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;

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 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.

References

[1] Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc,Washington DC,National Academy Press,2001.
[2] N.C.Andrews,"Disorders of iron metabolism",National England Journal of Medicine 341(1) pp,1986-95, 1999.
[3] S. Miret,R.J .Simpson,A.T. McKie , "Physiology and molecular biology of dietary iron absorption,". Annual Review Nutrition, 23, pp 283-301,2003.
[4] R.F. Hurrell, "Preventing iron deficiency through food fortification," Nutrition Review, 55, pp 210-22, 1997.
[5] I.W. Booth , Aukett, M.A. "Iron deficiency anemia in infancy and early childhood," Arch Disadvantaged Child, 76 (3), pp 549-53,1997.
[6] B.Annibale, D.Capurso, G.Chistolini, A. D'Ambra, G. DiGiulio, E. Monarca, B. *et. al.* "Gastrointestinal causes of refractory iron deficiency anemia in patients without gastrointestinal symptoms,"American Journal of Medicine 3 (111), pp .439-45,2001.
[7] R.S. Gibson, "Assessment of iron status" in, principles of nutritional assessment, S. Gibson (ed.) ,pp. 349-76. Oxford UK, Oxford University Press,1997.
[8] D. Burman, "Iron requirements in infancy", British Journal of Haematology,20, pp. 243-47,1997.
[9] B.Lozoff,G.M. Briwttenham,F.E Viteri,A.W Wolf, J.J Urrutia , "The effects of short term oral-therapy on developmental deficits in iron deficient anemic infants", Journal of Pediatrics ,100, pp. 351-57,1982.
[10] F.A.Oski,A.SHonig,B.Helu,P.Howanitz, "Effect of iron therapy on behaviour performance in nonanemic, iron deficient infants", Paediatrics, 71, pp. 877-80,1993.
[11] R.G. Strauss "Iron deficiency infections and immune function: a reassessment" American Journal of Clinical Nutrition,31, pp 600-66,1978.
[12] J.D. Haas, T. Brownlie, " Iron deficiency and reduced Work capacity: a critical review of the research to determine a causal relationship", Journal of Nutrition, 131 (69), pp. 1-6,2001.
[13] P. Bhaskaram, "Immunobiology of mild micronutrient deficiencies", British journal of Nutrition,85(2),pp. 75-80,2001.
[14] J.Beard,W.Green,,L.Miller, C.A finch, "Effect of iron deficiency and the productivity of adult males in Indonesia",In American journal of Clinical Nutrition, 32, pp. 916-25,1984.
[15] D. Archer, F. Young, "Contemporary issues: diseases with a food vector", Clinical microbiology reviews, 1(1), pp.377-398,1988.

[16] P.A.Davies, L.A Gothefors, Bacterial infections in the fetus and newborn, Major problems in clinical pediatrics, Vol 26,Philadelphia,W.B. Saunders,1984.
[17] M. Taylor, "The hemolytic uraemic syndrome: a clinical perspective",PHLS microbiology digest, 7, 133-140,1990.
[18] E.E. Ekanem, C.O. Akitoye, "Child feeding by Nigerian mothers during acute diarrhoeal illness", Journal of the Royal Society of Health, 5 (1),164-165,1990.
[19] C.R. Kothari, Research Methodology; Methods and Techniques. New Age International Publishers, India, 2004
[20] R.S. Riley, "How to Prepare & Interpret Peripheral Blood Smears", Medical report, Virginia Commonwealth University,1999.
[21] GOK and UNICEF , "Anemia and the status of iron, vitamin A and zinc in Kenya",The 1999 micronutrient Survey report, The Government of Kenya and United nations Children's Fund. Nairobi,1999.
[22] M.F. Miller,R.J. Stoltzfus, N.V Mbuya ,L.C. Malaba, P.J. Iliff , "Total body iron in HIV-positive and HIV-negative Zimbabwean newborns strongly predicts anemia throughout infancy and is predicted by maternal hemoglobin concentration", Journal of Nutrition, 133, pp. 3461–3468,2003.
[23] V. Naanyu, "Young Mothers, First time parenthood and Exclusive breastfeeding in Kenya", African Journal of Reproductive Health, 12 (3) ,pp. 125-138,2008.
[24] Kenya National Bureau of Statistics (KNBS) and ICF Macro "Kenya Demographic Health and Survey 2008-09" Calverton, Maryland, KNBS and ICF Macro,2010
[25] B. Lozzoff, I. de Andraca , M. Castillo, J.B. Smith, T. Walter, P. Pino, "Behavioral and developmental effects of preventing iron deficiency anemia in healthy full-term infants", Pediatrics, 112(1), pp . 846-54,2003
[26] ACC/SCN. Administrative Committee on Coordination & Sub- committee on Nutrition, "Eighth report on Emergencies In Nutrition", Geneva, ACC/SCN,2009.
[27] J.K Kung'u, " Bacterial populations in complementary foods and drinking-water in households with children aged 10-15 months in Zanzibar, Tanzania". Journal of Health Population and Nutrition ,2010 ,19 Jan,2011 [online].Availablehttp://findarticles.com/p/articles/mi_6829/is_1_27/ai_n32103140
[28] K.Molbak A.Gotschau, P. Aaby, "Prolonged breastfeeding diarrhoeal disease and survival of children in Guinea-Bissau" British Medical Journal, 308(6941), pp 1403-6,1994
[29] World Health Organization, " Populations at risk" Department of Protection of the Human Environment, Cluster of Sustainable Development and Healthy Environments, Food Safety Programme,Geneva, Switzerland,1999.
[30] H.P.S. Sachdev, T. Gera, P. Nestel, " Effect of iron supplementation on mental and motor development in children: systematic review of randomised controlled trials", Public Health Nutrition, 8, pp. 117-132,2007.
[31] H.P.S. Sachdev, T. Gera, P. Nestel, " Effect of iron supplementation on physical growth in children: systematic review of randomised controlled trials", Public Health Nutrition ,9, pp. 904-920.
[32] L.L.Iannotti, J.M Tielsch, M.M. Black, R.E.Black, "Iron supplementation in early childhood: health benefits and risks" American Journal of Clinical Nutrition, 84, pp 1261-1276,2006.
[33] T. Gera, H.P.S Sachdev, "Effect of iron supplementation on incidence of infectious illness in children", Systematic review, 325, pp 1142-1152.
[34] R.W. Steketee, "Pregnancy, nutrition and parasitic diseases", Journal of Nutrition, 133 (l 2), 1661S–1667S, 2003.
[35] E.D. Harris, "New insights into placental iron transport", Nutrition Rev, 50, pp.329–331, 1992.
[36] P.N. Singla, V.K Gupta, K.N. Agarwal "Storage iron in human foetal organs", Acta Paediatric Scand, 74, pp 701–706, 1985.

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