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Prevalence of Iron Deficiency Anaemia and Associated Factors among Children Aged Six to Fifty Nine Months Seen at Kabutare District Hospital, Rwanda

Erigene Rutayisire[1]*, Sylvia Oluchi Nwaike[2] and Onesmus Marete[1]

[1]*Public Health Department, School of Health Science and Nursing, Mount Kenya University, Kigali, Rwanda*

[2]*United Nations Development program (UNDP), United Nations Assistance Mission in Afghanistan, Kabul, Afghanistan*

***Corresponding Author**: Erigene Rutayisire, Senior Lecturer/Research Coordinator, Public Health Department, School of Health Science and Nursing, Mount Kenya University, Kigali, Rwanda.

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Abstract

Background: Iron deficiency anaemia has remained one of the most severe and important nutritional deficiencies in the world today. It is a condition that affects 20-25% of the world's children. It impairs their cognitive development, affects their immune system and is associated with increased morbidity rates. Although iron deficiency anaemia is largely preventable, there is a high rate of iron deficiency anaemia among children in most developing countries resulting in recurrent blood transfusions and its associated complications. In Rwanda, a national survey in 2014/2015 revealed that 37.0% of children aged 6 - 59 months were anaemic. Limited information is available on factors associated with iron deficiency anaemia among Rwandan children. The objective of this study was to establish the prevalence and factors associated with Iron deficiency anaemia among children aged 6 to 59 months seen at Kabutare District Hospital located in Huye District in the Southern province of Rwanda throughout the study period.

Materials and Methods: This was a cross-sectional study using the quantitative approach. A total of 126 children were selected randomly. Data was analyzed with SPSS. Categorical variables are presented as proportions and their associations determined by chi-square test with ($P<0.05$) as significant level and logistic regression. Multivariate analysis using logistic regression was carried out to determine the independent factors associated with iron deficiency anaemia.

Results: The result of the study revealed the prevalence of iron deficiency anaemia was 20.6% among respondents. Prevalence of anaemia was 25.4% with 81.2% of these cases having iron deficiency. No socio-demographic factor was associated with iron deficiency anaemia. The factors found to be associated with iron deficiency anaemia history of recent blood transfusion in past year [AOR = 5.81; 95%CI = 1.566 - 21.577; p = 0.009]. Children who consumed cow milk before six months were three times more likely to have iron deficiency anaemi, but no statistical significance observed.

Conclusion: The prevalence of anaemia and iron deficiency anaemia is still higher among children from southern province of Rwanda. Blood transfusion and cow milk consumption before six months increase the risk of iron deficiency anaemia among children aged 6-59 months. Findings of this study could be used to implement strategies to improve widespread awareness of impact of diet and iron supplementation on iron deficiency and anaemia.

Keywords: *Iron Deficiency Anaemia; Anaemia; Kabutare District Hospital*

Introduction

Iron-deficiency anaemia is the most prevalent nutritional disorder in the world, affecting both developed and developing countries. Iron deficiency was estimated to be the 13th out of 25 leading risk factors of disease burden in the world in 2010, accounting for 48,225 DALYs [1]. World Health Organization (WHO) has estimated that approximately 1.6 billion people have anemia. Africa is the most affected region where around 60% of African children aged less than 5 years [2-4]. It is well known that anaemia is most prevalence during the first two years.

In most developing countries, insufficient dietary iron is considered the primary cause of anaemia in children [5]. Estimates of the prevalence of iron deficiency anemia among children aged 6 - 59 months in Rwanda are provided in the 2014/2015 Demographic Health Survey report as 36.5% [6].

Also only 20 percent of Rwandan children consume food rich in iron, which is critical to growth and cognitive development [6].

Current anemia control programs in Rwanda include use of iron-folic acid supplements in pregnant women and children, exclusive breastfeeding, eating iron-rich beans, deworming of children and pregnant women and use of insecticide treated nets. Several studies have shown that iron deficiency anemia during the first two years of life leads to impairments in the cognitive and behavioral development that persist even after treatment of iron deficiency [7].

In Rwanda, there is some information on the prevalence of iron deficiency anaemia and its associated factors such as socio-demographic, and nutritional factors specifically in the areas. Most importantly, identifying and understanding the prevalence and specific factors associated with iron deficiency anemia is relevant in planning interventions for improved results.

The study established the prevalence and factors associated with iron deficiency anemia among children aged 6 to 59 months seeking care at Kabutare District hospital, Huye District, Southern Province, Rwanda.

On average, globally, 50% of the anemia is assumed to be attributable to iron deficiency. Globally, iron deficiency ranks number 9 among 26 risk factors included in the GBD 2000, and accounts for 841,000 deaths and 35,057,000 disability-adjusted life years lost. Africa and parts of Asia bear 71% of the global mortality burden and 65% of the disability-adjusted life years lost [1,4].

Iron deficiency causes 30-50% of anaemia in children and other age groups. In Africa, it is estimated that 60% of children under 5 suffer from anaemia [2]. Study done in Rwanda estimated the prevalence of anaemia among children aged six-fifty-nine months to be 36.5% [6].

Previous studies done in Rwanda found anemia to be higher in the Southern Province among children under 5 years of age [8]. Limited studies have been done on iron deficiency anaemia in this age group. Another study done in the southern province of Rwanda particularly in Huye district showed that every fourth child with anaemia had iron deficiency and the Hemoglobin difference between children with and without iron deficiency was in the range of 1 g/dl [9].

Currently, there are few conclusive studies on factors associated with iron deficiency anaemia among children in Huye District in the southern province in Rwanda.

Between January and August 2017, out of 925 children presenting to the hospital, 108 children aged six to fifty-nine months had blood transfusions in Kabutare District Hospital due to severe anaemia. Factors such as socio-demographic and dietary have not yet been fully investigated among children aged six to fifty nine months in the southern province. This study therefore, aims to establish the prevalence and determine the scope and strength of various risk factors for iron deficiency anemia in this age group.

Methods

Design

This was a cross sectional descriptive study in which information on prevalence and factors associated with iron deficiency anaemia among children aged six to fifty-nine months being seen at Kabutare district hospital during the study period was sought and obtained from caregivers.

Study site

The study was done in Kabutare District hospital. Established in 1957, the hospital is a 300 bed capacity hospital located in Huye District in the southern province of Rwanda. It is 2 km from the Butare University Teaching Hospital Kabutare hospital in serves the entire population of the Huye District, which is 328,605 inhabitants, covering an area of 581.5 km^2.

The hospital also serves the population of the neighbouring health centres with a population estimated at (40,000) forty thousand inhabitants. It is the only hospital in the district of Huye and receives references from 19 health centers.

Target population

The target population consisted of 250 children aged six to fifty-nine months who sought care at Kabutare district hospital during the three–month period from January to March 2018. Caregivers of these cases were used to obtain our information. All children admitted from the outpatient and emergency departments who fell into this category were all included irrespective of chronic health conditions. Those children with incomplete information and absent caregivers were however excluded from the study.

Sample size

The researcher selected the sample size using simple random sampling from all the cases that make up the sampling frame throughout the study period. Some children were excluded from the analysis on account of absence of data on birth date, weight, height, and hemoglobin concentration.

The sample size was calculated using the formula of Fisher., *et al*. (1998) formula was used to calculate the sample size.

$$n = \frac{z^2 pq}{d^2}$$

Where

n = The desired sample size.

z = The standard normal deviation, set at 1.96, which corresponds to 95% confidence level.

p = The proportion in the target population estimated to have a particular characteristic (36.5%).

q = 1.0-p

d = the degree of accuracy desired, here set at 0.05 corresponding to the 1.96.

From the above formula a total of 126 children were considered as sample size of this study.

Sampling techniques

All children aged six to fifty-nine months seeking care at Kabutare district hospital during the three-month period from January to March 2018 of the study were used. Simple random sampling was done of the cases of children aged six to fifty-nine months seeking care at the hospital during this period, simple random sampling using the ballot method.

Research tools

Data was collected over a three-month period from January to March 2018. Children with hemoglobin levels ≤ 10g/dL were considered to be mildly anemic, 7 - 9 g/dl moderately anaemic and < 7 g/dl severely anaemic in accordance with the WHO classification system [10]. Laboratory diagnosis was determined by assaying blood Hb levels in the collected samples using the Sysmex automated analyzer.

The Sysmex automated CBC analyzers used the following technologies to measure and count circulating blood cells and cellular components: direct current impedance, advanced optical light scatter technology, fluorescent flow cytometry and spectrophotometry. The Various cellular indices were calculated from the direct measurements by the CBC analyzer, including the MCV, MCH, MCHC, RDW-SD and RDW-CV. The RDW-CV is the conventional RDW reported as a CV [11]. Blood samples were obtained by qualified nurses trained for the study and investigations conducted according to the protocol described by the Sysmex analyzer machine manufacturer.

Measurements were done using standardized instruments and structured interviewer administered questionnaires was constructed to obtain information on demographics, dietary lifestyle, and cultural, socio-economic, environmental and household conditions.

Data analysis

Data analysis started at data collection and ended at interpretation of processed data. In this study, data was analyzed using analysis-recording sheets. Anemia was defined as a hemoglobin value ≤ 10 g/dl. This anemia cutoff value was lower than the WHO-recommended for this age group, but a race-specific anemia criterion (10 g/dl for blacks) optimized the screening performance of this indicator to detect iron deficiency [10]. Iron deficiency was defined based on the MCV, MCHC, RDW and Mentzer Index values used in the study.

Using the sample procedure in Statistical Package for Social Sciences (version 24.0) for MacBook (SPSS Inc., Chicago, IL, USA). Associations between anaemia and the exposure variables were assessed by logistic regression with estimation of odds ratios (OR) and a 95% confidence interval margin of error of 0.05 were used. Bivariate and multivariate analysis was done for all the variables investigated.

Ethical consideration

A research clearance certificate was sought and obtained from the Research and Ethical Clearance Board of Mount Kenya University. Approval and issuance of authorization letter from the Kabutare Hospital was obtained. Moreover, a written consent form from caregiver was signed before data collection.

Results

Demographic characteristics of respondents

Contacts were made with the caregivers of children in this age group who sought care at the hospital over the study period. A total of 126 respondents participated in the study. The distribution of socio-demographic characteristics among the respondents is shown in table 1.

A total of 126 children participated in the study, of which 64 (50.8%) were male, 48 (38.1%) were aged 6-18 months. Of 126 mothers, 92 (73%) were married, 97 (77%) had only primary education, 93 (73.8%) were farmers. For the fathers, 86 (68.3%) had primary education, 86 (68.3%) were farmers. The socio-class category used in this study was based on the already established socio-class category in Rwanda. More than a half of the families that participated in the study 67 (53.2%) were in the third category.

Prevalence of iron deficiency anaemia

Iron deficiency anaemia was assessed using four major parameters Hemoglobin (Hb) levels of ≤ 10g/dl for Mild Anaemia, 7 - 9 g/dl for Moderate Anaemia and < 7 g/dl for Severe Anaemia. The Mean Corpuscular Volume (M.C.V) levels of < 71fl for ages 6 - 24 months and < 76fl for ages 25 - 59 months. Mean Corpuscular Hemoglobin (M.C.H.C) levels of < 33.6 g/dl, Red cell distribution Width corpuscular volume (R.D.W.) levels of < 11.6% and Mentzer index of > 13.

Of the 126 study participants, 8 (6%) had severe anaemia Hb < 7 g/dl, 15 (11.9%) had moderate anaemia Hb 7 - 9 g/dl and 9 (7.1%) had mild anaemia 9 - 10 g/dl. Our study found that out of the 32 (25.4%) who had anaemia 26 (81.2%) had iron deficiency. Figure 1 illustrates the prevalence of iron deficiency anaemia in this study is 20.6%.

Variable	Frequency (n = 126)	Percent (%)
Sex		
Male	64	50.8
Female	62	49.2
Age in months		
6 - 18	48	38.1
19 - 31	20	15.9
32 - 44	24	19
45 - 59	34	27
Mean ± standard deviation	29.69 ± 17.82	
Marital status		
Single	26	20.6
Married	92	73.0
Divorced/Separated/Widowed	8	6.4
Mother's educational level		
None	10	7.9
Primary	97	77
Secondary	19	15.1
Mother's employment status		
Housewife	10	7.9
Civil servant	8	6.4
Farmer	93	73.8
Trader	15	11.9
Father's educational		
No formal education	19	15.1
Primary	87	68.0
Secondary and above	20	15.9
Father's employment status		
Farmer	86	68.3
Trader	16	12.7
Government or Private institution employee	24	19.0
Socio-class category		
First category	25	19.8
Second category	34	27.0
Third category	67	53.2

Table 1: *Socio-demographic characteristics of respondents.*

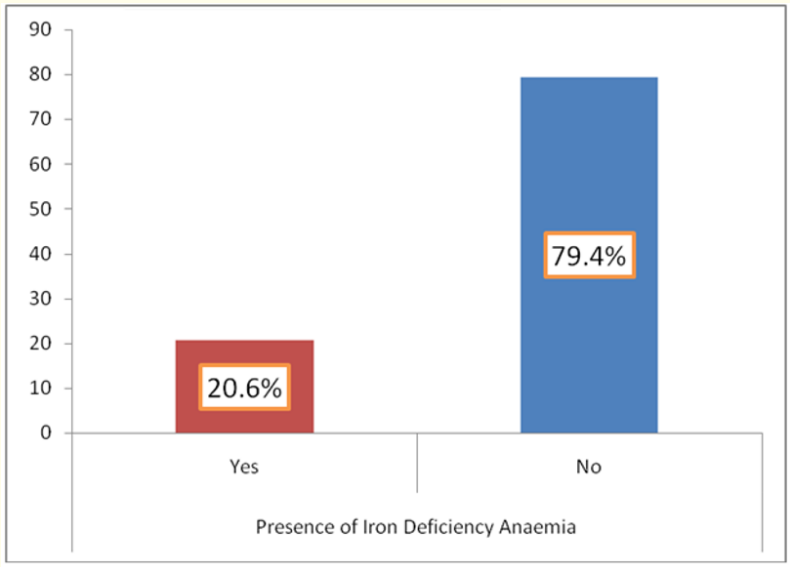

Figure 1: *Prevalence of iron deficiency anaemia.*

Relationship between child, family socio-demographic characteristics with iron deficiency anaemia were assessed by bivariate analysis where chi-square and p-value were estimated.

Variables	Presence of IDA		X^2	P value
	Yes n (%)	No n (%)		
Sex			0.282	0.596
Male	12 (46.2)	52 (52.0)		
Female	14 (53.8)	48 (48.0)		
Age in months			0.343	0.920
6 - 18	11 (42.3)	37 (37.0)		
19 - 31	4 (15.4)	16 (16.0)		
32 - 44	5 (19.2)	19 (19.0)		
45 - 59	6 (23.1)	28 (28.0)		
Marital status			2.215	0.330
Single	8 (30.8)	18 (18.0)		
Married	17 (65.5)	75 (75.0)		
Divorced/Separated/Widowed	1 (3.8)	7 (7.0)		
Mother's educational level			1.782	0.410
No formal education	3 (11.5)	7 (7.0)		
Primary	21 (80.8)	76 (76.0)		
Secondary	2 (7.7)	17 (17.0)		
Mother's employment status			4.212	0.239
Housewife	1 (3.8)	9 (9.0)		
Civil servant	0	8 (8.0)		

Farmer	23 (88.5)	70 (70.0)		
Trader	2 (7.7)	13 (13.0)		
Father's educational			2.257	0.324
No formal education	2 (7.7)	17 (17.0)		
Primary	18 (69.2)	69 (69.0)		
Secondary and above	6 (23.1)	14 (14.0)		
Father's employment status			0.422	0.810
Farmer	18 (69.2)	68 (68.0)		
Trader	4 (15.4)	12 (12.0)		
Government or Private institution employee	4 (15.4)	20 (20.0)		
Socio-class category			2.764	0.251
First category	8 (30.8)	17 (17.0)		
Second category	5 (19.2)	29 (29.0)		
Third category	13 (50.0)	54 (54.0)		

Table 2: *Relationship between child, family socio-demographic characteristics with iron deficiency anaemia.*

The findings presented in table 2 revealed that none of the demographic and socio-economic variables showed any statistical association with iron deficiency anaemia. The findings showed that more than a half of children with IDA were female (53.8%). Of the children with anaemia, 42.3% were aged between 6-18 months, 80.8% had mothers with only primary education, and 88.5% had mothers who are farmer and 50.0% their families belong in third socio-class category.

Dietary factors associated with iron deficiency anaemia

The dietary factors assessed for IDA included the history of breastfeeding, Current breastfeeding status, time of introducing complementary feeds, history of pica (ibumba) consumption with pregnancy, history of cow milk consumption before 6 month of age and the dietary diversity score using 24 hour recall. Table 3 illustrates these factors.

Variables	n (%)	Presence of IDA			
		Yes n (%)	No n (%)	X^2	P value
Current breastfeeding status				0.728	0.394
Yes	49 (38.9)	12 (46.2)	37 (37.0)		
No	77 (61.1)	14 (53.8)	63 (63.0)		
Time of introducing complementary feeds				2.040	0.361
Early	19 (15.1)	6 (23.1)	13 (13.0)		
Timely	104 (82.5)	19 (73.1)	85 (85.0)		
Late	3 (2.4)	1 (3.8)	2 (2.0)		
History of pica consumption during pregnancy				4.945	0.026
Yes	32 (25.4)	11 (42.3)	21 (21.0)		
No	94 (74.6)	15 (57.7)	79 (79.0)		
History of cow milk consumption before 6 months				11.116	0.001
Yes	15 (11.9)	8 (30.8)	7 (7.0)		
No	111 (88.1)	18 (69.2)	93 (93.0)		

Table 3: *Dietary factors associated with iron deficiency anaemia.*

The results from table 3 showed that two dietary factors, which were pica consumption during pregnancy and history of cow milk consumption before 6 months showed a statistical association with iron deficiency anaemia. Of the 26 children with IDA, 12 (46.2%) were still breastfeeding, 6 (23.1%) received early complementary feeding and 8(30.8%) consumed cow milk before 6 months.

Morbidity and environmental factors associated with iron deficiency anaemia

Morbidity and environmental factors were also assessed for a relationship with iron deficiency anaemia. Some of these factors include; birth place of child, immunization status, use of ITNs, malaria infection, diarrheal disease, blood transfusion, source of water supply and toilet system in use. Table 4 illustrates these factors.

Variable	Frequency (%)	Presence of IDA			
	n = 126	yes	no	X^2	P value
	n (%)	n (%)	n (%)		
Birthplace				1.070	0.336
Home	2 (1.6)	1 (3.8)	1 (1.0)		
Health institution	124 (98.4)	25 (96.2)	99 (99.0)		
Immunization status				0.461	0.497
Partial	20 (15.9)	3 (11.5)	17 (17.0)		
Full	106 (84.1)	23 (88.5)	83 (83.0)		
Use of ITN				1.070	0.301
Yes	124 (98.4)	25 (96.2)	99 (99.0)		
No	2 (1.6)	1 (3.9)	1 (1.0)		
Malaria infection				2.912	0.088
Yes	45 (35.7)	13 (50.0)	32 (32.0)		
No	81 (64.3)	13 (50.0)	68 (68.0)		
Intestinal parasite infection				2.259	0.133
Yes	47 (37.3)	13 (50.0)	34 (34.0)		
No	79 (62.7)	13 (50.0)	66 (66.0)		
Diarrheal disease (past month)				5.367	0.021
Yes	57 (45.2)	17 (65.4)	40 (40.0)		
No	69 (55)	9 (34.6)	60 (60.0)		
Blood transfusion (past year)				8.293	0.004
Yes	14 (11.1)	7 (26.9)	7 (7.0)		
No	112 (88.9)	19 (73.1)	93 (93.0)		
Source of drinking water				8.293	0.004
Tap	112 (88.9)	19 (73.1)	93 (93.0)		
Interrupted/ Stream	1 (0.8)	7 (26.9)	7 (7.0)		

Table 4: *Relationship of morbidity and environment factors with iron deficiency anaemia.*

The results presented in table 4 showed that had diarrheal disease one month before the survey (p = 0.021), had blood transfusion in past year (0.004) and source of drinking water (0.004) were significantly related with iron deficiency anaemia.

Of the 126 children, only 2 (1.6%) were born at home, no relationship was noted with iron deficiency anaemia and birth place of child. Regarding the immunization, 106 (84.1%) children had completed immunizations, no relationship was noted between immunization status and iron deficiency anaemia. The result on the history of malaria infection in the past month, 45 (35.7%) children had malaria in the previous month, however, no relationship with iron deficiency anaemia observed.

Variable	AOR	95% CI		P-value
		Lower	Upper	
History of pica consumption during pregnancy				
Yes	2.20	0.767	6.344	0.142
No	Ref			
History of cow milk consumption before 6 months				
Yes	2.92	0.649	13.151	0.163
No	Ref			
History of diarrheal disease in past month				
Yes	1.55	0.536	4.503	0.417
No	Ref			
History of blood transfusion in past year				
Yes	5.81	1.566	21.577	0.009
No	Ref			
Source of drinking water				
Tap	0.45	0.088	2.353	0.347
Interrupted/ stream	Ref.			

Table 5: *Factors associated with iron deficiency anemia.*

The findings from multivariate analysis showed that history of recent blood transfusion [AOR = 5.81; 95%CI = 1.566 - 21.577; P = 0.009] was significantly associated with iron deficiency anaemia. Children who consumed cow milk before six months were three times more likely to have iron deficiency anaemia, but no statistical significance observed. Similarly, children who have had diarrheal disease in past one month prior to the survey had higher risk of iron deficiency anaemia, but no statistical significant observed.

Discussion

This study has highlighted the prevalence and factors associated with iron deficiency anaemia among children aged 6 to 59 months seen in Kabutare district hospital, Rwanda. The findings of this study serve as a contribution towards the scarce baseline data on prevalence of iron deficiency anaemia among children below 5 years in Rwanda.

The prevalence of anaemia in this study was 25.4% which is lower compared to the results provided in the 2014/2015 Rwanda Demographic Health Survey which estimates prevalence of anaemia of 37% among under-five children. Compared to the prevalence of anaemia observed in this study, the higher prevalence (66.6%) was reported among Ethiopian children [12] and a prevalence of 58.8% was observed among Ugandan Children [13].

In our study, 81.2% of children with anaemia are seen to have iron deficiency, which is much higher compared to a study conducted in Rwanda where anaemia in pre-school children in the southern highlands of Rwanda was said to be frequent, and one in four anemic

children had iron deficiency [9]. The prevalence of iron deficiency anaemia observed in this study (20.6%) is much higher compared to what reported by other study conducted in Northern and Southern province of Rwanda [8].

The reduced prevalence of anaemia observed in this study when compared to other previous study conducted in Rwanda or elsewhere in Africa could be explained by public health interventions such as deworming of children and malaria diagnosis and treatment that have played a huge role in curbing the problem of anaemia in children in Rwanda like most other developing countries. Increased proportion of children with anaemia having iron deficiency can be explained by a large number of children having poor dietary iron intake in this study. Also serum ferritin measurement which is widely used in previous study conducted in Rwanda as a marker for iron status was not used in this study, its value may be limited by its role as an acute-phase reactant as it is known to be elevated in both infections and inflammations; also, another important factor to consider is its cost in a developing country like Rwanda.

Demographic and socio-economic status of the family showed no association with iron deficiency anaemia. Even though previous studies done in similar regions have demonstrated associations between anaemia and other indicators of poor socioeconomic conditions in Africa [14,15]. This inconstant result could be related to the study setting, where many previous studies were conducted in community settings while our study was conducted in hospital settings. In our study, we tested the association between iron deficiency anaemia and socio-demographic characteristics, while in other studies assessed the association between anaemia and socio-demographic characteristics, this could also explain our findings.

In multivariate analysis, we found that children who consumed cow milk consumption before six months were three times more likely to have iron deficiency anaemia. This is similar to another study done in Tanzania [16] which showed drinking of cow milk as a significant predictor of anaemia [AOR = 2.5; (CI = 1.1 - 5.2)]. This can be explained by poor iron absorption in cow milk. Cow's milk has decreased iron density and bioavailability, excess protein and minerals, notably calcium, and therefore it interferes in the absorption of iron from other feeds. Cow milk is also linked to small intestinal hemorrhage in young children. Also, Vitamin C has been recognized to enhance the absorption of iron. Cow's milk contains little vitamin C and pasteurization reduces that amount significantly.

We further found that children who have the history of blood transfusion had increased risk of iron deficiency anaemia. Children who receive blood transfusion in Rwanda under the Ministry of Health guidelines are those with severe anaemia (< 7 g/dl) with symptomatic or in life threatening health conditions. With respect to this, blood transfusion provides a solution to the acute problem and not necessarily the underlying problem. Iron deficiency if present will persist without iron supplementation to correct the lack and supplement the child's needs. It is important to find out why the child is anemic and treat the cause as well as the symptoms.

This is one of few studies in Rwanda that have assessed iron deficiency in children. In addition to strengths, limitations to this study exist. The study only included a limited number of children seen in a hospital and cannot be interpreted to be a generalized finding to a larger context without caution. Also, in diagnosing iron deficiency, Serum ferritin estimation could have increased the accuracy of its diagnosis.

Conclusion

This study yielded important information about the prevalence of iron deficiency anaemia, and the various factors associated with its prevalence. It has helped in assessing the prevalence of anaemia in this age group. Based on these findings, demographic and socio-economic status showed no direct association with iron deficiency anaemia. The study concludes that iron deficiency remains a very important cause of anaemia in children in this age group. It emphasizes the need for iron supplementation in children who have recently had blood transfusion on account of severe anaemia.

On the basis of the findings in this study, the following recommendations have been made: The role of the Government and Ministry of Health cannot be overemphasized with implementation of policies that promote exclusive breastfeeding for first 6 months, and proper

nutrition. This could be achieved through continuous information dissemination about iron rich foods and iron absorption by the human body, the improvement of environmental conditions and the application of reliable, easy to use and cheap methods for Hb estimation and possibly serum ferritin levels. Iron supplements should also be made affordable and easily accessible. Further studies in iron deficiency in adolescents will be vital as few studies have assessed iron deficiency in older children.

Conflict of Interest

Authors declare no conflict of interest.

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