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Non Dietary Factors Associated with Iron Deficiency Anemia among Infants Aged Six to Nine Months in Keiyo South Sub County Kenya

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Abstract: ***Infants have enough iron stores to last 4 to 6 months of age, which are thereafter replenished. The specific objectives of the study were to establish the prevalence of iron deficiency anemia and to determine factors associated with iron deficiency anemia among infants aged 6 to 9 months. A cross sectional study design was adopted in this survey. This study was conducted in three health facilities selected using a two stage cluster sampling procedure. The Systematic random sampling procedure was then used to select 244 mothers and their infants. Interview schedules and biochemical tests were used to generate data. The Hemo-control photochrometer was used to determine the levels of anemia and further peripheral blood smears were conducted to ascertain the type of nutritional anemia. The results indicated that the mean hemoglobin values were 11.3± 0.84 g/dl. The infants who had anemia were 21.7% and further all peripheral blood smears indicated iron deficiency anemia. Results indicated that the non dietary factors which were predictors of iron deficiency anemia in this study were; poor waste disposal (t=3.005; p=0.03), available fuel (t=-2.870; p=0.04), hygienic hand washing (t=-2.000, p=0.047). It was concluded that IDA was evident among infants and application of specific strategies to address respective causative factors towards prevention of anemia was recommended.***

Keywords: Iron, Deficiency, Anemia, Factors, Infants

1. Introduction

Infants have enough iron stores enough for 4 to 6 months of age, which are then replenished. In humans, iron is an essential component of proteins involved in oxygen transport [1]. It is also essential for the regulation of cell growth and differentiation [2]. Almost two-thirds of iron in the body is found in hemoglobin, the protein in red blood cells that carries oxygen to tissues. Smaller amounts of iron are found in myoglobin, a protein that helps supply oxygen to muscle, and in enzymes that assist biochemical reactions. Iron is also found in proteins that store iron for future needs and that transport iron in blood. Iron stores are regulated by intestinal iron absorption [3,4].

Many non dietary factors have been associated with iron deficiency anemia among infants which include: loss of blood from the intestinal tract as a result of various gastrointestinal disorders e.g. inflammatory bowel disease, milk protein allergy, celiac disease [5]. The prevalence of iron deficiency anemia has declined over the past decades but children that are at increased risk include those from low socioeconomic status, aboriginal children and infants with low birth weight

Malnutrition and infections are intertwined in the malnutrition infection cycle. Hence hygienic status in handling complementary foods and unclean water cannot be assumed. Inhygienic conditions are a major cause of diarrhoea. Likewise, gastrointestinal disorders that result in inflammation of the small intestine may result in diarrhea coupled with iron losses, poor absorption of dietary iron, and iron depletion [6]. The purpose of this research was to assess non dietary factors associated with iron deficiency anemia among infants aged six to nine months in Keiyo south sub county, Kenya.

2. Literature Survey

2.1 Anemia

Anemia is a condition that results in low of hemoglobin levels (Hb); below that is considered to be normal for specific demographic groups. In clinical terms anemia is insufficient mass of red blood cells circulating in the blood; whereas in public health terms anemia is defined as a low haemoglobin concentration in blood.

Growth and illness also affect Hb concentration. Total body iron, the sum of circulating iron, iron in myoglobin, and the quantity of storage iron is closely related to the body weight of the infant. Consequently, the need for iron in infancy is related to growth. Low Hb concentrations can also be caused by chronic infections and inflammations [7]. Certain infections, like malaria, hookworm, *trichuriasis*, *amoebiasis*, and *schistosomiasis* both vesical and intestinal forms cause blood loss directly from the body which contributes to anemia. Certain genetic factors, e.g. thalassemia, sickle cell trait, and glucose-6-phosphate dehydrogenase deficiency (G6PD) also cause anemia. A primary decline in hemoglobin concentration during the first 2 months of life can occur and a secondary decline between 8 and 10 months of life. The primary decrease may be related to suppression of the bone marrow as a result of the increased oxygenation of the blood after birth. The secondary decrease is probably related to iron deficiency [8]. Infants are therefore more vulnerable to iron

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deficiency anemia and it is quite vital to incorporate mhhfeasures towards prevention of occurrence of iron deficiency anemia.

2.2 Iron Deficiency Anemia

The most common cause of iron deficiency anemia in infants and children and is due to the inadequate supply of iron in the diet as the first 6 months of age iron stores are dependent on the iron stores during pregnancy which are start replenishing as from the 4th month. However other factors are also associated with IDA are: due to the possible low stores of iron during pregnancy, low birth weight or premature infants are particularly vulnerable to IDA.

The major changes that occur due to iron deficiency anemia are behavioural, cognitive and psychomotor deficits and decreased immune function. Behaviors such as lethargy, irritability, and the inability to concentrate are symptoms. This causes shortened attention span and may impair learning. Even the slightest case of iron deficiency anemia, before noticeable symptoms, can slow cognitive development. Most studies have evaluated infants between six months and 2 years of age using the Bayley scale of infant development, a test to evaluate sensory development, fine gross motor skills and language development. By this standard infants who are mildly iron deficient have a statistically significant decrease in responsiveness, activity, attentiveness and have increased body tension, fearfulness tendency to fatigue [9]. Another important finding is that even infants with very mild iron deficiency anemia, or simply with early evidence of impaired hemoglobin production, do not score as well as infants with no laboratory evidence of iron deficiency or evidence merely of depleted iron stores [10].

Research shows that iron deficiency anemia leads to decreased immune functions. Iron deficient children have abnormalities in lymphocytes and neutrophils. Iron deficiency anemia and infections are both common in poor populations, and have a cause-and-effect relationship [11] Iron-deficient individuals absorb increased amounts of lead and elevated blood concentrations have been observed among some children with laboratory evidence of iron deficiency, hence a tendency to develop lead poisoning [11]. Children that have recurrent infections should be tested for anemia. The symptoms of severe or prolonged anemia are failure to thrive, swollen tongue, spoon-shaped brittle nails and splits or sores in the corners of the mouth. The severest case can cause heart failure. A deficiency of iron limits oxygen delivery to cells, resulting in fatigue, poor work performance, and decreased immunity [1,12,13]. An impaired capacity to maintain body temperature in a cold environment is another consequence of iron deficiency anemia [14].

2.3 Consequences of Poor Hygiene

Contaminated weaning foods may lead to food borne diseases that can cause severe and long-lasting damage to health, including acute, watery and bloody diarrhoea (leading to severe dehydration or ulceration), meningitis, as well as chronic diseases affecting the renal, articular, cardiovascular, respiratory, and immune systems [15,16,17]. Archer reported in a study that about 2% of adults infected with an arthritogenic strain of *Salmonella spp.* may consequently suffer from reactive arthritis [15]. A proportion of patients especially children, who are affected by enterohaemorrhagic *E. coli* can develop haemolytic uraemic syndrome (HUS), which is characterized by acute renal failure [18]. However, the most serious implications of food borne infections are their effects on nutritional status.

A food borne disease can lead to a reduction in food intake owing to anorexia. In addition, in certain cultures parents may also contribute to a reduction in their child's food intake by withholding or substituting certain foods during illness [19]. A poor food intake, aggravated by loss of nutrients from vomiting, diarrhoea, malabsorption and fever over an extended period, leads to nutritional deficiencies with serious consequences for the growth and immune system of the infants and children. Thus, an infant whose resistance is suppressed becomes vulnerable to other diseases (including respiratory infections) and is subsequently caught in a vicious cycle of malnutrition and infection

3. Methodology

3.1 Research Design

The cross-sectional study design was adopted. This study was conducted one point in time [20]. No follow up on the subjects to collect more data took place.

3.2 Sampling technique

Data 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, have the same climatic conditions, and the food security situation. A two-stage cluster sampling was used [20] where in the first stage, twenty (20) health facilities within the highlands of Keiyo South Sub county formed the main cluster. From these, a simple random sampling was done to select three health facilities; Kamwosor Sub- Sub County hospital, Nyaru dispensary and Chepkorio health centre.

Systematic random sampling was used to select infants who had met the inclusion criteria in infants 6 to 9 months were identified by their age on immunization cards, and listed from the clinic registers. These infants aged 6 to 9 months were selected because at 6 months, iron stores the baby was born with have been used up from the body reserves. By 9 months, anemia is evident if factors affecting iron availability are present . All the names of the infants were listed as per next date of visit to the clinic. To select the starting point from the simple random table, at an interval of every 5th child which was selected by dividing the sample size by a total of 1207 infants in all the three health facilities' registers. 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 and eighty one (81) from both Nyaru and Chepkorio health facilities. This was done until a total of 244 respondents was attained.

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3.3 Data Collection

Research assistants were trained for one week on the use of the questionnaire to ensure accuracy, where questions were explained to them and entries made. A pilot study was conducted in Flax health facility, using 10% (n=25) of the subjects to ensure validity and reliability of the instruments. Questions which could contribute towards generation of valid data were included after the pilot study. Hemo_Control Photochrometer was properly checked before use to ensure that it was not faulty. Proper adjustment after one measurement was ensured to prevent errors. The research assistants were re-trained for three days on the changes that had occurred on the instruments. All this was done to ensure reliability and validity of results. The pilot study ensured accuracy on the data collection process and hence better results .Finally, the tools were made familiar and easier to use to for both the researcher and the research assistants. Then the actual data collection commenced.

3.4 Actual data collection

Primary data was collected by use of interview schedules, administered to mothers of the infants. To ensure accuracy, interpretation of questions and translation to Kiswahili for vernacular language was done. Interview schedules generated data on the socio demographic characteristics of the mothers; mothers' age, parity, religion, level of education, marital status income and source of fuel, sanitation factors, health care factors which generated qualitative data.

Biochemical methods were used to determine the prevalence of anemia. 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 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 dried in the air 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. The finger was then squeezed to obtain blood. 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 awaiting disposal [21].

3.5 Ethical Clearance

This research was approved by the Institute of Research and Ethics Committee, (IREC), Moi University. Permission to carry out this 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 and hence confidentiality was maintained throughout the study.

3.6 Data Analysis

Information on the questionnaires was edited for any wrong entries to reduce errors and omissions. Coding and ordering, 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 anemia (i.e. hemoglobin levels). The independent variables were: sanitation factors, health factors and socio demographic factor.

Data was entered into a computer and analyzed using the SPSS version 17, 2009 for means, frequencies and cross tabulations. Univariate analysis was carried out to determine to the proportion of infants who were anemic. Bivariate analysis specifically by Pearson's chi-square to show the relationship between the various factors and iron deficiency anemia was used. Multiple linear regressions to show predictions between the dependent variable and all the independent variables were carried out.

4. Results

4.1 Anemia and IDA

Results regarding proportion of infants with IDA were as follows (Table 1).

Table 1: Prevalence of anemia in infants

Classification of anemia	*Values (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

g/dl: grams per deciliter

Anemia cases (Hb 10-10.9, and 7-9.9) were 53 infants. The prevalence of those who were positively screened for iron deficiency anemia was therefore 21.7%.The mean hemoglobin values were 11.3 g/dl± 0.84 while 14.1g/dl was the maximum haemoglobin (Hb) and the minimum 8.0g/dl. Therefore and equal percentage (21.7%) of those who were anemic were positively screened for iron deficiency anemia.

4.2 Factors associated with IDA

4.2.1 Socio-demographic factors and IDA

The socio-demographic characteristics of the respondents, which consisted of some basic causes of IDA, were investigated and results consisting of frequencies and percentages were presented as shown in Table 1. The findings from this study show that the age of mothers ranged from 16 to 40 years with the mean age being 30.25 ± 7.45 years (Table 2). The mothers who were below the age of 20 were 14.3%, whereas slightly more than

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Table 2: Socio-Demographic Factors

Variable	*Frequency*	*Percentage*
Age of mother (years)		
Below 20	35	14.3
21-30	83	34.0
31-40	126	51.7
Number of children in family		
1-3	148	42.2
4-6	91	37.3
Above 6	50	20.5
Age of child(months)		
6	72	29.5
7	47	19.3
8	21	8.6
9	104	42.6
Sex of Child		
Male	119	48.8
Female	125	51.2
Mothers religion		
Catholic	108	44.2
Prptestant	129	52.9
Muslim	7	2.9
Marital Status		
Married	157	64.3
Single	86	35.2
Divorced/seperated	1	0.4
Level of education		
None	6	2.5
Primary	71	29.2
Secondary	74	30.3
College	58	23.8
University	35	14.3

Nearly half (42.6%) of the infants were 9 months old, with the least number of the infants (8.6%) being aged 8 months. The mean age of the infants was 7.64 ± 1.29 months. Female infants were more (51.2%) than the male infants who were (48.8%). Mothers who were Catholics were 44.3% while those who were Muslims were merely 2.9%.

4.2.2 Relationship of IDA with various factors

Sex of the infants had no significant relationship (χ^2 =0.447; df=1; p=0.504) with IDA (Table 3). Marital status ($\chi^{2=}$ 3.827; df=2; p=0.418) had no significant relationship with IDA. Education had no significant relationship (χ^2=9.133; df=4; p=0.158) with IDA (p < 0.05). Religion, sex of the child, marital status, education and income had no significant relationship with IDA status as per findings from this study.

Table 3: Relationship of IDA with various factors

Variable	χ^2	*df*	*p*
Socio-demographic factors			
Religion	3.049	2	0.2018
Sex	0.447	1	0.504
Marital Status	3.827	2	0.148
Education	9.133	4	0.058
Income	6.419	4	0.170
Health care factors			
Iron supplementation	0.0080	1	0.778
Maternal anemia	1.323	1	0.205
Illness	2.344	1	0.126
Health seeking behavior	3.067	2	0.216
Sanitation			
Water Source	4.207	3	0.240
Water treatment	2.438	1	0.118
Toilet Possesion	0.463	1	0.496
Storage of foods	3.689	2	0.158

P<0.05 Significant

Iron supplementation had no significant relationship (χ^2, =0.008; df=5; p=0.778), with IDA. Illness had no statistically significant relationship (p<0.05) with IDA (χ^2=2.344; df=1; p=0.126). The null hypothesis which states that: *Ho*= Illness in the past two weeks as an immediate cause has no significant relationship with IDA, was therefore accepted. Therefore illness had no significant relationship with IDA in this study (Table 3)

Table 4: Factors with a significant relationship with IDA

Variable	χ^2	*df*	*p*
Age of mother	60.32	24	0.000
Number of children	10.02	2	0.007
Age of child	14.64	0	0.002
Occupation	11.73	4	0.019
Source of fuel	14.24	3	0.003
Hand washing	4.796	1	0.0029
Waste disposal	9.858	1	0.0029
Storage of utensils	9.219	3	0.027

4.3 Factors with a significant relationship with IDA

Results from this study (Table 4) indicate that the age of the mother had a significant relationship (χ^2 =0.325; df; p=0.000) with IDA. Other factors with a significant relationship (p < 0.05) were the number of children, age of the child, occupation source of fuel, sanitation and dietary factors. Hand washing using soap had the strongest statistical relationship with IDA (χ^2= 4.796; df= 1; p =0.029.)

4.3.1 Factors predicting IDA

The variables which showed a significant relationship with IDA (i.e. age of the mother, number of children in the family, age of the child, occupation ,hygiene hand washing practices using soap, storage of utensils, compost pits, and iron intake) following Chi-square tests were further fitted into linear stepwise logistic regression model. This was to establish the factors which predicted IDA in this particular study. The best fit model chosen had r=0.361 which showed a difference between the predicted and observed variables. The R^2 was 0.130 which meant that there was a less error of unexplained variance which demonstrated a better prediction hence the best fit model.

The adjusted R^2 was 0.116 and the Standard error of estimate was 0.38.

Table 5: Factors predicting IDA

Variable	*Beta*	*t*	*p*
Constant		13.559	0.00*
Waste disposal	0.185	3.005	0.03*
Fuel use	-0.173	-2.870	0.04*
Hygiene handwashing	-0.122	-2.000	0.047*
Age of the mother	0.103	1.683	0.094
Number of children	0.046	0.751	0.454
Age of child	0.062	0.964	0.336
Occupation	0.042	0.594	0.553
Storage of utensils	0.019	0.312	0.755
r= 0.3061 R^2 =0.116 SE= 0.38 R^2 Adjusted= 0.116			

*** p< 0.05 significant**

Table 5 shows that the factors which were predictors of IDA in this study were: iron intake (t =-3.138; p= 0.01), proper waste disposal (t =3.005; p =0.03), available fuel (t=-2.870;

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p=0.04), hygiene hand washing (t=-2.000; p=0.047). Only waste disposal was a positive predictor .On the other hand, availability of fuel and inappropriate hygiene practices like hand washing without soap predicted negatively.

5. Discussion

In this particular study the prevalence of anemia was 21.7%. In Africa, the general prevalence of IDA is at 39%. According to the survey conducted by the government and UNICEF (1999) in Kenya, 89% of the children under 6 years were anemic. Prevalence was as high as 91% in the Lake basin region [22]. This is slightly higher due to age characterization and the sample size used. The prevalence was found to be lower than the overall prevalence of anemia which was 9.4% in a study conducted among European children [23]. The differences could be attributed to geographical conditions, age categorization and underlying causes of the disease. Anemia is the advanced stage of iron depletion, with the first stage being reduction of iron stores, iron depletion without anemia, then anemia. It is possible that the prevalence of iron deficiency could be higher than the 21.7% of anemia if further biochemical tests were conducted.

About one- third (30.3%) of the mothers had attained secondary school education. Mother's education can imply that most of them were not aware of the right iron-rich foods to include in their infants diets, foods to avoid because of the low iron content and the frequency of feeding. One of dire consequences of illiteracy being not applying the nutrition education they've been taught. However in this particular study, education had no significant relationship with IDA. This is contrary to most studies in Kenya which state that maternal education has a significant relationship with the child's nutritional status [22,24,25]. This might be attributed to the fact that in this study only 2.5% of the mothers had no formal education. In addition, mothers could have received informal education due to proximity to urban areas regarding prevention of IDA. This could have been through trainings conducted through community based organizations and nutrition education by various other stakeholders in nutrition and health.

The results of this study show that there was a large percentage (42.6%) of infants aged 9 months. This could be due to the fact at 6 months; children visit the clinic for vitamin A supplementation while at 7 and 8 months only growth and monitoring is conducted hence most of the mothers do not attend. At 9 months children are brought in for measles vaccination. By 7 months of age IDA was evident, with the peak being at 9 months. Age of the child had a significant relationship with IDA. This is consistent with studies that state that by 9-12 months, anemia is evident in infants [26]. In addition, most of the infants with anemia were males.

Available fuel for cooking had a significant influence on IDA and predicted IDA . In times of fuel shortage, households may be forced to change their cooking habits reducing the number of meals, the quantity of food consumed and the types of food cooked. Fuel shortages may also affect the quality and nutritional value of food consumed. In Angola, newly displaced women were forced to use leaves and twigs for cooking. Water did not boil due to an inadequate fire, contributing to waterborne diseases and difficulties in cooking beans. It took up to ten hours of cooking for the beans to reach an edible state. In times of fuel-wood scarcity women spend extra time searching for wood. This is time they could spend producing and preparing food, caring for children and earning income. Insufficient boiling of water due to fuel shortages may increase the incidence of illness from consuming contaminated water or poorly prepared food. Children are particularly affected by diarrhea caused by poor hygiene or improperly cooked foods, causing iron losses [27].

Foods which are nutritious should also be wholesome, and safe to prevent infection. Food should therefore be prepared hygienically and safely. Water sources which were used from the study were wells, rivers/lakes. Over half (52.9%) of them did not treat the water. This poses a risk if this water is given to infants. It increases the risk of diarrhoea, and consequently major iron losses. Most (89.3%) mothers did wash hands during food handling using soap. This practice should be encouraged because it reduces incidences of diarrhoea. Most of the foods leftover were covered but not refrigerated. This allowed for food deterioration and a high risk of bacteriological contamination. Most mothers did not store food in refrigerators, yet others did not even cover the foods. Others used non cold facilities to store food and did not cover the foods (53.7%). This possibly raised the risk of contamination. These findings are consistent with results from studies in Zambia where mothers who used soap reduced the incidence of food borne infections by 30%. This conforms with studies that early complementary feeds has been associated with inadequate prepared or poorly stored foods [28]. For instance in Nigeria, alternative feeds have resulted in higher instances of diarrhoea while in Guinea-Bissau the incidence of diarrhoea is higher in partially breastfed children [29]. Majority had toilets and compost pits, which aid in preventing wastes contaminating foods via flies. Hygienic hand washing using soap, storage of utensils and pit possession had a significant relationship with IDA. Waste disposal and hygiene hand washing predicted IDA.

According to WHO (1999) recommendation [30], iron supplementation is also mandatory to pre-term and term infants; however in this study iron supplementation was poorly conducted at 4.9%.This is consistent with the Kenya Demographic Health and Survey (2009) results whereby iron supplementation in ages 6-8 months was 6.8% and 9-11 months was 4.5%. Randomized controlled trials evaluating influences of iron supplementation on mental, motor and physical development and hemoglobin response in children have been systematically reviewed. A beneficial effect from iron supplementation on either mental or motor development or physical growth among young children could not be identified, although where baseline iron deficiency anaemia was prevalent, iron supplementation appears to benefit mental development [31]. There is also some data to suggest impairment in linear growth among children in developed countries where baseline iron deficiency was less common [32]. The hemoglobin response to iron supplementation appears related to the baseline prevalence and etiology of anemia and the local malaria endemicity [33]. Routine iron

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supplementation reduces the prevalence of anemia among populations in non-malaria endemic areas from 62.3% to 37.9%, but by only 31.8% to 5.8% in malaria hyper-endemic regions [34].

Results from the present study showed that 36.5%) of the mothers in this study had maternal anemia. Poor nutritional status in pregnancy has adverse consequences that can persist from one generation to the next, since women who are underweight or stunted are at risk of delivering premature or low birth weight infants, who are themselves at risk of poor growth and development and anemia in childhood and adolescence i.e. lifecycle nutrition [35]. Transfer of iron from the mother to the fetus during pregnancy is regulated by the placenta [36] with approximately two-thirds of fetal accretion occurring during the third trimester [37]. A recent study was carried out in Zimbabwe has shown that maternal anemia and low birth weight are significant predictors of low total body iron (TBI) in infants, with the odds of subsequent anemia at 6, 9, and 12 months of age being more than three times higher in infants in the lowest TBI quartile compared with those in the highest quartile [23] The combination of maternal iron deficiency and placental malaria therefore places infants born to pregnant women in malaria-endemic areas at particularly high risk of developing iron-deficiency anemia during the first year of life. However maternal, child, and care practices had no significant relationship with IDA in this study. This is attributed to the fact that most of practices were conducted appropriately

IDA was evident and hence the most common of nutritional anemia among infants in Keiyo South District. On the factors associated with IDA, fuel for cooking, waste disposal, and hygienic hand washing had a significant relationship and also predicted anemia. Sanitation therefore was a key factor in determining IDA, and this explains the malnutrition infection cycle. This socio- demographic factor was important, as it affected types of iron rich foods to be cooked, proper cooking of foods to avoid foodborne illnesses and availability of mothers to care for the infants instead of looking for fuel.
Application of multiple strategies to curb IDA, apart from nutritional interventions be considered.

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7. Further Research

1. Further cross-sectional and longitudinal studies to test the level of iron depletion in infants to design appropriate interventions
2. Comparative studies on the extent of iron deficiency in malnourished and well nourished children.
3. Interventional studies on the best food combinations to sustain proper iron status during the critical time of infancy.
4. Comparative study of iron deficiency anemia in regions with different climatic conditions and food security situations.

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