>6 months (n=161)	99 (61.5)	62 (38.5)	
Underweight	No (n=82)	57 (69.5)	25 (30.5)	<0.001
	Yes (n=63)	31 (49.2)	32 (50.8)	

KSH: Kenya Shillings; *significant at p <0.05

Discussion

This study assessed the prevalence and associated factors of anaemia among children aged 6 to 59 months in Masogo sub county, Kisumu county. The overall prevalence of anaemia was 41.6%, a clear demonstration that it's a common issue at the study area. This prevalence is higher as compared to that of WHO recommendations cut-off point of 11 g/dL in the same African children [41]. Our finding was similar to 2016 Ethiopian DHS prevalence reported for the Amhara Region (42%) [5] and study conducted in Jimma, Ethiopia (46%) [22]. However, the result of the present study is lower than studies conducted in Nepal (49.5%) [23], South-East Nigeria (49.2%) [24], Hohoe municipality and Volta Regional Hospital of Ghana (47.5% &55.0%) [25,26], and Limpopo Province, South Africa (75.0%) [27]. The difference in the prevalence might be attributed in the study design, sampling techniques, and sample size. The difference might also be due to variation in the geographical location of the study participants or due to variation in socio-demographic characteristics or socioeconomic status of parents in the areas.

In this study, there was a higher prevalence of anaemia among children under two years old and it decreased as the age of the children increased. This could also be as a result of high iron demands associated with rapid growth rate and erythropoiesis, diets poor in bio-available iron, and low maternal iron reserve during pregnancy [33]. This finding is supported by other studies conducted in Ethiopia [28-30] and other developing countries [31,32] who also reported similar findings.

Like other study reports documented from South-East Nigeria [24] and the Volta Regional Hospital of Ghana [26], the present study found that sex difference did not show association with anaemia. However, other studies found a higher prevalence of anaemia among boys than girls [29], and also in girls than boys [27]. This inconsistency may be explained by the social norms in differential intake of iron-rich foods between genders; however, subsequent studies are required to better understand this complex issue.

Children of mothers with low educational levels were three times more likely to be anaemic than children of a mother with secondary and above education level. This may be explained by the fact that education enhances the mother's knowledge needed for their children's health and an appropriate feeding practice, which help to improve their children nutritional status [27]. However, this finding is inconsistent with the study conducted in Khartoum state, which showed the prevalence of wasting (3.3 to 21.1%) stunting (20.3 to 51.0%), severe stunting (12.9 to 25.2%) and underweight and severe underweight represent 24.4 to 35.0% and 6.6 to 48.0%, respectively [30,40]. The present study also found that children with low family income were highly more likely to be anaemic than those with high family income. A possible explanation for the high prevalence of anaemia might be that families with low income are less likely to purchase nutrient-rich foods (like iron, vitamins etc.), secure food availability, and afford health service during illness for their children. This finding was similar to studies conducted in other parts of the world, which reported that children from poor families were at risk of anaemia compared to their counterparts [11,13,30,32,34]. The higher prevalence of anaemia among children with less educated mothers and low-income families indicates that anaemia should be a marker of socioeconomic disadvantage [36,37].

The observed higher prevalence of anaemia among children with early (<6 months) introduction of complementary foods was consistent with previous studies [11,38]. Complementing breast milk before 6 months of age reduces the bioavailability of iron by upto 90%; the early introductions of complementary foods like cow's milk interfering in the absorption of iron in the breast milk because cow's milk has excess protein and minerals notably calcium and most digestive enzymes are inadequate at this age [11]. In addition, early initiation of complementary feeding exposes children to microbial pathogens due to contamination and resulting high risk of diarrheal diseases, there by malabsorption [5]. Other pathogens like *H. pylori* has also been documented to possess a lactoferrin-binding protein receptor which has a higher affinity for Iron hence if present in the stomach can reduce the amount of iron being absorbed [39]. However, this finding is in contrary to study done in Sri Lanka which showed that children who were exclusively breastfed for 6 months or more were more likely to be anaemic than children who were exclusively breastfed for less than 6 months [35].

Nutritional status was also associated with anaemia among children aged 6-59 months. In this study, underweight children were most affected more likely to be anaemic than children with normal weight. This finding is similar to a study conducted in Northern Ethiopia [30] and Brazil [38]. Usually, the causes of anaemia and underweight (malnutrition) are similar and aggravated by poverty and food insecurity. Food insecurity affects the nutritional status of children by compromising the quantity and quality of dietary intake, which contributes for development of anaemia [6].

One of the limitations of this study is the cross-sectional nature of the study design; it does not reveal causal links between independent variables and anaemia. Due to constraint of resource, we were unable to measure serum ferritin concentration, soluble transferrin receptor concentration, folate levels, vitamin B12 levels, thalassemia, and G6PD deficiency, which could have helped in finding the causes of anaemia. The other limitation is that this study was conducted at a sub county hospital hence, further community based studies should be conducted to have findings more representing the whole population. Despite the limitations, we have determined the magnitude of anaemia and identified important factors associated with anaemia among children aged 6-59 months in Masogo sub county hospital.

Data availability statement

We wish to sincerely acknowledge and thank MCH/PMTCT department members and laboratory department of Masogo sub county hospital for providing us the required data. We also thank Elsy jebitok for the assistance on the bench work on sample analysis and lastly the hospital in-charge for allowing us to do our research in the facility.

Funding information

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or

position of any affiliated agency of the author.

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