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Prevalence and determinants of iron-deficiency anaemia among children 6-23 Months attending Thika level-5 hospital, Kiambu County, Kenya

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Abstract

It is evident that iron in childhood is key for proper health and cognitive development as it is required for academic and work productivity in adulthood. There is paucity of data concerning the prevalence of IDA in children aged 6-23 months since most studies focus mainly on the selection of iron rich foods as criteria for determining those at risk of IDA. The age limit in most of these studies is 5 years and above. There is limited scientific data on the prevalence and determinants of IDA in children aged 6-23 months old in Thika Level 5 Hospital attending well baby clinic (WBC). A cross-sectional analytical study design was adopted for the study in the month of May 2013. The study targeted a sample size of 241 children selected by systematic random sampling method. Data were collected by researcher administered interview schedule given to mothers or caregivers of the children attending the WBC at Thika Level 5 Hospital. This was followed by a collection of venous blood samples from children for hemoglobin, red cell width and mean cell volume determination. The study participants were also followed up to their homes at a later date to quantify the utensils used to measure food. The data were cleaned coded and analyzed using SPPS Version 20. Data on dietary intake was analyzed using Nutri-survey statistical package (2008) and ENA for smart (2008) was used to analyze anthropometry. Descriptive statistics were used to describe the daily intake of nutrients, sanitation, economic and socio-demographic factors. IDA status was based on hemoglobin levels while predictors of complementary feeding practice were considered an indicator of proper food intake. Chi-square test was used to determine the relationship between IDA with dietary intake of iron-rich foods and complementary feeding practices. Binary logistic regression was used to test the significance between IDA with malaria, helminthic infestation and immunization status. The level of significance of accepting the null hypotheses was <0.05. The minimum dietary diversity was (34%), minimum meal frequency (58%) and minimum acceptable diet was (58%). Binary logistic regression analysis revealed significant relationships between malaria with IDA (ODDS Ratio [OR] =2.95, CI=0.72-3.22, p=0.013), helminthic infestation with IDA (ODDS Ratio [OR] = 3.87, CI=0.84-4.12, p=0.001) and immunization status with IDA (ODDS Ratio [OR] = 2.98, CI = 0.63-3.16, p=0.032). Mean hemoglobin values from the present study were found to be (8.3 ± 2.3g/dl) whereas the overall IDA prevalence was (73.2%) indicating severe IDA among children attending a WBC at Thika Level 5 Hospital. Determinants of IDA included; the age of the child, education of the caregiver, the occupation of the caregiver, complementary feeding practices, dietary intake of iron-rich foods, rubbish waste disposal, human waste disposal, the presence of stagnant water, malaria infection, deworming practices, helminthic infection and immunization. Aggressive awareness campaigns targeting proper complementary feeding and proper iron–rich diet for mothers with under five-year children in hospitals, markets and chief's barazas should be launched by all stakeholders in (IYCF) Infant and young child feeding.

Keywords: Complementary feeding practices, minimum dietary diversity, minimum meal frequency, and minimum acceptable diet

1. Introduction

Iron is an essential nutrient for all body tissues and it is present in the brain of the developing fetus, where it is needed for the proper formation of the neural tissue and development of brain cells (Hermoso *et al.*, 2011) [6]. Iron deficiency is probably the most prevalent and common micronutrient deficiency in the developing world today existing in populations of low socio-economic status. It is responsible for a higher incidence of morbidity because of the lack of proper investigation, prophylactic and therapeutic measures (Maheshwari, Raut & Argawal, 2011) [11]. Twenty-five percent of the world population is affected by IDA, the seriously affected being children of preschool age and women of reproductive ages (UNICEF, 2009a) [18].

Unless maternal iron deficiency is severe, term infants are generally considered to be protected from IDA throughout the first six months of life (Nyaradi *et al.*, 2013) [13] but as iron stores are used up, a sharp decline of iron occurs and the infant becomes vulnerable to deficiency if the supply of dietary iron is not adequate. Scientific evidence shows that the brain is the most vulnerable organ during critical periods of development, including the last trimester of fetal life and the first 2 years of childhood, which is a period of rapid brain growth termed as "brain growth spurt" (Hermoso *et al.*, 2011) [6]. Childhood period of 6 months to 2 years is characterized by increased daily iron and energy requirements. This period is also correlated to the depletion of iron stores and the introduction of cereal-based complementary foods rich in phytate and tannates from which absorption of iron can be as low as 5% (Aamer, 2011) [1].

The etiology of IDA is multifactorial and starting with the antenatal period, the iron status of an expectant woman is a key determinant of the infant and subsequent child's iron status since iron passes from the maternal blood through the placenta to the foetal blood. Secondly, the natural (unfortified) diet of infants above 6 months does not contain enough iron to cover their requirements, iron stores acquired from the mother's womb are already exhausted and thus dietary iron is the only reliable source. Other common etiologies of IDA include; malaria infection, helminthic infestation, sanitation, hereditary haemoglobinopathes, low socio-economic status and micronutrient deficiencies such as folic acid, retinol and iron deficiency. The main causes of IDA are however summarized as dietary intake of non-heme iron, poor sanitation and low socio-economic status (Bharati *et al.*, 2013) [4].

2. Materials and methods

A cross-sectional analytical study design was adopted for the study in the month of May 2013. The study targeted a sample size of 241 children selected by systematic random sampling method. Data were collected by researcher administered interview schedule given to mothers or caregivers of the children attending the WBC at Thika Level 5 Hospital. This was followed by a collection of venous blood samples from children for hemoglobin, red cell width and mean cell volume determination conducted by a trained laboratory technician. The study participants were also followed up to their homes at a later date to quantify the utensils used to measure food. The data were cleaned coded and analyzed using SPPS Version 20. Data on dietary intake was analyzed using Nutri-survey statistical package (2008) and ENA for smart (2008) was used to analyze anthropometry. Descriptive statistics were used to describe the daily intake of nutrients, sanitation, economic and socio-demographic factors. IDA status was based on hemoglobin levels while predictors of complementary feeding practice were considered an indicator of proper food intake. Chi-square test was used to determine the relationship between IDA with dietary intake of iron-rich foods and complementary feeding practices. Binary logistic regression was used to test the significance between IDA with malaria, helminthic infestation and immunization status. The level of significance of accepting the null hypotheses was <0.05.

3. Results and discussion

3.1 Socio-demographic profiles of the children

The youngest child from this study was aged 6 months and 2 days old, while the eldest child was aged 22 months 2 weeks. The majority of children were aged between 12-23 months (53.9%) occupying more than half of the children under study population.

Table 1: Demographic characteristics of the children

Variable	N = 227	Percentage (%)
Age of the child		
6-8 months	51	22.4
9-11months	54	23.7
12-24 months	122	53.9
Total	227	
Sex of the child		
Male	102	45.2
Female	125	54.8
Total	227	
Relationship of the child towards the caregiver		
Own child	213	93.4
Adopted* or fostered*	12	5.3
Other relation	2	1.3
Total	227	

Adopted or fostered child refers to one, who has been obtained through legal means;*other relation refers to either niece or nephew of the caregiver.

Female children had the highest turnout (54.8%) in comparison to the male children (45.2%).The largest proportions of the caregivers were parents of the children (93.4%) (Table 1).

3.2 Socio-economic profiles of the caregivers

The largest proportion of caregivers in the course of the day (70%) was the mothers of the children. This was consistent with Sparks, (2011), where majority of caregivers reported in his study were mothers of the children who took care of the children throughout the day. In terms of religion, the majority of caregivers were Christians (97.4%) whereas the Muslim occupied the least percentage (2.6%). Caregivers interviewed did not have any religious restrictions towards iron rich foods that may have contributed to IDA. Close to half of caregivers from this study had secondary education (46.9%), followed closely by primary education (34.6%). The least percentage of caregivers attained the tertiary level of education (17.3%).

Table 2: Socio-economic characteristics of the caregivers

Variable	N= 227	Percentage (%)
Caregiver throughout the day		
Mother	161	70.6
Relative	17	7.5
House help	23	10.1
Daycare	26	11.4
Total	227	
Highest education level attained		
Primary	79	34.6
Secondary	107	46.9
Tertiary*	41	17.3
Total	227	
Religion		
Christian	222	97.4
Muslim	5	2.6
Total	227	

*Tertiary education refers to either college or university education.

3.3 Nutritional status of the children

Nutritional status refers to the condition of the body as influenced by diet, levels of nutrients in the body and the ability of those levels to maintain normal metabolic integrity. The measures that were used to assess nutrition status in children were weight for height, height for age and weight for age (WHO, 2006; Abubakar *et al.*, 2012). The percentage of children found to be malnourished was high and thus need immediate attention. The high percentage of malnourished children was mainly attributed to poor dietary intake as the majority of children, according to information obtained from the caregivers, ate potatoes. A good number took porridge daily with no other meal consumed during the day and others maize paste and kales throughout hence missing out on vital protein intake. The majority of these meals were mainly composed of energy giving foods without the body building foods or the protective foods hence the high rate of malnutrition. The recommended daily dietary intake was also never achieved because of low income among the mothers/caregivers.

3.3.1 Wasting in children

This measurement refers to low weight for height. A wasted child has a weight for height below -2SD of the reference population. In this study, close to a fifth of the children were wasted (18%). Severe acute malnutrition (SAM) was in the range of (5%) among children having a weight for height Z-scores less than -3SD (Table 3).

Table 1: Nutritional status of children

Child's nutritional status		
Wasting(WHZ)	**N**	**%**
Normal	145	63.9
Moderately wasted	30	13
Severely wasted	11	5
Underweight (WAZ)		
Overweight	40	17.5
Normal	101	44.5
Moderately underweight	68	30
Severely underweight	18	8
Stunting (HAZ)		
Normal	209	92
Moderately stunted	13	5
Severely stunted	5	2

Cut off values for wasting, stunting and underweight are ≤ 2 standard deviation units (WHO, 2006).

3.3.2 Underweight in children

This measurement refers to acute and chronic malnutrition combined (WHO, 2006).The indicator is a low weight for age. An underweight child has a weight for age Z-score below -2SD of the reference population. More than a third of the children were underweight (38%). Severe acute malnutrition (SAM) was (8%) among the children having a weight for age Z-scores less than -3SD. whereas the rest (44.5%) and (8%) were in the normal and overweight category respectively (Table 3).

3.3.3 Stunting in children

Stunting is low length/height for age and is determined by use of height for age Z-score. Height for age Z-scores below -2SD of the reference population is classified as stunting. It is a sign of a chronic nutritional disorder (WHO, 2006). The percentage of children stunted was (7%) while about (2%) had height for age Z-scores less than -3SD indicating severe stunting (Table 3).

3.3.4 Nutritional status according to the sex of a child

From Table 4, the percentage of wasting, underweight and stunting of male children were (18.4%), (19.2%) and (6.4%) respectively, whereas those for female children were (17.6%), (18.6%) and (5.9%) respectively. From these results, female children were more likely to have better nutritional status in comparison to the male children.

Table 2: Nutritional status of the children by sex

Sex Distribution	Boys		Girls			
Forms of malnutrition	**N**	**%**	**N**	**%**	**Total**	**%**
Wasting	23	18.4	18	17.6	41	41.8
Underweight	24	19.2	19	18.6	43	43.9
Stunting	8	6.4	6	5.9	14	14.3

Cut off values for wasting, stunting and underweight are ≤ 2 standard deviation units (WHO, 2006)

3.4 Prevalence of iron deficiency anaemia

Prevalence of IDA is estimated based mainly on haemoglobin levels. Red cell width and mean cell volume tests are also important since they give confirmed evidence of IDA (WHO, 2001).

Table 5: Indices used to measure iron deficiency anaemia among children

Variable	N=227	Recommended Levels	% with IDA
	Mean ± SD		
Mean cell volume	58 ± 2.2 FL	≥ 75 FL	70.1%
Red cell width	18.1 ± 2.1%	≤ 14 %	74.0%
Haemoglobin	8.3 ± 2.3 g/dl	≥ 11g/dl	75.6%
Average			73.2 %

Percentage of children with IDA based on haemoglobin values was 75.6% however, according to mean cell volume and red cell width it was (70.1%) and (74%) respectively. Prevalence of IDA was thus (73.2%), obtained from an average of the three indices (Table 5). The mean haemoglobin values were observed to decrease with increasing age (Table 9). Such observations are expected due to increased iron requirements as the age of the children advance from 6 months to 2 years (Aamer, 2011) [1].

3.5 Nutritional status of children in relation to IDA

HB level decreased from 8.0g/dl and 7.6g/dl respectively as the degree of wasting increased. For the underweight children, as the nutrition status moved from -2SD to -3SD the HB level likewise decreased to 7.5g/dl and 7.3g/dl respectively. For stunting, the HB level for the severely stunted was slightly lower 7.8g/dl than moderately stunted which was 7.9g/dl (Table 6).

Table 6: Relationship between IDA and the nutritional status of the children

Child nutritional status:			
Wasting	**N**	**%**	**Mean HB**
Normal	145	63.9	9.7 g/dl
Moderately wasted	30	13	8.0 g/dl
Severely wasted	11	5	7.6g/dl
Underweight			
Overweight	40	17.5	9.9 g/dl
Normal	101	44.5	8.6g/dl
Moderately underweight	68	30	7.5g/dl
Severely underweight	18	8	7.3g/dl
Stunting			
Normal	209	92	9.8g/dl
Moderately stunted	13	5	7.9g/dl
Severely stunted	5	2	7.8g/dl

Mean HB was 8.3±2.3 g/dl, Cut off values for wasting, stunting and underweight are ≤ 2 standard Deviation units (WHO, 2006).

3.6 Relationship between mean cell volumes with independent variables

Mean cell volume (MCV) is a measure widely used to evaluate nutritional IDA (WHO, 2001; WHO, 2004). The cutoff values by which a child is classified as having IDA is MCV<75FL (WHO, 2001; WHO, 2004). Apart from determining percentages and mean, the chi-square test was used to determine the relationship between the independent variables; age, gender, malaria infection and helminthic infection versus the dependent variable (IDA) among the children based on MCV values.

Children aged 12-23 months had the lowest mean MCV (51 ± 2.2FL) hence more likely to have a high prevalence of IDA in comparison to the other age groups. Age of the children had a significant positive relationship with IDA (chi-square value; p

<0.001). (Table 7). This meant that as the age of the children advanced the more they were susceptible to IDA. Considering gender, male children had lower mean MCV (54 ± 2.1FL) as compared to the female children (63 ± 2.6FL). Most likely to indicate better iron status in female than male children, although there was no significant relationship between gender and MCV (chi-square value; p = 0.121).Children with malaria infection had lower MCV (45 ± 2.4FL) in comparison to the children who did not have a malaria infection (69 ± 2.1FL). Similarly, those who had helminthic infection recorded lower values of MCV (51 ± 2.2FL) in comparison to those without helminthic infection who had higher values (66 ± 2.3FL).The age of the children and malaria infection had a positive significant relationship with IDA except for the gender of the children and helminthic infection (Table 7) implying that neither did gender of children nor helminthic infection among the children seem to influence their IDA status.

Generally, a larger proportion of the children failed to meet the cutoff values for MCV indicating a high prevalence of IDA. Children aged 12-23 months had the lowest mean MCV in comparison to other age groups, hence increased the risk of IDA among this group. Female children from the study were more likely to have improved iron status as reflected by their higher MCV values in comparison to the male children

Table 7: Relationship between mean cell volumes with independent variables

Variable	Iron deficiency anaemia						Mean (MCV FL) SD	Chi square p-value
	No	%	Yes	%	Total	%		
Age								<0.001*
6-8months	12	23.5	39	76.5	51	22.4	69 ± 2.0	
9-11months	19	35.2	35	64.8	54	23.7	55 ± 2.4	
12-23 months	38	31.1	84	68.9	122	53.9	51 ± 2.2	
Gender								0.121
Male	33	32.4	69	67.6	102	44.9	54 ± 2.1	
Female	22	17.6	103	82.4	125	55.1	63 ± 2.6	
Malaria infection								0.015*
Yes	21	36.2	37	63.8	58	25.6	45 ± 2.4	
No	43	25.4	126	74.6	169	74.4	69 ± 2.1	
Helminthic Infestation								0.132*
Yes	0	8.3	11	91.7	12	5.3	51 ± 2.2	
No	53	24.7	162	75.3	215	94.7	66 ± 2.3	

Significance at p<0.05; MCV< 75FL indicate IDA MCV≥ 75FL indicate adequate iron status (WHO, 2001);* refers to significant associations; SD refers to standard deviation; **No** indicates the child has no IDA while Yes indicates that the child has IDA.

3.7 Relationship between red cell widths with independent variables

Red cell width is a measure of variability in the width of circulating RBCs. The cutoff value used was (≤14 RCW %) for children who did not have IDA (WHO, 2001). Indicating that any child who had RCW value above (14%) was considered to have IDA. Determinations for RCW included percentages, mean and chi-square test that was used to determine the relationship between the independent variables; age, gender, malaria infection and helminthic infection versus the dependent variable (IDA) based on RCW values. From (Table 8), as the age of the children advanced so did their mean RCW. Children aged 12-23 months had the highest mean RCW (19.87 ± 2.3%) among all the age groups, hence there was an increased likelihood among this age group of having the highest incidence of IDA compared to the others. On the contrary, the mean RCW was lowest among children aged 6-8 months (16 ± 2.3%) indicating a low incidence of IDA in this age category. Age was a significant predictor of RCW in comparison to the other variables (chi-square value; p <0.000).

Female children from the study were most likely to have a higher IDA prevalence as indicated by their mean RCW (19.21 ± 2.2%) compared to male children who had a mean RCW (17.96 ± 2.1%). There was no significant relationship between gender of the children and RCW at (chi-square value; p = 0.121) which applied to all the age groups. Children with malaria infection were more likely to be iron deficient with a mean RCW (19.36 ± 2.3%) in comparison to those without malaria infection that had a much lower mean RCW of (13.50 ± 2.1%).There was a significant relationship between malaria infection and RCW (chi-square value; p = 0.015) (Table 8).

Table 8. Relationship between red cell widths with independent variables.

Variable	Iron deficiency anaemia						Mean RCW (%) SD	Chi square p-value
	No	%	Yes	%	Total	%		
Age								<0.000*
6-8months	12	24.1	39	75.9	51	22.4	16.23 ± 2.0	
9-11months	9	18	45	82	54	23.7	18.96 ± 2.2	
12-23 months	38	31	84	69	122	53.9	19.87 ± 2.3	
Gender								0.121
Male	25	24.5	77	75.5	102	44.9	17.96 ± 2.1	
Female	47	37.6	78	62.4	125	55.1	19.21 ± 2.2	
Malaria infection								0.015*

Yes	6	10.3	52	89.7	58	25.6	19.36 ± 2.3	
No	45	26.6	124	73.4	169	74.4	13.50 ± 2.1	
Helminthic Infestation								0.132*
Yes	1	8.4	11	91.6	12	5.3	18.85 ± 2.1	
No	56	26.0	159	74.0	215	94.7	19.12 ± 2.3	

Significance at p<0.05;* refers to significant associations; RDW, normal values range between ≤ 14. Values > 14 indicate IDA (WHO, 2001); SD refers to standard deviation. No indicates the child has no IDA while Yes indicates that the child has IDA.

Children with helminthic infection had a lower mean RCW of (18.85 ± 2.2%) as compared to those who did not suffer from helminthic infection with mean RCW of (19.12 ± 2.3%) despite the fact that there was no significant relationship between helminthic infection and RCW (chi-square value; p = 0.132). Age of the children and malaria infection had significant relationships with IDA except for helminthic infection and gender of the children (Table 8) implying that both the gender of children and helminthic infection did not seem to influence their IDA status. These results are consistent with Roosy *et al.*, (2009).

3.8 Relationship between haemoglobin with independent variables.

Apart from determining percentages, the chi-square test was used to determine the relationship between the independent variables; age, gender, education and occupation versus the dependent variable (IDA) as assessed by haemoglobin levels.

The mean haemoglobin (Table 9) decreased as the age of children increased with the lowest value of haemoglobin recorded in children aged 12-23 months. From this study, age was the most significant predictor (chi-square value; p<0.000) of IDA in comparison to other variables. The mean haemoglobin for male children was (9.30 ± 2.2 g/dl) whereas (8.56 ± 2.2g/dl) for female children. Despite the fact that the HB values for female children were slightly lower than that for male children, the gender of a child from this study seemed not have any significant association (chi-square value; p=0.127) with the haemoglobin level. From (Table 9), education of the caregiver likely influenced (chi-square value; p =0.002) the IDA status of the children. Occupation of the caregivers was another determining factor of IDA with a (chi-square value; p =0.012). Age of the children, education and occupation of the caregivers had significant relationships with IDA except for gender of the children (Table 9) that did not seem to significantly affect their IDA status.

Table 9. Relationship between haemoglobin with independent variables

Variable	Iron deficiency anaemia						Mean HB(g/dl) ± SD	Chi-square p-value
	No	%	Yes	%	Total	%		
Age								<0.000*
6-8months	12	23.6	39	76.4	51	22.4	10.2 ± 2.1	
9-11months	10	18.5	44	81.5	54	23.7	8.84 ± 2.3	
12-23 months	38	31	84	69	122	53.9	7.76 ± 2.4	
Gender								0.127
Male	25	24.5	77	75.5	102	44.9	9.30 ± 2.4	
Female	47	37.6	78	74.4	125	55.1	8.56 ± 2.3	
Education								0.002*
Primary	6	10.3	52	89.7	58	25.6	7.81 ± 2.4	
Secondary	45	26.6	124	73.4	169	74.4	8.64 ± 2.3	
Tertiary							9.98 ± 2.2	
Occupation								0.012*
Employed	21	36.8	36	63.2	57	25.1	9.97 ± 2.2	
Waged labor	9	11.5	69	88.5	78	34.4	7.96 ± 2.4	
Business	21	30.0	49	70.0	70	30.8	8.71 ± 2.3	
Unemployed	0	0	4	100.0	4	1.8	7.42 ± 2.4	
Farming	6	33.3	12	66.7	18	7.9	10.1 ± 2.1	
Mean				74%			8.3 ± 2.3	

Significance at p<0.05,* refers to significant associations; Iron deficient refers to Hb level<11g/dl whereas iron replete refers to HB level ≥11g/dl.; Tertiary level of education refers to either college or university education.

3.9 Relationship between IDA and the caregiver of the child

More than ninety-three percent (93.8%) of the caregivers were mothers of the children. The nature of caregiver of the child during the day might not have significantly (chi-square value; p=0.063) affected the IDA condition among the children (Table 10).

Table 10. Relationship between IDA and the caregiver of the child

Relationship of the child towards the caregiver	Iron deficiency anaemia						Chi-square; p value= 0.063
	No	%	Yes	%	Total	%	
Own child	55	25.8	158	74.2	213	93.8	
Adopted or fostered child	2	16.7	10	83.3	12	5.3	
Other relation (niece or nephew)	0	0	2	100	2	0.8	

*Significance at p<0.05; Iron deficient refers to Hb level<11g/dl whereas Iron replete refers to HB level≥11g/dl.

3.10 Relationship between IDA among the children and income of the caregiver

Income or wealth from this study was defined by the occupation of the caregivers' because it influenced the purchasing power of foods. Children of waged employed caregivers had the highest percentage of IDA (34.5%). All children of caregivers who were unemployed were all iron-deficient. Occupation of the caregivers significantly affected IDA (chi-square value; p = 0.012) (Table 11). Consistent with Ayieko & Midikila, (2010) rural farming communities were observed to have better access to food thereby reducing reliance on income to provide for family meals.

Table 11: Income and its relationship with IDA among the children

Occupation of the caregiver	Iron deficiency anaemia						Chi-square ; p =value
	No	%	Yes	%	Total	%	0.012*
Employed salaried	16	28.1	41	71.9	57	25.1	
Waged labor	13	16.7	65	83.3	78	34.4	
Business person	21	30	49	70	70	30.8	
Unemployed	0	0	4	100	4	1.8	
Farming	7	38.9	11	61.1	18	7.9	

Significance at $p<0.05$; * refers to significant associations; Iron deficient refers to HB level<11g/dl whereas Iron replete refers to HB level≥11g/dl.

3.11 Dietary intake among the children

3.11.1 Food consumption patterns

Food consumption patterns in this study were based on a 7-day food frequency interview.

Food consumption patterns of the children were evaluated using the FFQs so as to gauge the type and number of times a particular food was consumed. Dietary diversity was then computed based on 7 food groups as recommended by (WHO, 2008b) which comprise of grains, roots and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry and organ meats); eggs; vitamin-A rich fruits and vegetables; other fruits and vegetables. Studies in Kenya have shown porridge to be the main cereal introduced to children (Murage *et al.*, 2010; Chelimo, 2008) [5]. Nearly all the children consumed cereals and grains despite the fact that the meal frequency differed from one child to the other. Only 5 children were reported not to have been introduced to starchy foods. They were aged 6 and half months old each. The majority of the children (98%) consumed cereals and grains with most children taking them 4-5 times per week.

Table 12. 7 day food frequency questionnaire of children 6-23 months old

Foods n=7	Daily	4-5 times/week	3 times/week	2 times/week	Onces /week	Never	Total consumption
Cereals and grains	48.3%	38.2%	5.3%	4.7	1.5 %	2 %	98%
Legumes and nuts	2.7%	4.1%	25%	36.1%	10.1	22%	78%
Vitamin A rich fruits and vegetables	1.7%	8.6%	24.1%	14%	6.6%	45%	54%
Other fruits and vegetables	5.2%	2.3%	11%	49.2%	21.3%	12%	88%
Meat /poultry/fish /eggs	2.2%	0.7%	1.2%	2.4%	13.5%	80%	20%
Milk products	81%	6.4%	1.1%	5.6%	1.9%	4%	96%
Food made with fat and oil	68.5%	7.6%	2.2%	0.5%	1.2%	20%	80%

7 food groups as recommended by (WHO, 2008b); SD refers to standard deviation.

More than three-quarters of the children (78%) consumed legumes and nuts with the majority taking them twice per week in their meals. The majority of caregivers confirmed that the children took legumes in their diet, however, most of them confessed not give their children vitamin C rich fruits and vegetables along with the legumes in turn increasing their susceptibility to IDA due to decreased iron bioavailability. These findings compare with similar studies conducted in Kenya by Chelimo, (2008) [5] and in Nepal by Joshi *et al.*, (2011). Meat, poultry, fish and eggs considered as excellent sources of heme iron were consumed by the least number of children (20%) and also once per week by the majority who consumed them. All children interviewed consumed milk despite the fact that the quantities differed among the children. The total consumption per week was (96%) with more than 4/5 of the children taking milk daily. Most of the children (80%) consumed fat and oil added to foods during the cooking process. Children who ate other fruits and vegetables per week were higher in percentage (88 %) in comparison to those who ate vitamin A rich fruits and vegetables (54%).

3.11.2 The form of iron consumed among the children

During the 24 hours, recall and food frequency interview schedule, foods rich in iron consumed by the children were recorded along with their accompaniments such as vitamin C-rich fruits and vegetables so as to come up with the form of iron consumed by the children in the study. Non-heme iron-rich foods such as beans, peas, green grams without enhancers formed the majority (46%) whereas heme iron-rich foods such as beef, poultry, fish and eggs were consumed by the least percentage (7%). Most caregivers confirmed that although they gave their children cereal protein they did not accompany it with vitamin C sources of fruits and vegetables.

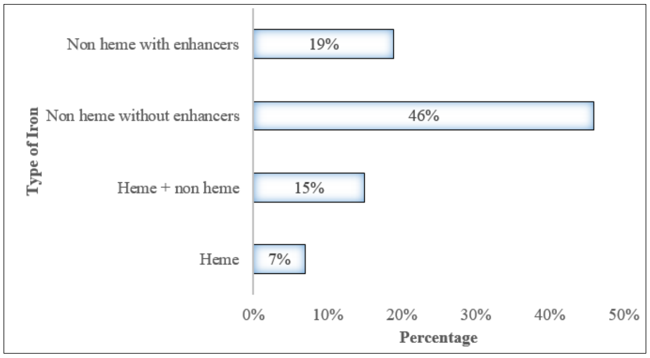

Fig 1: Percentages of heme and non-heme iron sources consumed

Non–heme iron food sources without iron absorption enhancers were consumed in the range of (46%). In contrast, heme iron food sources which were consumed in the lowest rate of (7%) (Figure 1).

3.11.3 Complementary feeding practices

Data collected from the food frequency questionnaires was analyzed to get minimum dietary diversity, minimum meal frequency and minimum acceptable diet of the children (IYCFP, 2010) guidelines.

Table 13. Complementary feeding practices

Complementary feeding practices among children 6-23 months	Number of children(N)	Mean Percentage
Minimum dietary diversity for children 6-23 months old (N=227).		
Minimum dietary diversity < 4 food groups	77	34
Average		34
Minimum meal frequency for children 6-23 months old:		
2 times for breastfed infants 6-8 months old (N=51)	14	27
3 times for breastfed children 9-23 months old (N=54)	21	39
4 times for non-breastfed children 6-23 months old (N=79)	51	65
Average		58
Minimum acceptable diet for children 6-23 months old		
Breastfed (N= 176)	76	43
Nonbreastfed (N= 51)	19	37
Average		39

3.11.3.1 Minimum dietary diversity

Minimum dietary diversity was determined by getting the proportion of children between 6-23 months who received food from 4 or more food groups in the past 24 hours. The food groups were; cereals and grains, roots and tubers, legumes and nuts, dairy products, flesh foods, eggs, vitamin A rich fruits and vegetables and other fruits and vegetables (WHO, 2008b). The percentage of children who met the minimum dietary diversity was 34%. These put a large percentage 66% at risk of malnutrition and consequently IDA.

3.11.3.2 Minimum meal frequency

Minimum meal frequency from the study was determined by establishing the feeding times as follows; for breastfed children between 6-8 months old 2 times. Increasing to 3 times for breastfed children between 9-23 months old. Non-breastfed children between 6-23 months old were to be fed a minimum of 4 times a day. In all the cases, an additional 1-2 nutritious snacks were to be included. The percentage of children who met the minimum meal frequency was (58%) whereas (42%) did not meet the RDA.

3.11.3.3 Minimum acceptable diet

The minimum acceptable diet was assessed by the proportion of children 6-23 months of age who received minimum dietary diversity and minimum meal frequency 24 hours preceding the study. In this study breastfed and non-breastfed children who met minimum acceptable diet were more than a third (39%)whereas the rest 61% did not meet the minimum acceptable diet. This value was slightly higher than that for KDHS, 2014, which was 21%.This might have been because the present study was only concentrated in Thika District, unlike the KDHS study that covered the whole of Kenya likely to capture more cases of inappropriate complementary feeding.

3.11.4 Amount of nutrients and kilocalories consumed by children 6-23 months old

Food frequency questionnaires and 24-hour recall methods were used to establish the amount of nutrients and kilocalories consumed by the children. The mother /caregivers described the meal and the amounts of foods taken at each meal based on household measures such as cups, plates and spoons. A number of nutrients in the food servings and ingredients was established through the Nutri-survey software (2008).These amounts were compared with the recommended daily allowance (WHO, 2008). The resulting adequacy of kilocalories and selected nutrients consumed per day by the children is shown in (Table 14).

Table 14. Adequacy of kilocalories (Kcal) and consumption of selected nutrients by children 6-23 months old

Nutrients	RDA	Mean(SD) nutrient consumption in 24 hours	Number meeting the RDA	% meeting the RDA
Energy(kcal)	743 kcal	436 ± 14	141	62.1
CHO	95gm	40 ± 8	115	50.7
Vit. A	600μg	445 ± 4	84	37.0
Vitamin C	55μg	43 ± 13	104	45.8
Iron	8mg	5.8 ± 6	145	63.9

SD means standard deviation; RDA means recommended dietary allowance; RDAs were adopted from (WHO, 2008).

Energy is important for physical activity and basal metabolism. Three out of every five children (62.1%) met the RDA for energy from this study with a mean (SD) kilocalorie (kcal) intake being (436 ± 14) against an RDA of (743 Kcal).The mean (SD) carbohydrate intake was below the recommended levels (40 ± 8 grams) against an RDA of (95) grams from the foods they consumed (WHO, 2008).The percentage of children who met vitamin A and vitamin C RDA values were (37%) and (45.8%) respectively. The mean vitamin A and vitamin C intake consumed was far below the recommended levels (445 ± 4) µg and (43±13) µg respectively (Table 14).

More than half of the children (63.9%) met dietary iron requirements, although the mean consumption was below the recommended value (5.8 ± 6) milligrams of iron (Table 14).

Table 15. Relationship between IDA with dietary intake of Iron among the children

Variable	Iron deficiency anaemia						
	No	%	Yes	%	Total	%	Chi-square p=value
Dietary intake of iron rich foods							0.002*
Below 8mg/day	18	23.4	59	76.6	77	34	
8 and above mg /day	63	42	87	58.0	150	66	

Significance at $p<0.05$; * Significant association; Recommended dietary allowance of iron 743Kcal WHO, 2008

Slightly more than two-thirds (66%) of children consumed dietary iron of 8mg/day and above, whereas (34%) consumed dietary iron of less than 8mg/day. Dietary iron intake from iron rich foods had a positive significant association with IDA (chi-square value; p = 0.002).

3.12 Sanitation in the children's homestead.

3.12.1 Rubbish waste disposal

Improper rubbish or waste disposal can result in a favorable environment for the breeding of insects such as mosquitoes. About (73%) of household waste was deposited in the composite pit and (27%) in the open areas of the homestead (Figure 2).

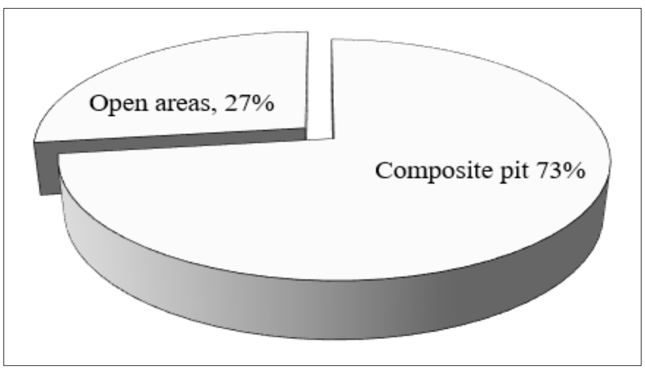

Fig 2 Rubbish waste disposal

3.12.2 Human waste disposal

Excreta is the primary source of diarrheal disease agents which are further transmitted through foods and fluids. Containment of excreta is the best means to prevent diarrhoea disease agents from proliferating and being transmitted (Olack *et al.*, 2013).

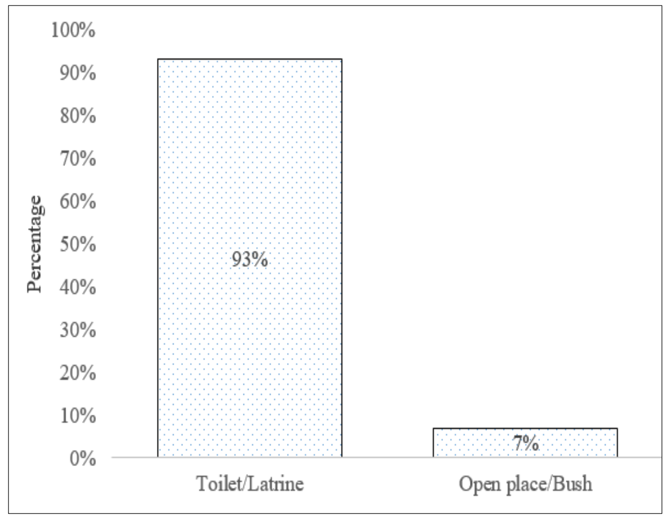

Fig 3: Human waste disposal

The largest proportion of human waste disposal (93%) was done in pit latrines and flush toilets whereas (7%) in other places such as bushes (Figure 3). Disposal in open places from the present study might have exposed the children to zoonoses and hence helminthic infection, in turn, reducing iron absorption that may have resulted in the high prevalence of IDA in the present study.

3.12.3 Presence of stagnant water

About (32.2%) resided close to stagnant water sources, whereas (67.8%) were not near any stagnant water source (Table 16).

Table 16. Relationship between IDA and sanitation practices in the children' homesteads

Variable	Iron deficiency anaemia						Chi-square; p-value
Rubbish waste disposal	No	%	Yes	%	Total	%	0.032*
Composite pit	41	24.7	125	75.3	166	73.1	
In the open near the homestead	16	26.3	45	73.7	61	26.9	
Human waste disposal							<0.000*
Toilet/Latrine	55	26	157	74.0	212	93.4	
Other place	11	73.3	4	26.7	15	6.6	
Presence of stagnant water							<0.000*
Lives near stagnant water	19	26.1	54	73.9	73	32.2	
Lives away from stagnant water	40	26	114	74.0	154	67.8	

*Significance at $p<0.05$ * refers to significant associations; Iron-deficient<11g/dl whereas normal iron levels are ≥ 11g/dl; No indicates the child has no IDA while Yes indicates that the child has IDA; other place refers to bushes.

The study found out that more than 7 households out of every 10 (73.1%) disposed of their rubbish in the composite pit, which was the ideal method of waste disposal, whereas (26.9%) disposed of their rubbish in the open areas near the homesteads. Rubbish waste disposal had a significant positive association (chi-square value; p=0.032) with IDA status of the children.

Not all homes had toilets or pit latrines for disposing of their human waste. (6.6%) homes disposed of human waste in bushes. Human waste disposal seemed to have a positive significant association with IDA (chi-square value; p=<0.000) (Table 16) indicating that children from homes where human waste was disposed in the bushes were more likely to have IDA. About a third of the homes were located close to stagnant water (32.2%). Stagnant was significantly associated with IDA (chi-square value; p=<0.000) (Table 16) thus, children living in homes close to the stagnant water were more likely to have IDA.

3.13 Health condition of the children

More than a quarter (25.6 %) of the children had malaria infection whereas the rest 74.4% were free from malaria. More than three-quarters of the children (94.3%) slept under mosquito nets whereas only (5.7%) failed to sleep under mosquito nets. Children with malaria might have experienced red blood cell destruction by malaria parasites which are a key component in haemoglobin formation. These results agree with the findings by Santana-Morales *et al.*, (2013**)** in Ethiopia however, they are not consistent with findings by Osazuwa, (2010) that failed to establish any link between malaria and anaemia.

Table 17: Health status among the children

Variable	N=227	Percentage
Malaria		
Yes	58	25.6%
No	169	74.4%
Sleeping under a mosquito net		
Yes	214	94.3%
No	13	5.7%
Deworming practice		
Yes	93	40.9%
No	134	59.1%
Helminthic Infestation		
Yes	12	5.3%
No	215	94.7%
Immunized		
Yes	218	96.1%
No	9	3.9%

Less than half of the children (40.9%) were dewormed with the rest (59.9%) not being dewormed. A larger proportion of the children did not have helminthic infection (97.3%). Helminthic infection was evident in less than one-ninth of the children (5.3%). This rate vary with KDHS, (2008) where a much lower value was recorded (4 out of 10 children) received deworming medication.

Assessment of universal immunization is done against the six vaccine-preventable diseases (namely; tuberculosis, diphtheria, whooping cough, tetanus, polio and measles) (UNICEF, 2013) [19]. The majority of children from this study (96.1%) were either totally immunized or immunization compliant (following the immunization schedule) in line with information obtained from child information booklet. Only (3.9 %) of the children were not either fully compliant with the immunization schedule or had not been immunized.

Table 18. Relationship between IDA with health status of the children

			95%		
Variables	**Mean SD in g/dl**	**Odds ratio**	**Lower**	**Upper**	**Chi square; p-Value**
Malaria infection N=227					0.013*****
Yes =58 (25.6%)	7.83 ± 2.4	2.95	0.72	3.22	
Non=169 (74.4%	8.30 ± 2.2	Reference			
Sleeping under mosquito net N=227					0.022*
Yes =214 (94.3%)	8.47 ± 2.6	0.065	0.21	0.96	
No =13(5.7%)	8.13 ± 2.3	Reference			
Deworming practice N=227					0.011*****
Yes =93 (40.1%)	9.60 ± 2.2	0.41	0.18	0.64	
No =134 (59.1%)	7.01 ± 2.3	Reference			
Helminthic Infestation N=227					0.001*****
Yes n=12(5.3%)	8.05 ± 2.2	3.85	0.84	4.12	
No n=215(94.7%)	8.55 ± 2.3	Reference			
Immunized N=227					0.032*
Yes=218 (96.1%)	9.12 ± 2.7	2.98	0.63	3.16	
No= 9 (3.9%)	7.40 ± 2.5	Reference			

Significance at < 0.05; *Refers to significant associations; A child is considered immunized if he/she has received: a BCG vaccination against tuberculosis; three doses of DPTvaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPTand vaccinations against both hepatitis B and Haemophilus influenza type B); at least three doses of polio vaccine; and one dose of measles vaccine. These vaccinations should be received during the first year of life (UNICEF, 2013) [19].

Non-categorical independent variables (malaria infection, sleeping under mosquito nets, deworming practices and helminthic infection) were subjected to binary logistic regression to assess their respective relationships with IDA as the dependent variable. There was a positive significant relationship between malaria and IDA (ODDS Ratio [OR] =2.95, p=0.013), from the study, a child with malaria was 2.95 times more likely to have IDA in comparison to a child without malaria. Children who slept under insecticide-treated mosquito nets (94.3%) had a higher mean HB value (9.57 ± 2.2 g/dl) in comparison to those who did not sleep under insecticide-treated mosquito nets (8.13 ± 2.3g/dl) (Table 18). This meant that sleeping under insecticide-treated mosquito nets gave children protection against iron losses translating to higher HB levels. There was a positive significant association between children who slept under mosquito nets and IDA (chi-square value; p =0.022).

The proportion of children dewormed was a bit higher (40.9%) against those who were not dewormed (59.1%). There was a positive significant association (chi-square value; p =0.011) between the deworming practice and IDA. Children infected with helminthic infection recorded a lower mean value for haemoglobin (8.05 ± 2.2 /dl) while those without helminthic infection had a higher mean value of (8.55 ± 2.3g/dl) (Table 18). There was a significant relationship (chi-square value; p=0.001) between helminthic infection with IDA. Similarly, a significant relationship was observed between immunization with IDA (chi-square value; p=0.032).

4. Conclusion

Determinants of IDA from the study included the age of the child, education, occupation of the caregiver, complementary feeding practices, dietary intake of iron-rich foods, rubbish waste disposal, human waste disposal, the presence of stagnant water, malaria infection, deworming practice, helminthic infection and immunization.

The recommended dietary allowance of iron in the background diet and complementary feeding practices fell below the recommendations. A greater percentage of children consumed non-heme iron sources without iron absorption enhancers such as vitamin C-rich fruits and vegetables which might have resulted in decreased iron bio-availability and consequently low HB levels evident among most children in this study. Heme iron sources such as meat, poultry, fish and eggs considered to be excellent sources of bioavailable iron were the least consumed. A low percentage of children attained the minimum dietary diversity and minimum acceptable diet among children 6-23 months old.

The magnitude of under-nutrition was also high among children 6-23 months old based on weight for age. Sanitation in the area was unsatisfactory; in terms of health, an average proportion of children had malaria and helminthic infection. A child with malaria was 2.95 times at risk of becoming iron-deficient compared to one without malaria. Mean haemoglobin values from the present study was found to be (8.3± 2.3g/dl) whereas the overall IDA prevalence was (73.2%) indicating severe IDA among children attending the well-baby clinic at Thika Level 5 Hospital. Other determinants of IDA from the study included age of the child, education of caregiver, occupation of the caregiver, inappropriate foods, presence of stagnant water, deworming practices and immunization.

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