PREVALENCE OF IRON DEFICIENCY ANAEMIA AND DIETARY IRON INTAKE AMONG INFANTS AGED SIX TO NINE MONTHS IN KEIYO SOUTH SUB COUNTY, KENYA

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ABSTRACT

The increased prevalence of iron deficiency among infants can be attributed to the consumption of an iron deficient diet or a diet that interferes with iron absorption at the critical time of infancy, among other factors. The gradual shift from breast milk to other foods and liquids is a transition period which greatly contributes to iron deficiency anaemia (IDA). The purpose of this research was to assess iron deficiency anaemia among infants aged six to nine months in Keiyo South Sub County. The specific objectives of this study were: to establish the prevalence of infants with iron deficiency anaemia and dietary iron intake among infants aged 6 to 9 months. The cross sectional study design was adopted in this survey. This study was conducted in three health facilities in Keiyo South Sub County. The infants were selected by use of a two stage cluster sampling procedure. Systematic random sampling was then used to select a total of 244 mothers and their infants. Eighty two (82) infants were selected from Kamwosor sub-district hospital and eighty one (81) from both Nyaru and Chepkorio health facilities. Interview schedules, 24-hour dietary recall and food frequency questionnaires were used for collection of dietary iron intake. Biochemical tests were carried out by use of the Hemo-control photochrometer at the health facilities. Infants whose hemoglobin levels were less than 11g/dl were considered anaemic. Further, peripheral blood smears were conducted to ascertain the type of nutritional anaemia. Data was analyzed using the Statistical Package for Social Sciences (SPSS) computer software version 17, 2009. Dietary iron intake was analyzed using the NutriSurvey 2007 computer software. Results indicated that the mean hemoglobin values were 11.3 ± 0.84 g/dl. Twenty one percent (21.7%) of the infants had anaemia and further 100% of peripheral blood smears indicated iron deficiency anaemia. Dietary iron intake was a predictor of iron deficiency anaemia in this study (t=-3.138; p=0.01). Iron deficiency anaemia was evident among infants in Keiyo South Sub County. The Ministry of Health should formulate and implement policies on screening for anaemia and ensure intensive nutrition education on iron rich diets during child welfare clinics.

Key words: Iron, Deficiency, Anaemia, Dietary, Infants, Six, Nine, Screening

INTRODUCTION

The gradual shift from breast milk to other foods and liquids is a transition period that has been recommended by the World Health Organization (WHO) to commence at six months of age through the age of two years or more [1]. Complementary feeding involves incorporating nutrient rich foods and liquids in the diets of infants along with continued breastfeeding. The most common complementary foods given to infants aged 6-11 months in Kenya are milk products (57.8%), foods made from grains (81%), fruits and vegetables (30.2%) and protein rich foods (13.1%) [2]. Staple foods commonly fed to infants are porridge or *ugali* made from maize, millet and sorghum. Non-cereal staples are potatoes, cassava and plantain. Various fruits and vegetables are also served to infants [3]. The type of complementary foods fed to infants and children, not only affect growth patterns, but also iron status and that of other micronutrients. Anaemia is one of the widespread public health problems in the world. The WHO estimates the number of anaemic people worldwide to be 3.5 billion. Iron deficiency is ranked at the top of three global "hidden hungers" (Iron, Iodine and Vitamin A: sub clinical deficiency without visible signs of deficiency) with about one fifth of the world's population suffering from Iron Deficiency Anemia (IDA) [4]. Iron deficiency anaemia is an advanced stage of iron depletion. In Asia, the prevalence of anaemia has been documented to be between 20-29%, in Europe 12%, Africa 39%, in Kenya 89% and the lake basin region 91% [5]. The prevalence of anaemia has been used as a proxy for IDA [6], but it should be kept in mind that only approximately 50% of all types of anaemia can be attributed to iron deficiency. At various health facilities within Keiyo South District, over 50 cases of severe anaemia among 843 children under five years of age attending Child Welfare Clinics between July 2010 to December 2010 were reported [7].

Iron deficiency anaemia can lead to diminished cognitive function, changes in behaviour, delayed infant growth, decreased exercise tolerance and impaired immune function [8, 9]. The clinical signs of severe or prolonged deficiency include swollen tongue, spoon-shaped brittle nails and splits or sores in the corners of the mouth. In severe cases anaemia can cause heart failure. A deficiency of iron limits oxygen delivery to cells resulting in fatigue and poor work performance [10,11,12]. An impaired capacity to maintain body temperature in a cold environment is another consequence of iron deficiency anaemia [13].

Lethargy, irritability, and the inability to concentrate are the mild symptoms. These symptoms are followed by psychomotor and cognitive impaired skills. This causes shortened attention spans and may impair learning. Even the slightest case of iron deficiency anaemia, before noticeable symptoms, can slow cognitive development.

The purpose of this research, therefore, was to assess the prevalence of iron deficiency anaemia and dietary iron intake among infants aged six to nine months in Keiyo South Sub County, Kenya.

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METHODOLOGY

Research design
The cross sectional study design was adopted. This study was conducted one point in time [14]. No follow up on the subjects to collect more data took place.

Sampling technique
Data for this cross sectional study was collected at three health facilities in Metkei and Chepkorio divisions situated in the highlands of Keiyo South Sub County. These divisions were selected because they are both located in the valley and have the same climatic conditions and food security situations. A simple random sampling was done to select three health facilities: Kamwosor Sub County hospital, Nyaru dispensary and Chepkorio health centre of the 20 present in the highlands of Keiyo South Sub County [14].

Systematic sampling was used to select infants who had met the inclusion criteria. All infants 6 to 9 months were identified by their age on immunization cards, and listed from the clinic registers. By 9 months, anaemia is evident if inappropriate feeding practices are employed [8]. All the names of the infants were listed as per next date of visit to the clinic. It was decided to select every 5th child by dividing the desired sample size of 244 calculated by Fishers formula by a total of 1207 infants in all the registers of the three health facilities. Simple random sampling to select the starting point was done, and every 5th child from the register was selected. Eighty two (82) infants were selected from Kamwosor Sub County hospital, eighty one (81) from Nyaru and the same number from Chepkorio health facilities, giving a total of 244 respondents.

Data collection
Research assistants were trained for one week on the use of the questionnaire to ensure accuracy, where questions were explained to them. A pilot study, using 10% (n=25) of the subjects to ensure validity and reliability of the instruments, was conducted in Flax health facility. From the pilot study, the common foods consumed were listed, which aided in the proper preparation of the food frequency questionnaire.

Hemo Control Photochrometer was properly checked before use to ensure that it was not faulty. Proper adjustment after each measurement was ensured to prevent errors. The Research assistants were re-trained for three days on the adjustments needed for the specific measurement taking in the actual study.

Primary data were collected by use of interview schedules administered to mothers of the infants. To ensure accuracy, interpretation of questions and translation to Kiswahili or vernacular language was done. Interview schedules generated data on the socio demographic characteristics of the mothers' age, parity, religion, level of education, marital status income

and source of fuel, and on complementary feeding practices which generated quantitative data.

A 24- hour recall and food frequency questionnaire generated data on dietary iron intake from the complementary foods. This was done by having a common calibrated bottle and a cup, which were used to estimate the amount of liquid foods. A tablespoon and a teaspoon were used to estimate mashed foods. This gave a rough estimate from pre weighed standard containers. The mother was asked the type of foods consumed, ingredients, method of preparation and how many times it was consumed per day. Once the quantities were established, the amounts were converted to measurements of dietary iron intake in milligrams contained in the foods by use of the NutriSurvey (2007) software. These were entered into SPSS version 17 to calculate the means and percentage RDA (Recommended Daily Allowance) obtained. Qualitative food frequency questionnaires were also administered to establish the frequency of consumption of iron rich foods in the past one month. Recommended standard procedures were used to carry out the hemoglobin test. The reason why the procedure was to be carried out was explained to the mother. After the mother gave consent, blood samples were then collected by finger prick to measure haemoglobin (Hb) using the Hemo Control Photochrometer (EKF diagnostic) as follows: first, the hand and finger of the subject were rubbed to stimulate blood flow, after which the fingertip was cleaned with alcohol swab. The fingertip was then air-dried before being pricked with a sterile lancet. The first drop of blood that appeared was wiped away using a cotton swab; the second drop was then collected into microcuvette. When the microcuvette was full, any spilled blood was carefully wiped away using a cotton swab from its edges before inserting it into the Hemo Control Photometer device. All the used up items were safely disposed into a safety box [15]. The cut-off points used for anaemia classification are indicated in Table 1.

Ethical Clearance
This research was approved by the Institute of Research and Ethics Committee (IREC), Moi University. Permission to carry out the study was also granted by the Keiyo South Sub County Commissioner and the Sub County Medical Officer of Health (SCMOH) Keiyo South sub-county. Consent from the mothers to participate in the study was done by requesting participants to sign a consent form. Code numbers were used to identify candidates and blood samples; hence, confidentiality was maintained throughout the study.

Data Analysis
Information on the questionnaires was edited to reduce errors. Coding and ordering were done, that is assigning numerical or other symbols to answers so that responses were put into a limited number of categories or classes. Classification of attributes was done. The dependent variable was anaemia using the hemoglobin levels. The independent variables were: socio demographic characteristic and dietary iron intake.

Data was entered into a computer and analyzed using the SPSS version 17, for means, frequencies and cross tabulations. Univariate analysis was carried out to determine the proportion of infants who were anaemic. Bivariate analysis specifically by Pearson's chi-square was used to show the relationship between socio-demographic characteristics and iron deficiency anaemia. Multiple linear regressions to show predictions between the dependent variable and all the independent variables were carried out.

RESULTS

Anaemia and IDA

From the results of this study, anaemia cases (Hb 10-10.9, and 7-9.9) were 53 (21.7%). The mean hemoglobin value was 11.3 g/dl± 0.84, range 8.0g/dl to 14.1g/dl. Thereafter, those who were anaemic were screened for iron deficiency anaemia. When the peripheral blood smear was observed under the microscope, the blood cells were all microcytic, hypochromic, and showing poikilocytosis and ankylocytosis without neutropenia. These were distinct characteristics of iron deficiency, eliminating other forms of anaemia (Table 1).

Dietary iron intake
Thirty three (33) respondents (14.3%) (Table 2) consumed above the recommended 11 mg/day, the mean dietary iron intake was 8.3±1.90mg/day. A sample t-test confirmed that there was a statistically significant p (< 0.05) difference (p=0.000) in mean dietary iron from the RDA (Recommended Dietary Allowance) of 11. The mean deviation was -2.611mg.

Frequency of consumption of iron rich foods
Results from the food frequency questionnaire in this study indicate that animal sources of iron which are the best sources of iron were rarely consumed; liver and fish were taken less frequently within the week as none of the infants consumed them more than two times a week. Six percent (6.2%) of the infants frequently consumed beef 5-6 times per week. However, the majority 125 (51.2%) consumed beef less frequently (1-3 times) per month. Eggs were consumed more frequently (5-6 times) per week by 116 (47.5%) of the infants. Green leafy vegetables were eaten by more than one third (98) (40.1%) of infants once a week. Lentils and peas were, however, not popular, being consumed 5-6 times a week as a complementary food for infants. Bread was eaten daily by the infants (92) (37.8%). In addition, rice was taken 2-4 times per week by 156 (63.9%) of the infants. Maize products like *ugali* and maize porridge was taken daily by half (124) (50.8%) of the infants. Millet and sorghum porridge were taken by all the infants daily.

Relationship of IDA with complementary feeding practices
Dietary iron intake had a significant relationship (p<0.05) with IDA (p = 0.002). The factor which was a predictor of IDA in this study was dietary iron intake (t =-3.138; p= 0.01).

DISCUSSION

Prevalence of anaemia and IDA

This study showed that the prevalence of anaemia was 21.7%. In Africa, the general prevalence is at 39%. According to the survey conducted by the government and UNICEF in Kenya, 89% of the children under 6 years were anaemic. Prevalence was as high as 91% in the Lake Basin region [5]. This is slightly higher due to age characterization and the sample size used. The prevalence in this particular study is higher as compared to prevalence of 9.4% anaemia in a study conducted among European children [12].The differences could be attributed to geographical conditions, age categorization and underlying causes of the disease. Anaemia is the advanced stage of iron depletion, with the first stage being reduction of iron stores, iron depletion without anaemia, then anaemia. It is possible that the prevalence of iron deficiency could be higher than the 21.7% of anaemia if further biochemical tests were conducted.

Regarding dietary iron intake, findings from this study indicate that 14.3% of the sample consumed above 11mg/day. These findings are similar to findings from a National Nursing Home Survey (NNHS) study in the USA, which was conducted in 1992-1993 confirming that iron intakes were low. This was the only mineral for which dietary supplementation did make a useful contribution generally. However, iron bioavailability is usually fairly low. In one survey it was found that iron intake fell from late infancy until two years of age [16].

The frequency of the iron rich foods consumed was minimal, on average thrice per week. Best sources of iron like fish and beef were less frequently consumed. This is attributed to the fact that these foods might be costly and other best sources readily available like chicken were more frequently consumed. The good sources were beans and vegetables like spinach; however, millet porridge and maize porridge had low iron content. Findings in this study are consistent with the Kenya Demographic Health Survey (KDHS) [2], which showed that13.1% and 18.2% of infants 6-8 months and 9-11 months, respectively, were consuming iron rich foods. Low intakes of iron during infancy can cause iron deficiency and even anaemia and hence great emphasis should be put during this period when iron needs are high.

From this study, foods which inhibit iron absorption such as tea and non-soaked legumes were also consumed. Studies in Adelaide and England have confirmed that the low bio-available iron contained in wheat bran which has high phytate content that inhibits iron absorption was absorbed by 80% of the total number of infants by 12 months [17]. In the present study, cow's milk was taken by 45.9% of the infants as the first complementary food. This is similar to findings from the study in Adelaide whereby as breast and formula-feeding stopped or decreased, cow's milk, which has a dose-related inhibitory effect on iron [17], became the main drink for more than 60% of infants after 6 months. This is similar to a

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study by Naanyu [3] where generally, mothers introduced complementary foods earlier than the recommended 6 months with a mean age of 2.4 months. This is attributed to the fact that the mothers had to go to work and attend to other duties, hence spend less time breastfeeding. However, the mean age of introduction of complementary foods from the results of this study was 1.6 months. This was contrary to the study by Naanyu [3] where the mean time for introducing complementary foods was 2.4 months. The reasons for this difference were probably because the sample size of 1,121 was large compared to this study where 244 was the sample size. In addition, the age group considered by Naanyu [3] was less than twenty four months, whereas in the present study the age group was six to nine months.

Termination or reduced breastfeeding can result in infants not getting all nutrients for proper growth [18,19]. Given the high cost of commercial weaning foods, lack of sufficient knowledge in preparing a well-balanced diet from limited foods can lead to malnutrition [20]. Therefore, the early introduction of iron rich foods can cause essential nutrients obtained from breast milk to be missed out, leading to IDA. At the same time, late introduction of complementary foods can lead to IDA because iron quantities in breast milk are inadequate.

From 6 months, foods fortified with iron should be encouraged for term babies. The iron status of pre-term babies should be monitored and, iron supplementation should be provided when needed. Results from this study show that nearly all the mothers (97.5%) were still breastfeeding along with complementary feeding. A few mothers had stopped breastfeeding probably because they had a lactation failure, not enough milk, engorged breasts, sore nipples, sickness and a busy employment schedule which involved traveling [21]. Such possibilities have been proven from studies in Nigeria where complementary foods are introduced due to perceived lactation inefficiency [21, 22]. However, mothers in developing countries introduce complementary feeding for many reasons. In Nigeria few infants are exclusively breastfed but instead they are given alternative feeds like water, formula and herbal tea from an early age [21]. In a Malawian study, only 19% of the infants in a cohort of 720 were exclusively breastfed for the first six months in their first year of life [22]. Exclusive breastfeeding is considered 'risky', hence supplementary water herbal infusions are believed to enhance growth, quench thirst, and serve as food and medicine [23]. In addition, it is a mother's perception that breastfeeding is 'physically draining' especially when lactating mothers find limited access to nutritious and adequate amount of food for themselves [21]. Some of the Indian communities believe infants need additional fluids to maintain body-water balance [24], while in Honduras solid foods are introduced early in order to extend the time between feeds and because mothers believe breast feeding to be time demanding [25]. In the United Kingdom, early introduction of complementary foods was because the babies were hungry and not satisfied with breast milk alone [26].

In the present study, a third of the mothers (35.2%) intended to breastfeed up to 2 years of age. Breastfeeding is ideal for 2 years as it contributes to proper growth and development of the child. More than half of the mothers (54.5%) were aware of the right time to introduce

iron rich foods. Most (47.5%) of the mothers believed that the ideal time of introduction of the foods was at 4 months of age.

Nearly half of the mothers (45.9%) in the present study fed infants on fresh cow's milk. This is consistent with other studies conducted in Australia and Asia [27]. However, as recommended, cow's milk should be avoided in the first year of life as it causes intestinal bleeding and hinders iron absorption from foods [10]. Children who take fresh cow's milk for long become anaemic ultimately and, therefore, fermented milk should be given instead because it is better digested and tolerated by the infants as the low pH in it increases the absorption of iron [28]. If legumes are not soaked properly before cooking they contain phytates and anti-protease enzyme, which are anti-digestive factors and will hinder iron absorption and utilization [26]. Findings from this study showed that non-soaked legumes were some of the first complementary foods introduced. A few (13.5%) of the mothers had introduced infant formula, especially the working class women. Foods affecting iron bioavailability include maize and millet porridge, which if not fermented can contain iron inhibitors. Other foods affecting iron absorption which were given in the last 24 hours were citrus fruits, vegetables puree and breakfast cereals. Iron rich complementary foods were not adequately provided to the infants. This might pose a risk of the infants being iron deficient and hence anaemic.

CONCLUSION

Iron deficiency anaemia was evident and the most common form of nutritional anaemia among infants in Keiyo South Sub County. It was concluded that anaemia could be used as a proxy of IDA in this population. Dietary iron intake was lower than the recommended RDA of 11mg/day. Rich heme and non-heme sources of iron were infrequently consumed by the infants, and hence low dietary iron intake was likely a major contributing factor to IDA.

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Table 1: Prevalence of anaemia among infants aged nine to six months in Keiyo South Sub County, Kenya

Classification of anaemia	Values of haemoglobin (g/dl)	Frequencies	Percentages
Normal	Over 11	191	78.2
Mild	10-10.9	47	19.3
Moderate	7-9.9	6	2.5
Severe	Below 7	0	0

Key: g/dl: grams per deciliter

Table 2: Dietary iron intake in mg/day

Iron intake (mg/day)	Frequency	Percentage
Below 7	84	34.8
7.1- 10.9	127	50.9
11 and above	33	14.3

Key: Mg/day-milligrams per day

Table 3: Relationship of IDA with complementary feeding practices

Variable	Frequency (IDA)	Frequency (No IDA)	Total n=244	%	χ^2	df	p
Time of foods introduction					5.582	2	0.061
0-3 months	24	86	110	45.1			
4-6 months	17	84	101	41.4			
After 6 months	12	21	33	13.5			
Breastfeeding status					1.330	1	0.249
Yes	52	180	232	95.1			
No	1	11	12	4.9			
Intended duration of breastfeeding					3.662	3	0.454
Not breastfeeding	1	39	40	16.4			
Less than 1 year	10	46	56	23			
1-1.5 years	15	64	79	32.4			
1.6-2 years	22	31	53	21.7			
Over 2 years	5	11	16	6.5			
Iron rich foods introduced					1.643	1	0.200
Yes	90	43	133	54.5			
No	35	76	111	44.5			
Foods affecting iron absorption					3.721	5	0.590
Tea	13	33	46	18.9			
Milk	20	92	112	45.9			
Legumes	4	10	14	5.7			
Formula	8	25	33	13.5			
Porridge	3	18	21	8.6			
Others	5	13	18	7.4			

p< 0.05 significant   IDA: Iron deficiency anaemia Df-degrees of freedom p-p value

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