DECLARATION

“This thesis is my original work and has not been presented for any degree in any other University.”

Signature ……………………….... Date…………………………

Neddy Lwile Wangusi: H60/12696/2009

Supervisors:

We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

I dedicate this work to my children Evans, Newton, Boaz, Abigail and also my spouse Joseph Kiyondi for peace of mind, encouragement and material support they have directed towards my work.
ACKNOWLEDGEMENTS

My acknowledgements are directed towards my supervisors Prof. Judith Waudo, Prof. Beatrice Mugendi together with the entire Food, Nutrition and Dietetics department teaching staff of Kenyatta University. I also accord special thanks to my research assistants Alex Vijedi Mugalizi and Salome Wandako for their invaluable support in data collection. Last but not least data analyst Nelson Simiyu for his exemplary work in data analysis.
# TABLE OF CONTENTS

DECLARATION ........................................................................................................... ii  
DEDICATION ............................................................................................................. iii  
ACKNOWLEDGEMENTS .......................................................................................... iv  
TABLE OF CONTENTS ............................................................................................... v  
LIST OF TABLES ........................................................................................................ ix  
LIST OF FIGURES ....................................................................................................... x  
LIST OF ABBREVIATIONS AND ACRONYMS ................................................................ xi  
DEFINITION OF TERMS ........................................................................................... xii  
OPERATIONAL DEFINITIONS OF TERMS ........................................................................ xiv  
ABSTRACT ................................................................................................................. xv  

## CHAPTER ONE: INTRODUCTION ............................................................................ 1  
1.1 Background information .......................................................................................... 1  
1.2 Problem statement and justification ........................................................................... 3  
1.3 Purpose of the study ................................................................................................. 4  
1.4 Objectives of the study ............................................................................................. 5  
1.5 Hypotheses of the study ........................................................................................... 5  
1.6 Significance of the study .......................................................................................... 5  
1.7 Delimitation ............................................................................................................. 6  
1.8 Limitation of the study ............................................................................................ 6  
1.9 Conceptual framework ............................................................................................ 6  

## CHAPTER TWO: LITERATURE REVIEW ............................................................. 9  
2.1 Global picture of IDA .............................................................................................. 9  
2.2 Causes of iron-deficiency anaemia .......................................................................... 11  
2.2.1 Complementary feeding practices ...................................................................... 12  
2.2.2 Dietary intake of bio-available iron .................................................................... 13  
2.2.3 Socio-demographic and economic factors ......................................................... 14  
2.2.4 Sanitation among children ................................................................................ 15  
2.3. Relationship between IDA and health status ....................................................... 16  
2.3.1 Immunization coverage ...................................................................................... 16  
2.3.2 Deworming interventions ............................................................................... 17  
2.3.3 Malaria epidemic ............................................................................................. 17  
2.4 Health consequences of IDA ................................................................................. 19  
2.4.1 Impaired cognitive and psychomotor development .......................................... 19  
2.4.2 Behavioral problems ....................................................................................... 20
2.4.3 Nutritional status of children .......................................................................................... 20
2.4.4. Summary of literature review ....................................................................................... 21

CHAPTER THREE: RESEARCH METHODOLOGY ......................................................... 23
3.1 Study design ....................................................................................................................... 23
3.2 Study variables ................................................................................................................ 23
3.2.1 Dependent variables ..................................................................................................... 23
3.2.2 Independent variables ................................................................................................... 23
3.3 Study location .................................................................................................................. 23
3.4 Target population ........................................................................................................... 24
3.4.1 Inclusion criteria ......................................................................................................... 24
3.4.2 Exclusion criteria ......................................................................................................... 24
3.5 Sample size determination .............................................................................................. 25
3.6 Sampling techniques ....................................................................................................... 26
3.7 Research instruments ...................................................................................................... 27
3.7.1 Interview schedule ...................................................................................................... 27
3.7.1.1 Sanitation level in the homesteads ........................................................................... 27
3.7.1.2 Malaria and immunization status .......................................................................... 27
3.7.1.3 Helminthic infection bio data ............................................................................... 28
3.7.2 Dietary intake instruments .......................................................................................... 28
3.7.2.1 A 24-hour dietary recall ......................................................................................... 28
3.7.2.2 A 7-day food frequency questionnaire .................................................................. 29
3.7.3 Research equipment .................................................................................................... 31
3.7.3.1 Hemocue globinometer ......................................................................................... 31
3.7.3.2 Automated Coulter Counter ................................................................................... 31
3.7.3.3 Anthropometric tools ............................................................................................ 32
3.8 Pretesting of the instruments .......................................................................................... 33
3.8.1 Validity ....................................................................................................................... 33
3.9 Selection and training of enumerators ............................................................................. 34
3.10 Data analysis and presentation ...................................................................................... 36
3.11 Logistical and ethical considerations ............................................................................. 38

CHAPTER FOUR: FINDINGS .................................................................................... 39
4.1 Introduction ....................................................................................................................... 39
4.2 Characteristics of the study population .......................................................................... 40
4.2.1 Socio-demographic profiles of the children ................................................................. 40
4.2.2 Socio-economic profiles of the caregivers ................................................................. 41
4.3 Nutritional status of the children .................................................................................... 42
4.3.1 Wasting in children ......................................................................................................... 42
4.3.2 Underweight in children ................................................................................................. 43
4.3.3 Stunting in children ......................................................................................................... 43
4.3.4 Nutritional status according to the sex of a child ............................................................ 44
4.4 Prevalence of iron deficiency anaemia ............................................................................... 44
4.5 Nutritional status of children in relation to IDA ................................................................. 45
4.6 Relationship between mean cell volume with independent variables ......................... 45
4.7 Relationship between red cell width with independent variables .................................... 47
4.8 Relationship between haemoglobin with independent variables ...................................... 49
4.9 Relationship between IDA and the caregiver of the child ................................................. 50
4.10 Relationship between IDA among the children and income of the caregiver .................. 50
4.11 Dietary intake among the children ................................................................................... 51
4.11.1 Food consumption patterns ........................................................................................ 51
4.11.2 The form of iron consumed among the children ........................................................... 52
4.11.3 Complementary feeding practices ................................................................................. 53
4.11.3.1 Minimum dietary diversity ....................................................................................... 54
4.11.3.2 Minimum meal frequency ......................................................................................... 54
4.11.3.3 Minimum acceptable diet ......................................................................................... 55
4.11.4 Amount of nutrients and kilocalories consumed by children 6-23 months old .......... 55
4.12 Sanitation in the children’s homestead ............................................................................ 57
4.12.1 Rubbish waste disposal ............................................................................................... 57
4.12.2 Human waste disposal ................................................................................................. 58
4.12.3 Presence of stagnant water .......................................................................................... 58
4.13 Health condition of the children ...................................................................................... 60

CHAPTER FIVE: DISCUSSION OF FINDINGS ......................................................................... 63
5.1 Introduction ......................................................................................................................... 63
5.2 Socio-demographic profiles of the children and caregivers ............................................ 63
5.3 Nutritional status ................................................................................................................ 64
5.3.1 Wasting in children ....................................................................................................... 65
5.3.2 Underweight in children ............................................................................................... 65
5.3.3 Stunting in children ....................................................................................................... 66
5.3.4 Nutritional status and sex of a child .............................................................................. 66
5.3.5 Haemoglobin level and the nutritional status of the study participants ....................... 67
5.4 Mean cell volume of the study participants ...................................................................... 68
5.5 Red cell width of the study participants ........................................................................... 69
5.6 Socio-demographic characteristics and its relationship with IDA among the children... 70
5.7 Relationship between income and haemoglobin level among the children ....................... 74
5.8 Food consumption among study participants................................................................. 74
5.9 Sanitation in the children’s homes .................................................................................. 77
5.10 Iron level with selected health assessment................................................................. 78
CHAPTER 6: SUMMARY, CONCLUSION AND RECOMMENDATIONS ........... 82
6.1 Summary of findings ....................................................................................................... 82
6.2 Conclusions ................................................................................................................... 84
6.3 Recommendations for policy and practice................................................................. 85
6.4 Recommendations for research..................................................................................... 87
REFERENCES .................................................................................................................. 88
APPENDICES ................................................................................................................. 101
APPENDIX A: INTRODUCTORY NOTE ....................................................................... 101
APPENDIX B: KITAMBULISHO ..................................................................................... 102
APPENDIX C: INFORMED CONSENT ......................................................................... 103
APPENDIX D: KUJULISHWA KWA MZAZI AU MLEZI ............................................. 104
APPENDIX E: STRUCTURED INTERVIEW SCHEDULE, FFQ AND 24 HOUR RECALL ......................................................................................................................... 105
APPENDIX F: MPANGILIO YA MASWALI KUHUSU CHAKULA MASAA 24 YALIYO PITA NA PIA SIKU SABA ZILIZOPITA ................................................................. 110
APPENDIX G: MAP OF THIKA DISTRICT ................................................................. 115
APPENDIX H: KENYATTA UNIVERSITY RESEARCH AUTHORIZATION LETTER ............................................................................................................................... 116
APPENDIX I: ETHICAL CLEARANCE LETTER ............................................................ 117
APPENDIX J: RESEARCH AUTHORIZATION LETTER FROM NCST ............... 119
APPENDIX K: RESEARCH PERMIT .............................................................................. 120
LIST OF TABLES

Table 1.1 Cut off values for iron-deficiency anaemia ......................................................... 10
Table 3.1 Data analysis ........................................................................................................... 37
Table 4.1 Demographic characteristics of the children ....................................................... 41
Table 4.2 Socioeconomic characteristics of the caregivers .................................................. 42
Table 4.3 Nutritional status of the children ........................................................................... 43
Table 4.4 Nutritional status of the children by sex ............................................................... 44
Table 4.5 Indices used to measure iron deficiency anaemia among children ................. 44
Table 4.6 Relationship between IDA and the nutritional status of the children ............... 45
Table 4.7 Relationship between mean cell volume with independent variables ............ 46
Table 4.8 Relationship between red cell width with independent variables .................... 48
Table 4.9 Relationship between haemoglobin with independent variables .................... 49
Table 4.10 Relationship between IDA and the caregiver of the child .................................. 50
Table 4.11 Income and its relationship with IDA ................................................................. 51
Table 4.12 7 day food frequency questionnaire of children 6-23 months old .................. 51
Table 4.13 Complementary feeding practices ..................................................................... 54
Table 4.14 Adequacy of kilocalories (kcal) and consumption of selected nutrients by children 6-23 months old .................................................................................... 56
Table 4.15 Relationship between IDA with dietary intake of iron among the children .... 57
Table 4.16 Relationship between IDA and sanitation practices in the children homestead ................................................................................................................................. 59
Table 4.17 Health status among the children ....................................................................... 60
Table 4.18 Relationship between IDA with health status of the children ......................... 61
LIST OF FIGURES

Figure 1.1 Conceptual framework on determinants of Iron deficiency anaemia ...................... 7
Figure 4.1 Percentages of heme and non-heme iron sources consumed ............................... 53
Figure 4.2 Rubbish waste disposal ....................................................................................... 57
Figure 4.3 Human waste disposal ....................................................................................... 58
# LIST OF ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BCG</td>
<td>Bacille Calmette-Guerin</td>
</tr>
<tr>
<td>CBC</td>
<td>Complete Blood Count</td>
</tr>
<tr>
<td>CDCP</td>
<td>Centers for Disease Control and Prevention</td>
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<tr>
<td>DDS</td>
<td>Dietary Diversity Score</td>
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<tr>
<td>DPT</td>
<td>Diphtheria, Pertussis, and Tetanus</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>FL</td>
<td>Femtoliters</td>
</tr>
<tr>
<td>HB</td>
<td>Hemoglobin</td>
</tr>
<tr>
<td>HH</td>
<td>House Hold</td>
</tr>
<tr>
<td>IDA</td>
<td>Iron- Deficiency Anemia</td>
</tr>
<tr>
<td>IYCFP</td>
<td>Infant and Young Child Feeding Practices</td>
</tr>
<tr>
<td>KCAL</td>
<td>Kilocalorie</td>
</tr>
<tr>
<td>KDHS</td>
<td>Kenya Demographic and Health Survey</td>
</tr>
<tr>
<td>MCV</td>
<td>Mean Cell Volume</td>
</tr>
<tr>
<td>NCAPD</td>
<td>National Council for Population and Development</td>
</tr>
<tr>
<td>NCST</td>
<td>National Council of Science and Technology</td>
</tr>
<tr>
<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
</tr>
<tr>
<td>RDA</td>
<td>Recommended Dietary allowance</td>
</tr>
<tr>
<td>RCW</td>
<td>Red Cell Width</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Science</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
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<tr>
<td>VMNIS</td>
<td>Vitamin and Mineral Nutrition Information System</td>
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<tr>
<td>WBC</td>
<td>Well Baby Clinic</td>
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DEFINITION OF TERMS

**Complementary feeding practices**- covers: time of introduction of solid and semi-solid foods or soft foods; frequency of feeding, dietary diversity; consumption of iron-rich foods and continued breastfeeding among children 6-23 months old (PAHO & WHO, 2003).

**Minimum dietary diversity**- proportion of children 6–23 months of age who receive food’s from four or more food groups during the previous day. The seven food groups used for tabulation of this indicator were: grains, roots and tubers; legumes and nuts; dairy products (milk, yoghurt and cheese); flesh foods (meat, fish, poultry and liver/organ meats); eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables (WHO, 2008b).

**Minimum meal frequency**- proportion of breastfed and non-breastfed children 6–23 months of age who receive solid, semi-solid or soft foods the minimum number of times or more (minimum is defined as two times for breastfed infants 6–8 months; three times for breastfed children 9–23 months; and four times for non-breastfed children (6–23 months) in the previous day (WHO, 2008b).

**Minimum acceptable diet**- proportion of breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day, and non-breastfed children 6–23 months of age who received at least two milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day (WHO, 2008b).
**Dietary diversity**- is the qualitative measure of food consumption reflecting household access to a variety of foods and also it is a proxy for nutrient adequacy in the diet of individuals (WHO, 2008b).

**Dietary diversity score**- is the sum total of the different food groups consumed by children 6-23 months of age (WHO, 2008b).

**Underweight**- is acute and chronic malnutrition combined. This is a low weight for age. It is a weight below -2SD of the reference population (WHO, 2006).

**Stunting** – is low length/height for age. It is a length/ height below -2SD of the reference population. It is a sign of a chronic nutritional disorder (WHO, 2006).

**Wasting**- is a low weight for length/ height. Usually, wasted children are under -2SD of the reference weight for length/ height. It is an acute nutritional disorder (WHO, 2006).

**Vaccinated**- a child is said to be fully vaccinated if he/she has received BCG vaccination against tuberculosis; three doses of DPT vaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPT and 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).
OPERATIONAL DEFINITIONS OF TERMS

Cognitive development - this is the process of acquiring intelligence and increasingly advanced thought and problem-solving ability from infancy to adulthood.

Hereditary haemoglobinopathes - is a hereditary condition involving an abnormality in the structure of haemoglobin.

Metabolism - refers to the chemical processes by which cells synthesize / breakdown nutrients to provide energy to sustain life.

Myelination - is the change or maturation of certain nerve cells whereby a layer of myelin forms around the axon which allows the nerve impulses to travel faster.

Neurotransmission - is the process by which chemical substances such as acetylcholine or dopamine transmits nerve impulses across a nerve synapse.

Psychomotor development - is the progressive acquisition of skills involving both mental and motor activities.

Significantly ill - a disease that can be detected by laboratory analysis or any condition in the child that can affect the normal behavior performance of the child and child development milestones.

Health status – refers to a child who has received all basic vaccinations, free from malaria related symptoms and also has undergone standard deworming procedure.
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. Intake of iron rich foods, sanitation, health, economic and socio-demographic factors are principal determinants of Iron-deficiency anaemia (IDA) in children. 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 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. 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. A follow up study to assess the relationship between nutritional status and IDA along with associated factors in children from birth up to 10 years should be done to establish any link between nutritional status and IDA and the possible effect on their development milestones.
CHAPTER ONE: INTRODUCTION

1.1 Background information

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). 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). 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).

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), 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). 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).
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 haemoglobinopathies, 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).

Different nutrients and co-factors are involved in maintaining the normal synthesis of hemoglobin, which is an important constituent of iron. The main nutrients involved in this synthesis include iron, folic acid, and vitamin B₁₂, however, in public health terms, iron deficiency is by far the first cause of nutritional anemia worldwide. Folic acid deficiency, on the other hand, is less widespread and it is often observed with iron deficiency. Deficiency of Vitamin B₁₂ however, is far rare, and thus, iron deficiency is the most frequent cause of anemia in the preschool children and women of reproductive ages on a worldwide basis (WHO, 2008).

Consequences of IDA during childhood include growth retardation, reduced school achievement, impaired motor and cognitive development, and increased morbidity. Specifically, iron deficiency can lead to deficits in memory and behavioral regulation as iron is required to make neurotransmitters such as dopamine, epinephrine and
serotonin (Beard et al., 2003). Also, impaired myelination contributes to deficits in motor function, some of these impairments are thought to be irreversible if they occur at an early age and the consequences may continue even after treatment, reinforcing the importance of early detection and prevention (Beard et al., 2003; Lin, 2010).

The form of dietary iron is an important determinant for IDA depending on its bio-availability. Heme iron mainly found in animal products has a high bio-availability index as opposed to non-heme iron mainly found in plant products with a low bio-availability index requiring enhancers to boost its bio-availability (Macphail, 2007). This study aims to establish the prevalence of IDA and its determinant factors in children aged 6-23 months attending a WBC at Thika level 5 Hospital, Kenya.

1.2 Problem statement and justification

It is reported that IDA is a risk factor for death resulting in about 726,000 deaths in the perinatal and childhood periods with the greatest toll in South East Asia and Africa (WHO, 2004; FAO/WHO, 2005). Iron-deficiency in the first months of life is a contributory factor to irreversible psychomotor and cognitive injuries that lead to lower life quality and hence reduced academic achievement and work performance in adulthood (Brunt et al., 2012).

Worldwide IDA prevalence is estimated at 25 percent (Calis, Phiri & Farragher, 2008; UNICEF, 2009b) however, nationally representative information on iron status is lacking and according to (VMNIS, 2011); data available is limited to vitamin A, iodine, and anemia prevalence. IDA prevalence has been obtained from estimation with the prevalence of anaemia of (69%) which is (34.5%) in Kenya (UNICEF, 2009b). The
prevalence of 34.5%, assumes that half of all anaemia cases are IDA related which is however not the case since anemia has multiple causal factors (Blair & Lynette, 2011).

Few studies have been done in children on IDA. One was conducted in Nyando division, Nyanza province in August 2010. Children studied were aged 6-35 months. The mean haemoglobin from the study was (9.6g/dl) and the overall prevalence of IDA was (71.8 %) (Foote et al., 2013). Another one was conducted between March to May 2009 in 30 primary schools in Nyando district in western Kenya in children aged 6-35 months (Kobina, 2011). The prevalence of IDA in this study was reported as (61.9 ± 2.2%).

There are limited studies in Central province of Kenya with the most recent one done by (KDHS, 2008) whose findings revealed that 7 out of every 10 children in the Central province of Kenya aged 6-35 months did not consume iron-rich foods, and from this study data on the prevalence of IDA was not captured. The paucity of data on IDA prevalence in Central province of Kenya, specifically, Thika west Sub County is the basis upon which this study was built.

1.3 Purpose of the study
To establish the prevalence and determinant factors of iron-deficiency anaemia in children aged 6-23 months attending a well-baby clinic at Thika level-5 Hospital, Kiambu County, Kenya.
1.4 Objectives of the study

1. To establish the prevalence of IDA through haemoglobin and complete blood count determination.
2. To establish the nutritional status of children aged 6-23 months.
3. To establish complementary feeding practices alongside intake of iron rich foods in children aged 6-23 months.
4. To determine whether the IDA status of the children aged 6-23 months is related to their dietary intake and socio-demography.
5. To establish the relationship between IDA and sanitation of households with children aged 6-23 months.
6. To determine whether the IDA status of the children aged 6-23 months is related to their health status as influenced by malaria, immunization, and helminthic infestation.

1.5 Hypotheses of the study

HO1. The prevalence of IDA in children aged 6-23 months attending Thika Level 5 Hospital WBC is not equal to or more than 34.5%.
HO2. The IDA status of the children is not related to their nutritional status.
HO3. The IDA status of the children aged 6-23 months is not related to their sanitation dietary intake and socio-demography.
HO4. The IDA status of the children aged 6-23 months is not related to their health.

1.6 Significance of the study

The study has generated information that would be useful to the Ministry of Health and other agencies working in child health survival programmes. The information is useful in designing appropriate interventions to improve complementary feeding and intake of
iron rich foods thus mitigating against IDA in these children. The study has also contributed to knowledge of ongoing research efforts on the prevalence and determinants of IDA among children.

1.7 Delimitation
The study was only carried out among children aged 6-23 months attending WBC at Thika Level 5 Hospital in Thika West Sub-County thus, the research findings can only be applied to the area and other areas with similar characteristics.

1.8 Limitation of the study
Data concerning dietary intake, environmental and socio-economic factors were based on the memory of the participants thus prone to recall bias.

1.9 Conceptual framework
The study used a conceptual framework adapted and modified to suit the present study by the researcher from the causes of maternal and newborn deaths in the state of the world’s children report (UNICEF, 2009a). The proximate determinants of iron deficiency anaemia were inadequate dietary intake and diseases. Proximate determinants were a result of inter-related underlying factors, encompassing: inadequate dietary intake; inadequate caregivers education, inappropriate health care together with poor sanitation and hygiene (UNICEF, 1998; Tatala, Svanberg & Muduma, 1998; Keskin et al., 2005). Inappropriate intake of iron rich foods and poor complementary feeding practices consist of; untimely introduction, improper feeding frequency and low dietary diversity of complementary foods resulting to inadequate dietary intake. Heme sources of iron are mainly meat, poultry, fish and eggs. They have
a higher proportion of bio-available iron in comparison to non-heme iron food sources which are mainly plant based products like legumes and vegetables (Gregory & Gordon, 2012; Macphail, 2007).

Figure 1.1. Conceptual framework on determinants of Iron deficiency anaemia


First, the socio-demographic and economic status influences the access and quality of food due to knowledge and education of the caregiver concerning iron rich foods (Islam et al., 2001; Soekarjo et al., 2001) also; it influences the health environment of the population where the high socio-economic class can easily access proper public health services such as clean and decent housing due to their financial power as opposed to
the low socio-economic class that cannot afford decent housing with proper sanitation and clean water. This, in turn, increases their risk of exposure to intestinal parasitic infections that are prone in such conditions. An example is a hookworm which interferes with iron absorption and leads to gastrointestinal blood loss (Olivares et al., 1999; Musaiger, 2002).
CHAPTER TWO: LITERATURE REVIEW

2.1 Global picture of IDA

Iron deficiency is the most common nutritional deficiency in the world (Grobois et al., 2005). Severe or prolonged iron deficiency can cause IDA. The prevalence of IDA is sensitive to the age at testing and the diagnostic criteria used (Leal et al., 2011). Haemoglobin concentration and hematocrit are the principal screening tests for detecting anemia. Hemoglobin can be measured quickly and accurately on a few drops of blood (Conway et al., 1998).

Despite the fact that haemoglobin and hematocrit are used in determining iron-level, diagnosis of IDA requires laboratory confirmed evidence of IDA as well as evidence of anaemia and low iron stores. A complete blood count can be useful in determination of the mean corpuscular volume or red cell width. Although iron deficiency is the most common cause of microcytic anaemia, up to 40 percent of patients with IDA will have normocytic erythrocytes. The current strategy to identify iron deficiency anemia relies on markers involving high costs. Red cell width >14% with hemoglobin ≤11.0 g/dl identifies iron-deficient anemic children without the need for the iron status markers which could help reduce the cost of management, especially in poor settings ≤11.0 g/dl (WHO, 2001).

Data on infants and children aged 6-23 months use a cut off value of ≤11.0 g/dl of haemoglobin for iron deficient children. These cut-off values were chosen by consensus and statistical analysis of the distribution of laboratory values in the population. Some experts argue that the normal limits for haemoglobin and for iron should be based on
analysis of the response to iron therapy, but efforts to define cut-off values in this manner have not yielded definitive results (WHO, 2001; White, 2005).

**Table 1.1. Cut off values for iron-deficiency anaemia**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Anaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>6-59 months</td>
<td>11g/dl</td>
</tr>
</tbody>
</table>

Adopted from (WHO, 2001).

Iron deficiency anaemia has also been documented as the commonest cause of nutritional anemia in infancy and childhood (Bertil, 2004). About 1.2 billion people worldwide demonstrate varying levels of iron deficiency. Worldwide, the major contributor of anaemia is iron deficiency and it is estimated that 25% of the entire world is affected with IDA with infants and young children being at a higher risk for developing iron deficiency due to their rapid growth in the first 2 years of life and also due to their use of complementary foods with low iron content and poor bioavailability (WHO, 2008).

There is paucity of data concerning IDA at national level for most countries and the only method used to determine IDA is an estimate, assuming that approximately 50% of anemia cases are caused by IDA, which is not always the case since anemia has multiple causal factors such as folic acid deficiency and Vitamin A deficiency (Blair & Lynette, 2011). Prevalence rates vary among countries; it affects 2.4 million children in the USA, 5.4% children in Spain (Munoz-perez et al., 1995), 14.0% in Estonia (Vendt et al., 2007), 30.8% under five Brazilian children (Viera et al., 2008), 22.3% under-five Nigerian children (Maziya-Dixon et al., 2004) and 34.5 % in Kenyan under
five year children (UNICEF, 2009b) based on anaemia prevalence of 69% for the under
five year children.

In Kenya very, few studies have been done on IDA in children. One was conducted in
Nyando division, Nyanza province in August 2010, it studied children aged 6-35
months and found out that the mean haemoglobin was (9.6g/dl) while the overall
prevalence of IDA was (71.8 %) (Foote et al., 2013). Another one was conducted
between March to May 2009 in 30 primary schools in Nyando district in western Kenya
in children aged 6-35 months (Kobina, 2011) in which the prevalence of IDA was
reported as (61.9 ± 2.2%).

In addition, a study by KDHS, (2008), reported that 71.8 percent of children in Central
Province of Kenya do not take iron-rich foods, however, this study did not indicate data
on the prevalence of IDA in these children. The paucity of data concerning prevalence
of IDA in children at provincial and national level necessitated the present study, which
sought to assess the factors responsible for IDA and also to determine the prevalence
of IDA in children aged 6-23 months attending a WBC at Thika Level 5 Hospital.

2.2 Causes of iron-deficiency anaemia

Nutritional factors are also key determinants of anemia risk. After the age of 6 months,
children have increased needs of iron for growth and development that surpasses the
iron supplied by breast milk (Ziegler, Nelson & Jeter, 2011). In addition, many
complementary foods that are introduced to infants are low in iron. Foods high in iron
that can alleviate IDA include animal-based products such as meat, chicken and eggs.
A study in Nigeria found that the weekly meat intake was one of the factors significantly
associated with increased hematocrit levels (Gara et al., 2010). Other nutritional factors that influence the risk of anemia include erythrocyte synthesis and/or development, such as folic acid, vitamin B₁₂ and vitamin A (Balarajan et al., 2011).

Other risk factors for developing IDA include the use of non-iron-fortified formula in the first year of life (without therapeutic iron supplementation); exclusive breastfeeding with no or erratic iron supplementation after 6 months of age; and the introduction of cow’s milk before 1 year of age (CDCP, 1998). The prevalence of IDA increases between 12 and 18 months of age as these factors come into play. Among term infants younger than 1 year, the prevalence of IDA is, however, low and haemoglobin and serum ferritin are uncorrelated (White, 2005). In developing countries, blood loss due to parasitic infection or malaria is another common cause of iron deficiency (Bhutta, 2010). Hereditary haemoglobinopathies (defect in the structure of haemoglobin), micronutrient deficiencies such as; folic acid, vitamin A, iron deficiency and premature clamping of the infants umbilical cord before iron stores are fully transferred to the infant, low dietary bioavailability of iron, low socio-economic status, and poor environmental sanitation are major factors contributing to the increased incidence of IDA (Pasricha et al., 2010).

### 2.2.1 Complementary feeding practices

Consumption of an appropriate diet is a critical component for a child’s proper growth and development (Aggarwal et al., 2008). The first two years of a child’s life are a critical window for ensuring optimal child growth and development (WHO, 2008a). Children should be exclusively breastfed for 6 months, after which nutritious
appropriate, adequate, and safe complementary foods should be introduced along with continued breastfeeding up to 2 years and beyond (WHO, 2008a).

Scientific evidence indicates that inappropriate feeding practices can have profound consequences for the growth, development, and survival of infants and children (Saha et al., 2008). Various inappropriate complementary feeding practices such as the untimely introduction of complementary food, improper feeding frequency, and low dietary diversity have been shown to have numerous negative effects on children’s health.

2.2.2 Dietary intake of bio-available iron

Dietary iron exists in two forms, heme and non-heme. Heme iron is found in foods that contain haemoglobin or myoglobin, which are animal sources, such as meat, fish and poultry. Non-heme iron is found in plant foods such as vegetables, legumes, fruit, nuts, and iron-fortified foods. The bioavailability of iron is dependent on its chemical form together with the presence or absence of dietary factors that interact with its absorption. Heme iron is soluble in the intestine and its absorption is not affected significantly by the composition of the background diet, and its bioavailability is considered relatively high, in the range of 15-35%. In contrast to heme iron, the bioavailability of non-heme iron is lower, in the range 2-20% and it is influenced by the presence of promoters or inhibitors (Gregory & Gordon, 2012).

Non-heme iron is absorbed by a divalent metal transporter 1 (DTM 1), which requires iron to be in the ferrous state. The most significant promoters of non-heme iron absorption are vitamin C (ascorbic acid), organic acids and the presence of meat, fish
or poultry protein, also known as the ‘meat factor’. Common inhibitors of non-heme iron absorption are phytate, polyphenols, oxalate and high doses of minerals for example tea, coffee and calcium which hinder absorption of non-heme iron when taken together with meals (Gregory & Gordon, 2012).

### 2.2.3 Socio-demographic and economic factors

Socio-demography is a major factor contributing to IDA both in developed and developing countries. In developing countries, low standards of living such as restricted access to food, personal hygiene, poor sanitation and lack of knowledge on good dietary practices contribute more to the high occurrence of iron-deficiency and hence anemia (Romano et al., 2012).

Household food purchasing power is an important determinant of household food security. Food intake is one of the important factors that affects the nutritional status of people in general and children in particular. It is mainly determined by household budget allocation on food. Food expenditure represents a big share of total household expenditure for low-income families in Kenya and is even a significant budget item even for the higher income families. Poor households, both in rural and urban are shown to spend (74%) and (57%) percent, respectively, compared to non-poor households (63%) and (44 %) respectively (KNBS, 2010).

There is a strong relationship between a child’s health and education level of his or her parents or caregivers (Allen, 2000). Higher maternal or caregiver education has been linked to increased knowledge about health and nutrition and hence increase in the quality of diets among children (Karr et al., 2001). Maternal education may also affect
the healthy decision-making, which in turn influences the probability of a child meeting certain nutrition-related requirement (Keskin et al., 2005). Research in developing countries has shown that children of literate mothers have a reduced risk of stunting (Bhargava, Bouis, & Scrimshaw, 2001; Houweling et al., 2003).

2.2.4 Sanitation among children
Sanitation is a key determinant of IDA. Intestinal parasitic infection mainly results due to poor sanitation and has been shown to reduce iron absorption, thus, increasing the prevalence of IDA in developing countries. In addition, parasitic infection leads to gastrointestinal blood loss and consequently iron-deficiency in children (Lander et al., 2012). Environmental enteropathy is a disease which alters the lining of the intestine and inhibits absorption of calories and nutrients. It is believed to be caused by the ingestion of large quantities of fecal pathogens (Lin et al., 2013; Kosek et al., 2013). In addition, it has been documented that enteropathy affects absorption of vitamin B12 and folic acid, which are essential nutrients for the production of haemoglobin (Nath, 2005).

In a study at Malaysia involving association between anaemia, IDA with neglected parasitic infections and socio-economic factors in rural children of West Malaysia aged 7-12 years in the period of November 2007 to July 2009, poor sanitation was cited as a factor leading to increased incidence of IDA in these children (Romano et al., 2012).

Malnutrition is a global problem in which factors other than the lack of food contribute to infections. Drinking water for instance, and more generally “domestic” water (including water necessary for hygiene and sanitation practices), is often a source of disease because of its poor quality (since it can contain bacteria, viruses, parasites as well as chemical agents) (Kosek, 2003; Pruss, 2002). Millions of people, most of them
being children are dying of diseases which are directly linked to the most basic hygiene rules (Kosek, 2003; Pruss, 2002). Some practical actions on hygiene, sanitation and water works proved that it was possible to reduce the frequency and economic impact of diseases. Many studies conducted at community or family levels in developed or non-developed countries, showed that the increase in water quantities available in households for various domestic uses, also the improvement of its bacteriologic qualities as a result of appropriate treatment of the water catchment site, or the modification of the storing method or utilization, reduces the risk of infections linked to water and especially the diarrheic diseases. Collections of water after heavy rainfall during the rainy season can serve as favorable breeding places for vectors of malaria as a result of stagnant water. Bushes which are common sites around dwelling places are often left to grow out of proportion in rainy seasons, creating a niche for larval proliferation in the community (Oladeinde, 2012).

2.3. Relationship between IDA and health status

2.3.1 Immunization coverage

World Health Organisation, considers a child to have received all basic vaccinations if he or she has received: a BCG vaccination against tuberculosis; three doses of DPT vaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPT and 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). Substantial increases in childhood immunization in all the eight provinces of Kenya has been documented to decrease childhood mortality in Kenya (KDHS, 2008).
The possibility that children will become seriously ill or die depends largely on whether their immune systems can fight off infections. Measles, for instance, rarely kills in industrialized countries, but can cause up to 40 percent mortality among infected children in overcrowded situations which may occur following earthquakes, floods or when populations are displaced by conflict. A variety of pathogens such as bacteria, viruses, and parasites are responsible for the major childhood diseases. Bacteria can cause tetanus, diphtheria, pertussis and tuberculosis. Viruses cause polio and measles. A single-celled parasite causes malaria. Childhood vaccination if not properly administered can result in illnesses known to interfere with proper food intake, absorption and utilization in the body contributing to malnutrition (Anekwe & Kumar, 2012).

2.3.2 Deworming interventions

Periodic deworming is carried out at intervals of three months, targeting children 12-59 months of age. This is a measure to improve micronutrient status, especially iron (KNBS & ICF Macro, 2010). Human hookworm infection has been identified as one of the leading causes of IDA in impoverished countries, especially in sub-Saharan Africa, South East Asia, and Oceania. Hookworms are parasitic worms that attach to the inside of the intestines of children and women. Hookworms are long-lived parasites, extracting blood every day to produce a sufficient blood loss that results in IDA (Hotez & Van-Leeuen, 2015).

2.3.3 Malaria epidemic

Malaria is the leading cause of morbidity and mortality in Kenya, with close to 70 percent (24 million) of the population at risk of infection (Dewey & Mayers, 2011).
Although malaria affects people of all age groups, children under five years of age and pregnant women living in malaria-endemic regions are the most vulnerable. The economic and social impacts of malaria are devastating: sick children miss school, working days are lost. Moreover, malaria disproportionately affects the rural poor who can neither afford insecticide-treated bed nets for prevention nor access appropriate treatment when they fall sick. Common malaria control activities based on the epidemiology of malaria in Kenya. Include; vector control using insecticide-treated nets (ITNs) and indoor residual spraying (IRS), case management (using Artemisinin-based combination therapies (ACTs) and improved laboratory diagnosis. Most malarial fevers and convulsions occur at home. Prompt and effective management of malaria cases, is, therefore, important for malaria control across all the epidemiological zones of the country.

Following reported drug resistance to sulfadoxine-pyrimethamine (SP), the government of Kenya in 2006 rolled out the use of artemisinin-based combined therapies (ACTs) for the treatment of uncomplicated malaria. The ACT adopted for Kenya was artemether-lumefantrine (AL). The target for case management of malaria is for 60 percent of fever cases to receive appropriate malaria treatment within 24 hours of onset of fever. Malaria and other illnesses that cause fever contribute to high levels of malnutrition and mortality in children. Fever is one indicator of immune system activation, which can suppress appetite and lead to re-allocation of nutrients away from growth (Dewey & Mayers, 2011).
2.4 Health consequences of IDA

2.4.1. Impaired cognitive and psychomotor development

Iron deficiency has been linked to impaired cognitive development and in addition, it has been reported that impairment of higher mental function like cognition and learning in humans may be linked to changes in neurotransmitter receptors and consequent signal transduction processes in the nervous system that occur due to iron deficiency (Brunt et al., 2012). Several cross-sectional and case-control studies have demonstrated an association between IDA with psychomotor, cognitive abnormalities and poor school performance in children (Halterman et al., 2001). In a recent cross-sectional analysis of NHANES III data, (71%) of iron-deficient children had below-average math scores, versus (49%) of children who had normal iron status (Halterman et al., 2001). Scores of tests on reading, block design, and digit span did not differ. After adjustment for age, gender, race, poverty status, caretaker education, and lead status, iron-deficient children were 2.4 times as likely to have low math scores (95% CI= 1.1-5.2; p=0.03).

Several causal hypotheses have been proposed to explain this association. The oldest is that the brain functions poorly in IDA because of decreased oxygen delivery to tissues. According to this theory, correction of anemia could reverse the neurocognitive deficits seen in cross-sectional studies. An alternative hypothesis is that iron deficiency leads to increased absorption of lead, which can also cause brain damage. Another alternative hypothesis is that, in the fetus, iron deficiency may cause abnormal metabolism of neurotransmitters or hypomyelination, leading to irreversible or very slowly reversible neurocognitive deficits. Evidence for this hypothesis comes primarily from animal studies (Felt et al., 2006). Investigators seeking supporting evidence in humans have measured auditory brainstem responses and visual evoked potentials in a cohort of
Chilean children who were diagnosed to have IDA as infants. At the time of initial diagnosis at 6, 12, or 18 months of age, infants with IDA had slower transmission through the auditory brainstem pathway than healthy controls. Although IDA was diagnosed and treated early, at 4 years of age the children who had IDA as infants still had slower transmission than healthy infants (Algarin, 2003). Recent critical review in Florida identified seven longitudinal studies in which low hemoglobin levels in early childhood were linked to poor cognitive development or school achievement in later childhood (Hurtado, 1999).

### 2.4.2 Behavioral problems

Virtually every case-controlled study done in America that examined the social-emotional behavior of children under 2 years of age found differences in iron-deficient anemic infants (for instance more wary, hesitant, solemn, unhappy, kept closer to their mothers). In a study in Chile, more of the group that did not receive supplemental iron showed no social interaction, no positive effect, no social referencing, and inability to be soothed by words or objects, and a lack of protest when toys were taken away (Lozoff et al., 2006), hence they were not sociable.

### 2.4.3 Nutritional status of children

Malnutrition in Sub-Saharan Africa contributes to high rates of childhood morbidity and mortality. Malnutrition is also related to impaired mental development. Anthropometry provides one of the most important indicators of children’s nutritional status (KDHS, 2014). The height, age and weight data are normally used to compute three summary indices of nutritional status: height-for-age, weight-for-height, and weight-for-age. These three indices are expressed as standardised scores (Z-scores) or
standard deviation units from the median for child growth standards recommended by the World Health Organisation. Children who fall more than two standard deviations below the reference median are regarded as undernourished, while those who fall more than three standard deviations below the reference median are considered severely undernourished. World Health Organization (WHO) classification is according to standard deviation units (Z-scores), based on the (WHO, 2006). Wasting (weight-for-height Z-score–WHZ) indicates thinness. It is usually the result of recent nutritional deficiency and is affected by seasonal shifts associated with the availability of foods and/or prevalence of disease. A WHZ of <-2SD defines the presence of acute malnutrition (wasting). Stunting, represented by low height-for-age Z-score (HAZ), results from extended periods of inadequate food intake, poor dietary quality, increased morbidity, or a combination of these factors. HAZ of <-2SD defines chronic malnutrition (stunting). Weight-for-age Z-score (WAZ) is essentially a composite of weight-for-height and height-for-age, thus a measure of both acute and chronic malnutrition. WAZ of <-2SD is used for defining a child as underweight. A Z-score of <-3SD defines severe levels of each of the indices.

2.4.4. Summary of literature review

Iron is vital for effective child development and it is required in the brain for several important functions including myelination of nerve fibers, energy metabolism and acting as a co-factor for a number of enzymes involved in neurotransmitter synthesis (Beard, 2003). Iron- deficiency in childhood results in cognitive and psychomotor problems that are manifested later in life as reduced academic achievement and work productivity in adulthood (Manterola, Ceccatelli & Mier, 2010). Major causes of IDA include hereditary haemoglobinopathes, (folic acid, vitamin A and iron deficiencies),
low dietary bioavailability of iron, low socio-economic status, poor environmental sanitation and malaria. There are limited studies of IDA in children aged 6-23 months in Kenya and the entire world. The common ones only focus on iron rich foods, but not the prevalence of IDA (KDHS, 2008). Those that focus on the prevalence of IDA base their study on a slightly higher age group $\geq 23$ months old children (Gitau et al., 2013; Foote et al., 2013; Kobina, 2011).
CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study design

The study adopted a cross-sectional analytical design to investigate the prevalence and determinants of IDA among children aged 6-23 months attending Thika level-5 Hospital, Kiambu County, Kenya. This design facilitated and enabled collection of quantitative and qualitative data, identification of associations between the dependent and independent variables of the study (Katzenellenbogen et al., 2002). This design was preferred because it provided a snapshot of the frequency and the characteristics of the study population at a particular point in time.

3.2 Study variables

3.2.1 Dependent variables

Iron-deficiency anaemia, haemoglobin levels (HB Levels), mean cell volume (MCV) and red cell width (RCW).

3.2.2 Independent variables

Socio-demography factors, economic status, sanitation, dietary intake, health and nutritional status.

3.3 Study location

The study was conducted at Thika Level 5 Hospital, situated in Thika West Sub County. Thika District has an elevation of 1531 meters (5026 feet) in altitude with an area of 1,960.2 Sq. Km² and a population of 645,713 people. Communities around are characterized by low to medium income earners and the high population density in most parts of the district has put pressure on land, leading to fragmentation into smaller
uneconomical units. In Thika West Sub-County, all forms of poverty are experienced including food shortage and absolute poverty due to factors such as unemployment, the collapse of the agricultural sector, the collapse of industries, and poor infrastructure (NCAPD, 2005).

3.4 Target population
The study targeted children aged 6-23 months and their mothers/caregivers who were respondents in the study so as to give information about complementary feeding and other relevant issues while children aged 6-23 months were assessed to determine their nutritional status, haemoglobin levels, red cell width and mean cell volume.

3.4.1 Inclusion criteria
Mothers/caregivers with children aged 6-23 months who had resided in Thika West Sub-county for not less than 6 months. Children who were neither significantly ill nor with a major illness such as inflammation, liver disease, autoimmune disorder and not receiving iron supplementation and without a history of blood transfusion were considered for the study.

3.4.2 Exclusion criteria
The children examined and found to have inflammation, liver disease, autoimmune disorder or receiving iron supplementation and also with a history of blood transfusion were excluded from the study as they would skew results.
3.5 Sample size determination

The sample size of 241 mothers/caregiver-child (6-23 months old) pairs visiting the well-baby clinic at the Thika level 5 hospital was estimated. An attendance of twelve months was obtained from the hospital records office, and then the total divided by twelve and an estimate of 623 per month was obtained. The sample size, therefore, targeted 241 mothers/caregiver-child (6-23 months old) pairs. This was calculated using a formula by Cochran, (1963) as cited by Fisher et al., (1998).

The following formula by Fisher et al., (1998) for calculating sample size was used.

\[
n = \frac{Z^2pq}{e^2}
\]

- \(n\) = the desired sample size when the population was more than 10,000
- \(Z\) = the standard normal deviate at 95% confidence level (1.96)
- \(p\) = the estimated proportion of the target population estimated to have iron deficiency anemia.
- \(q\) = 1 - \(p\)
- \(e\) = desired level of precision (0.05)

A prevalence rate of 34.5 % (UNICEF, 2009b), was used to estimate the proportion of pre-school children.

\[
q = 1 - p
\]
\[
e = \text{desired level of precision (0.05)}
\]
\[
n = \frac{(1.96)^2(0.35)(0.65)}{(0.05)^2} = 350
\]

Finite population correction was done to produce a sample size that is proportional to the population, therefore the sample size was calculated as follows; for a population, less than 10,000 the following formula by Fisher et al., (1998) was used.
\[ nf = \frac{n}{1+\frac{n}{N}} \]

Where

\( nf \) = the desired sample when the population was less than 10,000.

\( n \) = sample, when the total population was more than 10,000.

\( N \) = the estimated population of children 6-23 months attending WBC clinic at Thika Level 5 Hospital (623) per month.

\[ nf = \frac{n}{1+n/N} \]

\[ = \frac{350}{1+\frac{350}{623}} \]

\[ = 219 \]

The calculated sample size was inflated by 10% to cater for non-response, to make a sample size of 241. This study has presented data for 227 respondents.

### 3.6 Sampling techniques

Thika Level 5 Hospital was purposively sampled in this study because it is a public health institution and therefore costs are subsidized by the government making it cheap and affordable to the majority of the population around it. Systematic random sampling was used to obtain the study subjects. The estimated respondents per month were an average of 623 children based on the total attendance records of the year 2012 in Thika Level 5 Hospital. This number was divided by the sample size of 241 to obtain the sampling interval of \( \frac{623}{241} = 3 \). The clinic was operated for 5 working days every week, therefore, 24 mothers/caregiver-child (6-23 months old) pair were expected to visit the clinic per day. A random starting point was selected by the researcher writing numbers 1, 2, and 3 on three papers, randomly selecting number one which was to be the first study subject every day. The rest were selected systematically taking every 3\textsuperscript{rd}
mother/caregiver-child (6-23 months old) pair until the expected numbers were attained. The process was repeated for 10 working days between 8.00 am and 1.00 pm until a sample size of 241 mothers/caregiver-child (6-23 months old) pairs were attained.

3.7 Research instruments

3.7.1 Interview schedule

An interview schedule was used to collect data on socio-demographic characteristics, economic status, sanitation practices and health (in terms of malaria infection, immunization and deworming) from the caregivers of children during their routine visit to the well-baby clinic (Onimawo, 2010).

3.7.1.1 Sanitation level in the homesteads

An interview schedule was developed to obtain information on the family’s sanitation data, such as the presence of toilets/latrines, composite pit, household waste, water drainage and living conditions.

3.7.1.2 Malaria and immunization status

Data on malaria episodes was obtained using the interview schedule by asking the caregiver if the child had suffered from fever in the past two weeks and if so, the type of medicine that was administered. The pattern and type of immunizations of these children were obtained from the child information booklet. A child was said to be fully vaccinated if he/she had received BCG vaccination against tuberculosis; three doses of DPT vaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPT and 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 were to be received during the first year of life, however, children younger than one year confirmation were only done if they were complying with vaccination schedule according to their ages (UNICEF, 2013).

3.7.1.3 Helminthic infection bio data
This information was obtained from deworming practices. Questions on whether a child had ever been dewormed, the frequency of deworming and the presence or absence of ringworms were the indices upon which categorization of helminthic infection was done (Lander et al., 2012).

3.7.2 Dietary intake instruments
This was done by a dietary assessment using 24-hour dietary recall and 7-day food frequency questionnaire (Appendix E).

3.7.2.1 A 24-hour dietary recall
This method was preferred because this dietary intake assessment method is short term, hence respondents were more likely to recall all food items consumed during this period in comparison to other dietary intake assessment methods that capture long durations of dietary assessment (Streppel et al., 2013) (Appendix E). The 5-step multiple pass method was used for the 24-hour dietary recall. First, the respondents were asked to list the foods and beverages the children consumed the previous day. The recall period was from the time they woke up to when they went to bed. Next probing was done for any foods and beverages forgotten during the quick list. Thirdly, the time and eating occasion for each food item were recorded. Fourthly, for each food item eaten a detailed
description of ingredients, the amount eaten and any additions were collected. The respondents were provided with household measures such as cups, plates and spoons and asked to measure the amounts eaten. These amounts were measured and converted into weight measurement. Finally probing was done for anything else the child may have consumed during the 24 hours dietary recall period. This method relied on the accurate memory of the respondents and the ability to estimate the portion sizes. This was helped by the interviewer prompting the respondent to remember eating and drinking episodes by time periods, for instance, starting on awakening and linking to daytime activities.

### 3.7.2.2 A 7-day food frequency questionnaire

The Food-frequency questionnaire is widely used because it is more practical and covers a longer period of dietary recall. This method was preferred for this study since it was likely to give a true reflection of the food consumption pattern of the children (Streppel et al., 2013). In order to assess usual food consumption, the 7-day food frequency was considered. Respondents were expected to remember all foods they had eaten the previous 7 days.

The seven food groups included; grains, roots and tubers; legumes and nuts; eggs; flesh meats; vitamin A rich fruits and vegetables; other fruits and vegetables and dairy products (WHO 2008b). Respondents were asked how many times the child was fed on the foods from the 7 food groups in the previous 7 days. Appropriate complementary feeding practices were assessed using minimum meal frequency, minimum dietary diversity and minimum acceptable diet. Minimum meal frequency was obtained by establishing the proportion of breastfed and non-breastfed children 6–23 months of age
who had received solid, semi-solid or soft foods the minimum number of times or more (minimum is defined as two times for breastfed infants 6–8 months; three times for breastfed children 9–23 months; and four times for non-breastfed children (6–23 months) in the previous day.

Minimum dietary diversity was obtained by getting the proportion of children 6–23 months of age who had received foods from four or more food groups during the previous day. The seven food groups used for tabulation of this indicator were: grains, roots and tubers; legumes and nuts; dairy products (milk, yoghurt, and cheese); flesh foods (meat, fish, poultry and liver/organ meats); eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables (WHO, 2008b).

Minimum acceptable diet was obtained by getting the proportion of breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day and non-breastfed children 6–23 months of age who received at least two milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day. The type of iron consumed along with enhancers and inhibitors was determined by carefully taking into consideration any type iron rich foods the children were given, what foods accompanied the iron–rich foods so as to establish the different form of iron and the proportion in terms of percentages that was consumed by the children in the study. These categories included children who took heme iron-rich foods, heme together with non-heme iron rich foods, non-heme iron-rich foods without iron absorption enhancers (vitamin C rich foods) and non–heme iron-rich foods with iron absorption enhancers (Gregory & Gordon, 2012).
3.7.3 Research equipment

3.7.3.1 Hemocue globinometer

Hemocue globinometer (Hemocue, Angelholm HB, Sweden) (Nkrumah et al., 2011) was used to determine haemoglobin level. Haemoglobin determination entailed obtaining a blood specimen from the children by finger pricking followed by measurement on a hemocue globinometer. This apparatus is a portable battery-operated HB meter used for hemoglobin determination in the field. The hemoque system utilizes the principle of oxidation of haemoglobin sodium nitrite and subsequent conversion of haemoglobin to hemoglobin azide by sodium azide. The reagents for these reactions are contained in a small disposable microcuvette of approximately 10 microliters in volume. Ten milliliters of whole blood were drawn up into the microcuvette by capillary action and inserted into the hemocue photometer by the medical laboratory technologist under supervision and assistance of a registered medical officer. The light was then passed through the sample and an absorbance of methaemoglobin azide measured at 570nm and 880nm. The haemoglobin concentration was then displayed as a digital reading, in g/dl. This method was selected because it is fast, reliable, cheap and required minimal training to administer (Nkrumah et al., 2011). The blood specimen was disposed by incineration at 1000°C.

3.7.3.2 Automated Coulter Counter

Automated Coulter Counter (Beckman Coulter Inc., Fullerton, CA, USA) (Cynthia, Barbara & Berger, 2001) was used to determine complete blood count in order to evaluate red cell width and mean cell volume. A complete blood count method that takes into account the coulter principle which states that ‘particles pulled through an orifice, concurrent with an electric current, produce a change in electrical impedance
that is proportional to the volume of the particle traversing the orifice’. This pulse in impedance originates from the displacement of electrolyte caused by the particle (Myers et al., 2005). The medical laboratory technologist under supervision and assistance of a registered medical officer obtained 5 ml venous blood sample from each child’s vein after applying the topical anesthetic cream (2.5% lignocaine, 2.5% prilocaine).

The blood was then transferred to a chemical EDTA with a dilution effect of 1-2 percent to prevent clotting before being tested using an automated coulter counter (Beckman coulter Inc., Fullerton, USA). Finally, the blood specimen were disposed by incineration at 1000°C in an incinerator.

3.7.3.3 Anthropometric tools

They were used in the assessment of nutritional status of the children. Calibrated wooden length board of UNICEF was used to measure the height of the children to the nearest centimeter. For measuring weight, portable scale (Seca model 881) was used to measure the weight of children dressed in light clothing. Weights were recorded to the nearest 0.1kg. Children who could not stand on the scale were weighed with their caregivers, then the caregiver was weighed alone and the difference was used in obtaining the weight of the child. The ages of the children were obtained from the child information booklet. Information regarding weight and age was used to obtain the weight for age Z scores.
3.8 Pretesting of the instruments

This was done on five children accompanied by their caregivers in Ruiru District Hospital so as to optimize the study procedures, estimate the required time to interview each respondent and also to gauge reactions by respondents to the questions in order to frame the questions appropriately eliminating any ambiguity and discriminative questions. After review of the instruments all suggested revisions were incorporated before the instruments were administered in the actual study.

3. 8.1 Validity

This was done to ascertain the degree to which the data collection instruments measured what they purported to measure. The instruments were subjected to critique by three competent experts in the area of nutrition assessment from the department of Food, Nutrition and Dietetics, Kenyatta University. Face validation was used to validate the interview schedules. Questions in the interview schedules were read out to mothers or caregivers of the children before the actual interviewing date and answers recorded by the researcher. The interview schedules were then reviewed based on their feedback.

3.8.2 Reliability

The test-retest method was used to test the consistency of the interview schedule in producing the same results. Ten caregivers from an area similar to the study area were interviewed two times (with a span of one week between the interviews) using the same interview schedule. A comparison was then made between the answers obtained from both interviews. The correlation coefficient was determined using the Cronbach correlation formula by Cronbach & Richard, (2004) which yielded a correlation
coefficient of 0.8 that was acceptable. The pre-test subjects were given an opportunity to make comments and give suggestions concerning the interview schedule.

3.9 Selection and training of enumerators

Three research assistants were recruited. One was a registered medical officer who supervised and assisted the laboratory technologist in blood specimen collection, analysis and disposal. The other was a laboratory technologist who collected, analyzed and disposed blood specimen from the children in research and a nutritionist who distributed the interview schedules and assisted respondents in completing them. The research assistants underwent a two-day training which was facilitated by the researcher. The training was in the form of lectures, discussions, role plays and exercises with the help of training aids. They were first taken through the objectives and methodology of the study.

The training also involved rigorous guidance on interview schedule administration and anthropometric measurements. The research assistants were exposed to a practical experience in conducting the interviews, taking anthropometric measurements during classroom demonstrations, role plays and also pre-testing of the interview schedules. The responses recorded by the research assistants were compared with those recorded by the investigator himself and appropriate advice given to the assistants on areas they needed to improve. Standardization of anthropometric measurements was conducted using the anthropometry data analyzed using ENA for SMART version 2008.
3.10. Data analysis and presentation

Raw dietary data from food frequency questionnaires and 24-hour recall were entered and analyzed with Nutri-survey statistical package (2008). Data generated were then transferred to SPSS version 20 for cross analysis with other variables. Anthropometry data were analyzed using ENA for SMART (2008). The indices of interest were Weight for height, Height for age and Weight for age. WHO (2006) cut-offs were used to interpret the nutritional status. A Z-score of between -2 SD and -3SD categorized the child as moderately malnourished, while \( \leq 3\)SD reflected severely malnourished child. Anthropometric indices were calculated using reference medians recommended by World Health Organization (WHO) and classified according to standard deviation units (Z-scores), based on (WHO, 2006). To determine wasting, weight for height Z-score (WHZ) indicating thinness was used, for stunting, height for age Z-score (HAZ) was used and for underweight, weight-for-age Z-score (WAZ) which is a composite of both (WHZ) and (HAZ) was used.

Descriptive statistics (mean, standard deviation, frequencies and percentages) was used to describe the daily intake of nutrients, sanitation economic and socio-demographic factors. IDA status was based on HB levels, MCV and RCW. After reading of the haemoglobin and complete blood count values, categorization was done as severe iron deficiency (<7g/dl), medium iron deficiency (\( \geq 7 \) g/dl to < 11g/dl) and normal iron level (\( \geq 11 \)g/dl) for the children (WHO, 2001). Children with red cell width, values (>14%) were considered to have IDA whereas those with values (\( \leq 14 \)) were considered not to have IDA (WHO, 2001). MCV, on the other hand, was determined by considering values of (<75FL) that indicated IDA whereas values (\( \geq 75 \)FL) indicated that the children did not have IDA (WHO, 2001; Janus & Hopkins, 2010).
Minimum meal frequency, minimum dietary diversity and minimum acceptable diet were indices of assessing appropriate complementary feeding practices. Inferential statistics was used to test for associations between variables. Chi-square test was used to test for associations between the categorical and continuous variables. The Chi-square test was used to determine the relationship between IDA with dietary intake of iron-rich foods and complementary feeding practices, sanitation, HB, RCW and MCV. Binary logistic regression was used to test the significance between IDA with malaria, helminthic infestation and immunization status. A p value of < 0.05 was used as the criterion for statistical significance.
### Table 3.1. Data analysis

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Variables requiring descriptive analysis</th>
<th>Dependent Variables</th>
<th>Independent Variables</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>To establish the prevalence of IDA through haemoglobin and complete blood</td>
<td>IDA, HB, MCV and RDW</td>
<td>IDA, HB, MCV and RDW</td>
<td>Percentages, mean,</td>
<td></td>
</tr>
<tr>
<td>count determination</td>
<td></td>
<td></td>
<td>standard deviation,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>chi-square</td>
<td></td>
</tr>
<tr>
<td>To establish the nutritional status of children aged 6-23 months</td>
<td>Wasting, underweight and stunting</td>
<td>Wasting</td>
<td>Percentages, Mean</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and stunting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To establish the complementary feeding practices alongside intake of iron</td>
<td>MDD, MMF and MAD</td>
<td>MDD, MMF and MAD</td>
<td>Percentage, mean</td>
<td></td>
</tr>
<tr>
<td>rich foods in children aged 6-23 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To determine whether the IDA status of the children aged 6-23 months is</td>
<td>Food type, Age, sex, Occupation, income,</td>
<td>IDA</td>
<td>Percentage, mean and</td>
<td></td>
</tr>
<tr>
<td>related to their dietary intake or socio-demography</td>
<td>education, caregiver</td>
<td></td>
<td>standard deviation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To establish the relationship between IDA and sanitation of households</td>
<td>Waste disposal, human waste disposal,</td>
<td>IDA</td>
<td>Percentages, Mean,</td>
<td></td>
</tr>
<tr>
<td>with children aged 6-23 months</td>
<td>presence of stagnant water</td>
<td></td>
<td>Chi-square test</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To determine whether the IDA status of the children aged 6-23 months is</td>
<td>Immunization, malaria contraction,</td>
<td>IDA</td>
<td>Mean, Chi-square test,</td>
<td></td>
</tr>
<tr>
<td>related to their health status as influenced by immunization; malaria</td>
<td>helminthic infection</td>
<td></td>
<td>Binary logistic</td>
<td></td>
</tr>
<tr>
<td>contraction and helminthic infection</td>
<td></td>
<td></td>
<td>regression</td>
<td></td>
</tr>
</tbody>
</table>

3.11. Logistical and ethical considerations

A letter of introduction to get approval to conduct the study was first obtained from the graduate school Kenyatta University (APPENDIX H). Permit to conduct the study was then sought from Kenyatta University Ethics and Review Committee (APPENDIX I). Thereafter a research permit was obtained from the National Commission for Science, Technology and Innovation (APPENDIX J). Permission to access medical data was sought from the medical superintendent at Thika Level 5 Hospital.

Since the study was a high risk because of biochemical tests that were to be done involving the drawing of blood from the vein and finger pricking which might have resulted in inflammation of the vein due to blood clots, excess bleeding and even fainting, precaution was taken. This included using proper needles for drawing blood, using proper skin cleansing techniques such as cleaning the children’s skin with clean spirit swabs before drawing blood and also employing a trained phlebotomist to ensure the procedure was done effectively to avoid unnecessary injuries.

Benefits of the study included free HB testing and free nutritional and medical advice for those found with IDA. Participant’s confidentiality was assured and the right to be recruited in the study or not was at the sole discretion of the parent/guardian. Informed written or thumbprint consent was sought from the guardians of the children (Appendix C).
CHAPTER FOUR: FINDINGS

4.1 Introduction

This study was designed to establish the prevalence of IDA and its determinant factors in children aged 6-23 months attending a well-baby clinic at Thika level 5 Hospital, Kenya. A total of 241 children were recruited to the study, in the month of May 2013. The response rate was (94%). The remaining respondents (6%), although previously having given consent to participate in the study, declined to allow their children to undergo blood testing hence their data were not included in this study. The economic, socio-demographic characteristics, health assessment, as well as nutrition assessments of the children and caregivers were done. Dietary data were assessed by the 24-hour dietary recall and 7-day food frequency questionnaire to obtain minimum meal frequency, minimum dietary diversity, minimum acceptable diet and quantity of nutrient intakes. Food types consumed by the children were converted into metric values and then into values of energy, carbohydrate, protein, iron and vitamin C.

Children’s health and demographic characteristics were analyzed using descriptive statistics of (mean, standard deviation, frequencies and percentages). IDA was assessed through haemoglobin determination and complete blood count indices of mean cell volume and red cell width.

More than half of the children were aged between 12-23 months with female children being the highest in number. There were high rates of malnutrition from the study, including wasting, underweight and stunting. Their dietary intake was unsatisfactory. Most foods consumed were energy giving foods such as porridge, potatoes and maize paste with kales. The majority failed to take the vital protein diet that was key in building up their bodies.
The majority of children had either completed immunization or were compliant with an immunization schedule based on their ages, despite some having malaria and helminthic infection.

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 prevalence of IDA from the study was found to be (73.2%) with a mean HB of (8.3 ± 2.3g/dl). Results are reported under the following headings: characteristics of the study population, nutritional status of the children, prevalence of IDA in children, relationship between mean cell volume with independent variables, relationship between red cell width with independent variables, relationship between haemoglobin with independent variables, relationship between IDA and the caregiver of the child, the relationship between IDA among the children and the income of the caregiver, dietary intake among the children, sanitation in the children’s homestead and health condition of the children.

4.2 Characteristics of the study population

4.2.1 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.
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 4.1).

**4.2.2 Socio-economic profiles of the caregivers**

The largest proportion of caregivers in the course of the day (70%) were the mothers of the children. 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 4.1. Demographic characteristics of the children

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

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.
Table 4.2. Socio-economic characteristics of the caregivers

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

*Tertiary education refers to either college or university education.

4.3 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).

4.3.1 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 4.3).
Table 4.3. Nutritional status of children

<table>
<thead>
<tr>
<th>Child’s nutritional status</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wasting (WHZ)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>145</td>
<td>63.9</td>
</tr>
<tr>
<td>Moderately wasted</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Severely wasted</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td><strong>Underweight (WAZ)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>40</td>
<td>17.5</td>
</tr>
<tr>
<td>Normal</td>
<td>101</td>
<td>44.5</td>
</tr>
<tr>
<td>Moderately underweight</td>
<td>68</td>
<td>30</td>
</tr>
<tr>
<td>Severely underweight</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td><strong>Stunting (HAZ)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>209</td>
<td>92</td>
</tr>
<tr>
<td>Moderately stunted</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Severely stunted</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

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

4.3.2 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 4.3).

4.3.3 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 4.3).
4.3.4 Nutritional status according to the sex of a child

From Table 4.4, 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>
<thead>
<tr>
<th>Sex Distribution</th>
<th>Forms of malnutrition</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Wasting</td>
<td>23</td>
<td>18.4</td>
<td>18</td>
<td>17.6</td>
<td>41</td>
</tr>
<tr>
<td>Underweight</td>
<td>24</td>
<td>19.2</td>
<td>19</td>
<td>18.6</td>
<td>43</td>
</tr>
<tr>
<td>Stunting</td>
<td>8</td>
<td>6.4</td>
<td>6</td>
<td>5.9</td>
<td>14</td>
</tr>
</tbody>
</table>

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

4.4 Prevalence of iron deficiency anaemia

Prevalence of IDA is estimated 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>
<thead>
<tr>
<th>Variable</th>
<th>N=227</th>
<th>Recommended Levels</th>
<th>% with IDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>58 ± 2.2 FL</td>
<td>≥ 75 FL</td>
<td>70.1%</td>
</tr>
<tr>
<td>Red cell width</td>
<td>18.1 ± 2.1%</td>
<td>≤ 14 %</td>
<td>74.0%</td>
</tr>
<tr>
<td>Haemoglobin</td>
<td>8.3 ± 2.3 g/dl</td>
<td>≥ 11g/dl</td>
<td>75.6%</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>73.2 %</td>
</tr>
</tbody>
</table>

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 4.5).
4.5 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 4.6).

**Table 4.6. Relationship between IDA and the nutritional status of the children**

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

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

4.6 Relationship between mean cell volume 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 4.7). 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).

Table 4.7. Relationship between mean cell volume with independent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Iron deficiency anaemia</th>
<th>Mean (MCV FL) SD</th>
<th>Chi square p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>Yes</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8months</td>
<td>12</td>
<td>23.5</td>
<td>39</td>
</tr>
<tr>
<td>9-11months</td>
<td>19</td>
<td>35.2</td>
<td>35</td>
</tr>
<tr>
<td>12-23 months</td>
<td>38</td>
<td>31.1</td>
<td>84</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>33</td>
<td>32.4</td>
<td>69</td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>17.6</td>
<td>103</td>
</tr>
<tr>
<td>Malaria infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>21</td>
<td>36.2</td>
<td>37</td>
</tr>
<tr>
<td>No</td>
<td>43</td>
<td>25.4</td>
<td>126</td>
</tr>
<tr>
<td>Helminthic Infestation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>8.3</td>
<td>11</td>
</tr>
<tr>
<td>No</td>
<td>53</td>
<td>24.7</td>
<td>162</td>
</tr>
</tbody>
</table>

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.

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 4.7) implying that neither did gender of children nor helminthic infection among the children seem to influence their IDA status.

4.7 Relationship between red cell width 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 4.8), 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 4.8).

Table 4.8. Relationship between red cell width with independent variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Iron deficiency anaemia</th>
<th>Mean RCW (%) SD</th>
<th>Chi square p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (%)</td>
<td>Yes (%)</td>
<td>Total (%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8months</td>
<td>12 (24.1)</td>
<td>39 (75.9)</td>
<td>51 (22.4)</td>
</tr>
<tr>
<td>9-11months</td>
<td>9 (18)</td>
<td>45 (82)</td>
<td>54 (23.7)</td>
</tr>
<tr>
<td>12-23 months</td>
<td>38 (31)</td>
<td>84 (69)</td>
<td>122 (53.9)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25 (24.5)</td>
<td>77 (75.5)</td>
<td>102 (44.9)</td>
</tr>
<tr>
<td>Female</td>
<td>47 (37.6)</td>
<td>78 (62.4)</td>
<td>125 (55.1)</td>
</tr>
<tr>
<td><strong>Malaria infection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6 (10.3)</td>
<td>52 (89.7)</td>
<td>58 (25.6)</td>
</tr>
<tr>
<td>No</td>
<td>45 (26.6)</td>
<td>124 (73.4)</td>
<td>169 (74.4)</td>
</tr>
<tr>
<td><strong>Helminthic Infestation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1 (8.4)</td>
<td>11 (91.6)</td>
<td>12 (5.3)</td>
</tr>
<tr>
<td>No</td>
<td>56 (26.0)</td>
<td>159 (74.0)</td>
<td>215 (94.7)</td>
</tr>
</tbody>
</table>

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 4.8) implying that both the gender of children and helminthic infection did not seem to influence their IDA status.
4.8 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.

Table 4.9. Relationship between haemoglobin with independent variables

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

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.

The mean haemoglobin (Table 4.9) 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 4.9), 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 4.9) that did not seem to significantly affect their IDA status.

4.9 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 4.10).

<table>
<thead>
<tr>
<th>Relationship of the child towards the caregiver</th>
<th>Iron deficiency anaemia</th>
<th>Chi-square; p value=0.063</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Own child</td>
<td>55</td>
<td>25.8</td>
</tr>
<tr>
<td>Adopted or fostered child</td>
<td>2</td>
<td>16.7</td>
</tr>
<tr>
<td>Other relation (niece or nephew)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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

4.10 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 4.11).
Table 4.11. Income and its relationship with IDA among the children

<table>
<thead>
<tr>
<th>Occupation of the caregiver</th>
<th>Iron deficiency anaemia</th>
<th>Chi-square ; p = value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Employed salaried</td>
<td>16</td>
<td>28.1</td>
</tr>
<tr>
<td>Waged labor</td>
<td>13</td>
<td>16.7</td>
</tr>
<tr>
<td>Business person</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Farming</td>
<td>7</td>
<td>38.9</td>
</tr>
</tbody>
</table>

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.

4.11 Dietary intake among the children

4.11.1 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.

Table 4.12. 7 day food frequency questionnaire of children 6-23 months old

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

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

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. 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.

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. 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%).

4.11.2 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.

![Figure 4.1. Percentages of heme and non-heme iron sources consumed](image)

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 4.1).

**4.11.3 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 4.13. Complementary feeding practices

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

4.11.3.1 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.

4.11.3.2 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 (UNICEF, 2011). The percentage of children who met the minimum meal frequency was (58%) whereas (42%) did not meet the RDA.

4.11.3.3 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.

4.11.4 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 4.14).
Table 4.14. Adequacy of kilocalories (Kcal) and consumption of selected nutrients by children 6-23 months old

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

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 4.14).

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 4.14).
Table 4.15. Relationship between IDA with dietary intake of Iron among the children

<table>
<thead>
<tr>
<th>Variable</th>
<th>No</th>
<th>%</th>
<th>Yes</th>
<th>%</th>
<th>Total</th>
<th>%</th>
<th>Chi-square p=value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary intake of iron rich foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.002*</td>
</tr>
<tr>
<td>Below 8mg/day</td>
<td>18</td>
<td>23.4</td>
<td>59</td>
<td>76.6</td>
<td>77</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>8 and above mg/day</td>
<td>63</td>
<td>42</td>
<td>87</td>
<td>58</td>
<td>150</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

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).

4.12 Sanitation in the children’s homestead.

4.12.1 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 4.2).

Figure 4.2 Rubbish waste disposal
4.12.2 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).

![Diagram showing human waste disposal]

**Figure 4.3. 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 4.3).

4.12.3 Presence of stagnant water

About (32.2%) resided close to stagnant water sources, whereas (67.8%) were not near any stagnant water source (Table 4.16).
Table 4.16. Relationship between IDA and sanitation practices in the children’s homesteads

<table>
<thead>
<tr>
<th>Variable</th>
<th>Iron deficiency anaemia</th>
<th>Chi-square; p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rubbish waste disposal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite pit</td>
<td>No 24.7% 125%</td>
<td>Total 166% 73.1%</td>
</tr>
<tr>
<td>In the open near the homestead</td>
<td>Yes 26.3% 45%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.032*</td>
</tr>
<tr>
<td><strong>Human waste disposal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet/Latrine</td>
<td>55% 26% 157%</td>
<td>212% 93.4%</td>
</tr>
<tr>
<td>Other place</td>
<td>11% 73.3% 4%</td>
<td>15% 6.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.000*</td>
</tr>
<tr>
<td><strong>Presence of stagnant water</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lives near stagnant water</td>
<td>19% 26.1% 54%</td>
<td>73.9% 73%</td>
</tr>
<tr>
<td>Lives away from stagnant water</td>
<td>Yes 26% 114%</td>
<td>74.0% 154%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.000*</td>
</tr>
</tbody>
</table>

*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 4.16) 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 4.16) thus, children living in homes close to the stagnant water were more likely to have IDA.

### 4.13 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.

#### Table 4.17. Health status among the children

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

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%).

Assessment of universal immunization is done against the six vaccine-preventable diseases (namely; tuberculosis, diphtheria, whooping cough, tetanus, polio and measles) (UNICEF, 2013). 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 4.18. Relationship between IDA with health status of the children**

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

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 DPT vaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPT and 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).

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 4.18). 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 4.18).
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).
CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Introduction

The prevalence of IDA reported in the present study was (73.2%). This was expected since, in Thika District, all forms of poverty are experienced including food scarcity, absolute poverty due to factors such as unemployment, the collapse of the agricultural sector and industries along with poor infrastructure (NCAPD, 2005). The percentage of children malnourished was high with factors such as poor dietary intake, inappropriate complementary feeding and poor health in terms of malaria being cited as the contributory factors to IDA among the children. Other determinants of IDA included the age of the child, education, and occupation of the caregiver.

5.2 Socio-demographic profiles of the children and caregivers

Age of the children is an important factor. The majority of children were aged between 12-23 months. This was not expected since from the past, most immunizations are completed at 9 months. The period from 9 months to 5 years experiences less child welfare clinic turnouts because of only growth monitoring and vitamin A supplements that are given out. The high attendance in children 12-23 months of age from this study might have been partly because of the newly rolled out measles vaccine that is given out at 18 months of age in children. Female children had a higher turnout (54.8%) in comparison to the male children (45.2%) in the present study. Two similar studies showed slightly different results in terms of the turnout with the present study. The first one by KDHS, (2008) that recorded a turnout of (48.9%) for female children and (51.1%) for male children in the Central province of Kenya and also a study done by Osazuwa & Ayo, (2010) where the turnout for male children was higher (51.26%) than that of female children (48.73%).
Consistent with Sparks, (2011), the majority of caregivers reported in his study were mothers of the children who took care of the children throughout the day. Religion is a determinant of what people eat or not eat. Christians from the study were the dominant group with non-christians who were Muslims being the minority. Religion, however, did not pose any risk from IDA since one food that was not eaten was substituted with another from the same group. For instance, Muslims said they did not eat pork, but they substituted it with beef under the same food group.

5.3 Nutritional status

Malnutrition places children at increased risk of morbidity and mortality and it is also shown to contribute to impaired mental development (Abubakar et al., 2012). Three measures of growth failure were used to assess these children; wasting (acute malnutrition), stunting (chronic undernutrition) and underweight (acute malnutrition and/or chronic undernutrition). This is because each reflects a unique and different condition (WHO, 2006). According to the findings, the prevalence of wasting, underweight and stunting were above the WHO acceptable threshold levels for developmental areas which are each projected to be below 5% each for wasting, underweight and stunting in normal conditions and even in poor countries (WHO, 2006).

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.

5.3.1 Wasting in children

Children whose weight-for-height is below minus two standard deviations (-2SD) from the median of the reference population are considered wasted or thin. Wasting represents a failure to receive adequate nutrition during the period immediately before the survey, and typically is the result of recent illness episodes, especially diarrhoea, or of a rapid deterioration in food supplies. From the study, 18% of the children were wasted and 5% severely wasted. These results are a bit different with those of KDHS, (2014) where 5% of the total children were found to be wasted and 1% severely wasted. These results are, however, much close to those of Mutakaa, (2013) who found that 15.4% of children were wasted and 4.1% severely wasted in a study in Mathare Valley, Nairobi County.

5.3.2 Underweight in children

Children whose weight-for-age is below minus two standard deviations (-2 SD) from the median of the reference population are considered underweight. The measure reflects the effects of both acute and chronic malnutrition. Findings indicate that (19%) of the children were underweight with (8%) being severely underweight (Table 4.3). These findings slightly differ with those of Mutakaa, (2013) where (12%) of the children were underweight and (4.5%) severely underweight and also results by KDHS,
(2014), that classified (11%) of children as underweight and (2%) as severely underweight.

5.3.3 Stunting in children

Children whose height-for-age is below minus two standard deviations (-2SD) from the median of the reference population are considered stunted or short for their age. Stunting is the result of failure to receive adequate nutrition over an extended period and may also be affected by recurrent or chronic illness. From the study (6%) of the children were stunted with (2%) being severely stunted. These values are lower in comparison to results by KDHS, (2014) that found (26%) of children to be stunted and (8%) severely stunted and also results by Mutakaa, (2013) where (15%) were stunted and (5.7%) severely stunted.

5.3.4 Nutritional status and sex of a child

Gender inequality in terms of nutritional status has been documented in several studies. In a study by Ndiku et al., (2010), female children were more wasted, stunted and underweight than male children. Also, energy intakes for male children were higher than that for female children. In a KDHS, (2014) study, male children were found to be more stunted, wasted and underweight in comparison to the female children. From the current study, female children had better nutritional status in comparison to the male children as reflected by their lower percentage of wasting, underweight and stunting, which were (18.4%), (19.2%) and (6.4%) respectively for male children and (17.6%), (18.6%) and (5.9%) for female children. These results are consistent with Mutakaa, (2013) and also KDHS, (2014), where female children were found better nutritionally than the male children.
5.3.5 Haemoglobin level and the nutritional status of the study participants

Poor nutritional status places children below 5 years at risk of IDA (Abubakar et al., 2012). From the study, all the wasted, underweight and stunted children had mean HB below the recommended threshold of (≤11g/dl). This calls for immediate public health action. Children who were wasted, underweight and stunted all had lower mean HB in comparison to children with normal anthropometric measurements (Table 4.6). These results are consistent with Ferreira dos Santos, (2011) in a Brazilian study in children. These values are, however, lower compared to results of a study by Bhandari et al., (2013) conducted in Nepal in 2013 where nearly a quarter of the children were found to be severely underweight (-3SD) whereas (60%) were moderately underweight (-2SD). This might have been attributed to low socio-economic status that was evident in the current study.

Since the haemoglobin level decreased in all levels of malnutrition for wasting, stunting and underweight as they approached (-3SD) Z scores (Table 4.6) we conclude that the IDA status of the children is related to their nutritional status, and therefore fail to reject the second null hypothesis and conclude that ‘the IDA status of the children is related to their nutritional status’.
5.4 Mean cell volume of the study participants

Mean cell volume (MCV) and mean cell haemoglobin (MCH) provide identical information and are interchangeable in terms of their value in identifying the nutritional iron deficiency. MCV less than 75FL (femtoliters) is the value that has been used widely for the evaluation of nutritional iron deficiency (WHO, 2004). Low serum hemoglobin in the setting of reduced mean cell volume (MCV) is usually the initial finding of IDA on a routine complete blood count (Amy, 2010). The lower the MCV the higher the IDA level (Sunil, 2014).

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. These results are consistent with Mahmoud et al., (2014) in a study of IDA among children under 3 years in Kassala, Eastern Sudan, where higher MCV was recorded among female children in comparison to male children.

The majority of children with malaria infection had lower MCV. This was expected since malaria infection results in the destruction of red blood cells that are a component of MCV resulting in high prevalence rates of IDA (Bhutta, 2010). From the study, children with and without helminthic infection had MCV below the recommended values, hence IDA was evident among these children. From this study a very small proportion of children had helminthic infection, possibly explaining why helminthic infection did not significantly determine the IDA status.
5.5 Red cell width of the study participants

Current strategies to identify IDA rely on markers involving high costs. Red cell width is a reliable and preferable method highly recommended due to its low cost, sensitivity and specificity in its diagnosis of IDA (Aulakh et al., 2009). The cutoff value for RCW used in this study was (≤14 %) (WHO, 2001). Red cell distribution is a new routine parameter in fully automated hematology analyzer that can give the idea of early IDA before another test. It gives the idea of red cell size variation which is the earliest morphological changes in IDA (Sultana, 2013). The higher the RCW the higher the IDA level (Sunil, 2014).

Red cell width was evidently high in children aged 12-23 months hence corresponding to high rates of IDA and low in children aged 6-8 months. These high values of RCW in children aged 12-23 months were expected because this is the age at which iron requirements are highest in the growth of a child and any deficiencies of iron in the diet can translate to IDA in the children (Hermoso et al., 2011). In addition, this was the age with the lowest mean haemoglobin from the study. These results are consistent with Roosy et al., (2009) where RCW was directly proportion to the age of the children.

In relation to gender, 63.8 % of females had RCW below the cutoff values whereas only 10.1% of male children had RCW below the cut-off values. This pattern might have been related to the higher IDA values recorded among female children in the current study. Most children with malaria infection did not meet the cutoff values for RCW but a higher proportion of those without malaria infection met the cutoff values for RCW. Malaria parasites may have led to destruction and significant variation of red cell size (Roosy et al., 2009) hence resulting in lower values of RCW in children with malaria.
Children with helminthic infection had a lower mean RCW in comparison to the children without helminthic infection. These results were expected since helminths most likely resulted in the reduction of iron absorption and gastrointestinal blood loss consequently IDA in children (Lander et al., 2012). Results from the present study indicate that the mean RCW was \( (18.59 \pm 2.1) \) above the cut-off values of \((\leq 14\%)\) (WHO, 2001) suggesting an elevated level of IDA in these children. This test in the present study was used as a confirmatory test to ascertain the existence of IDA. These figures for RCW indeed confirm IDA to be high among the study participants.

5.6 Socio-demographic characteristics and its relationship with IDA among the children

Age of children has been found to be a risk factor for IDA where some studies have shown the risk to increase as the age progresses from 6 to 23 months (Yousefichaijan et al., 2014) while others have demonstrated the contrary, where the risk of IDA is documented to reduce with increasing age from 11-23 months (Mauricio et al., 2013). In a study by Yousefichaijan et al., (2014) the mean haemoglobin level was observed to decrease as the age of the children increased. In Southwest Iran, similar observations were made where the prevalence of IDA was highest among children aged 12 to 23 months and lowest in children under 12 months of age (Leal et al., 2011). The present study observed a positive significant relationship between age and IDA where the risk of IDA increased with increasing age. This was evident from the mean haemoglobin values which were observed to decrease with increasing age (Table 4.9). Such observations are expected due to increased iron requirements as the age of the children advance from 6 months to 2 years (Aamer, 2011).
Studies done in the past have found a varying trend in the relationship between gender and haemoglobin levels in children under 5 years of age. Some studies have found a significant relationship while others not. There is, however, no causal hypothesis or mechanism to explain this. A study by Romano et al., (2012) in West Malaysia observed that iron deficiency was significantly higher in female children (chi-square value; p=0.032) compared to male children. However, in a report by Rockville, (2006) the prevalence of IDA did not seem to differ based on gender. Male children from the present study had a slightly higher mean HB in comparison to female children, despite the fact that the gender from the present study was not significantly associated with haemoglobin level.

Parental care is likely to have a protective effect on the haemoglobin levels because children under full parental care are considered to be better nutritionally as opposed to those under alternate care (Sparks, 2011). The highest percentage of caregivers from this study were mothers who took care of children throughout the day. The mothers or caregivers from this study, however, did not significantly affect IDA status.

Occupation of the mother or caregiver is an important determinant of the purchasing power and food availability, in turn, determining the nutritional status of the children. The present study observed that a very small fraction of mothers or caregivers practiced farming, which might have been because the majority had just come into the area in search of employment and very few owned land in the area as a result of permanent residency. Children of caregivers who practiced farming had the highest mean HB value compared with the other categories (Table 4.10). These results are consistent with
Ayieko & Midikila, (2010) where rural farming communities were observed to have better access to food thereby reducing reliance on income to provide for family meals.

The majority of the caregivers did small scale businesses and waged labor (Table 4.2). The small scale businesses and waged labor contributed to unreliable and inadequate income, in turn, impacting negatively on the food availability and nutritional status, which might have contributed to low HB values of children under their care (Table 4.9). The children with caregivers who were employed and salaried had the second highest HB levels after the children of caregivers who practiced farming (Table 4.9). Children whose caregivers were not employed suffered severe IDA with none having adequate iron status. These results are consistent with that of a Bangladesh study in children aged 6-59 months by Khan et al., (2016), showing comparison between children of poor households, according to the composite wealth index, middle and rich household’s children that were (26%) and (34%) less likely to be anaemic respectively. A similar observation was made in a study done by Desai et al., (2005) in children less than 36 months. Children from poorer households were more likely to be anaemic compared to those from wealthier households.

Education is an important determinant of IDA due to its link to nutritional knowledge. This study reported a direct linear relationship between haemoglobin levels and education such that as the level of education advanced the haemoglobin values increased (Table 4.9). These findings are in agreement with Romano et al., (2012) where univariate analysis demonstrated that, the lower the level of the mother's education the lower the haemoglobin levels (OR=2.52; 95% CI=1.38–4.60; chi-square value; p =0.002). The study findings on the analysis of education and HB levels resulted
in a (chi-square value; = 0.002) denoting that education of the caregiver significantly affected the IDA status. These findings are in agreement with a series of studies one by Hyeon-Jeong et al., (2011) where more educated mothers were less likely to develop anaemia (chi-square value =0.0324) and iron deficiency (chi-square value; p= 0.0577) unlike the less educated mothers as reflected by their consumption of meat, poultry and derivatives (chi-square value ; p<0.0001). In a study done in Korea by Hyen-Jeon et al., (2011), the children of more educated mothers had lower indices of iron status and serum iron and also rates of anemia and iron-deficiency were found to be high among children of less educated mothers. In a Bangladesh study among children aged 6-59 months by Khan et al., (2016), children of non-educated, primary and secondary educated parents were more likely to be anaemic than children of parents with higher education. In addition, a study by Ndanu et al., (2013) in children aged 0-59 months in women’s prisons in Kenya, linked education level of the mothers to the nutritional status of their children.

Religions do not hold exactly the same ideology about diet, health, and spiritual wellness despite the fact that many do embrace similar practices. Religious leaders of the day developed rules about the consumption of foods and drinks, mainly due to lack of mechanisms to refrigerate or preserve foods which led to certain rituals, such as the draining of blood from slaughtered animals, while restrictions on the eating of foods known to spoil easily, such as eggs, dairy products, and meats, were devised for safety reasons (Abraham & Birmingham, 2008). A study by Abraham & Birmingham, (2008) found an association between religion and eating disorders, however; from this study religion did not significantly affect the IDA status of the children, possibly because one
food that was not eaten due to religious reasons was complemented by another one in the same food group (Table 4.2).

Muslims interviewed confirmed not to eat pork however they took other meat substitutes like chicken and beef hence minimizing the risk. The present study found out that more respondents were christians, unlike Muslims. This was expected since in Central Province of Kenya Pentecostal churches being equated to Christians are many as opposed to mosques which are few indicating few Muslims.

The prevalence of IDA in children aged 6-23 months attending Thika level 5 Hospital well baby clinic was more than 34.5% we thus reject the null hypothesis and conclude that ‘The prevalence of IDA in children aged 6-23 months attending Thika level 5 Hospital well baby clinic is more than 34.5%’

5.7 Relationship between income and haemoglobin level among the children

From the study, the higher the income of caregivers based on their type of occupation the higher the haemoglobin levels of their children. Percentage of IDA was highest among children of parents who were wage employed. These results are consistent with Asefa, Mosaic & Hamza, (2014) in their IDA study among children in Southwest Ethiopia and also another one by KDHS, (2008) where the higher the wealth quintile of the mothers the more the consumption of iron rich foods.

5.8 Food consumption among study participants

Breastfeeding practices and timely introduction of complementary foods are important determinants of the nutritional status of children, particularly among children under two
years of age. With improved nutritional status, the risk of childhood mortality is reduced and development is enhanced (KDHS, 2014). Delayed introduction of complementary foods has also been associated with nutritional deficiencies of iron, zinc, vitamin A and calcium.

The role of macro and micronutrients cannot be underestimated in determining the iron levels in the blood. The consumption of iron rich foods, vitamin-A-rich fruits and vegetables and other fruits and vegetables was low from this study. These findings compare with similar studies conducted in Kenya by Chelimo, (2008) and in Nepal by Joshi et al., (2011). The low consumption of vitamin A-rich fruits and vegetables may have been contributed to the high poverty level, therefore, limited income to purchase food. Studies in Kenya have shown porridge to be the main cereal introduced to children (Murage et al., 2010; Chelimo, 2008). This was evident from the study. Caregivers interviewed confirmed to introduce porridge as the first food to their children. Starch was consumed in the highest percentage (98%) (Table 4.12) among the food groups, mainly in the form of porridge, irish potatoes, green bananas and pumpkin. Despite the fact that starch was consumed in the highest percentage among the children, the mean kilocalorie intake in 24 hours was below the recommended level (436 ± 14-kilo calories) (WHO, 2008). The frequent consumption of starch might have contributed to the low mean value of haemoglobin because of its role in binding iron due to the phytates and polyphenols it contains (Gregory & Gordon, 2012).

The non–heme iron sources without enhancers were the highest consumed (46%) whereas heme iron sources were least consumed (7%). They mainly included beef, chicken, fish and eggs (Figure 4.1). Most mothers confirmed to have included legumes such as beans and green grams in the children meals, although they did not include vitamin
C rich foods such as fruits and green leafy vegetable sources to improve the bioavailability of iron in these legumes. This might have contributed to the low mean HB $(8.3\pm2.3 \text{ g/dl})$ from the study. Studies in the past have found a direct linear relationship between iron level consumed in the diet and the haemoglobin level in the blood (Gitau et al., 2013) which is in agreement with the present study. This is evident from (Table 4.15) showing a significant positive relationship between children who met the RDA of iron through their diet and IDA status.

Most of the children had been introduced to solid and semi-solids foods by the age of 6 months as per the recommendations by WHO, (2008b). The minimum acceptable diet recommends that breastfed children 6-23 months be fed foods from four or more food groups daily. Non-breastfed children should be fed milk or milk products in addition to foods from four or more food groups. This recommendation also requires that breastfed infants age 6-8 months be fed at least twice a day, while breastfed children aged 9-23 months must be fed at least three times a day. For non-breastfed children aged 6-23 months, the minimum meal frequency is solid or semi-solid food or milk feeds at least four times a day (IYCFP, 2010; KDHS, 2014).

Consumption of a diverse diet (of 4 or more out of 7 food groups) is recommended by WHO , (2008b) irrespective of routine vitamin A supplementation. Scientific studies have established that appropriate dietary diversity is associated with improved child nutritional status (Antwiwaa, 2011). Percentage of children who met the minimum dietary diversity was (34%), whereas (58%) and (39%) met the minimum meal frequency and minimum acceptable diet respectively. The minimum acceptable diet from this study was 39%, slightly higher than that for KDHS, 2014, which was 21%.
These results indicated slightly better nutritional status in Thika District compared to national figures (KDHS, 2014). 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.

5.9 Sanitation in the children’s homes

Household waste disposal when inefficiently done results in the transmission of vector-borne diseases. Examples of such diseases included diarrhoea and cholera that affect iron absorption. From the present study, waste disposal was not done adequately. A higher percentage (73.1%) of rubbish was disposed of in the open, near the homesteads. In addition, (6.16%) of human waste was disposed of in bushes hence likely to expose children to infections resulting in inefficient iron absorption. In addition, the population residing near stagnant water was very high in turn increasing the risk of water-borne diseases and malaria. These findings are consistent with that of a similar study in West Malaysia carried out between November 2007 to July 2009 among children seeking to find out the association between anaemia, IDA, neglected parasitic infections and socio-economic factors. Human waste was cited as an underlying cause of anaemia (Romano et al., 2012). 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.

The significant positive relationship between IDA and dietary iron level, sanitation and socio-economic status makes the third null hypothesis that stated that the IDA status of the children aged 6-23 months is not related to their sanitation, dietary intake and socio
demography to be rejected, we hence conclude that the IDA status of the children aged 6-23 months is related to their sanitation, dietary intake and socio-demography.

5.10 Iron level with selected health assessment

Malaria has been implicated in red blood cell destruction which is the key component in haemoglobin formation. Malaria parasites are inoculated into the human host by the female anopheles mosquito. Plasmodium falciparum, resistant to most standard antimalarial drugs, poses a major problem for the treatment of malaria and hence malarial anaemia (Newton et al., 2014). Malaria-associated anaemia is a major cause of morbidity, admission, and mortality among children in malaria-endemic areas of sub-Saharan Africa. Anaemia presents with non-specific signs and symptoms, and thus the condition is often unrecognized and under-treated. If left untreated, malarial anaemia is a major risk factor for mortality (Newton et al., 2014).

The percentage of children with malaria in the present study was higher than those without. The high percentage of malaria among these children might have led to high rates of IDA in the children. There was a significant relationship between malaria and haemoglobin level where children with malaria recorded low values of haemoglobin as opposed to those without malaria recording higher haemoglobin values. 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.
Recent studies have shown that consistent use of insecticide-treated bed nets (ITBNs) results in improved haemoglobin and a reduction in the prevalence of anaemia (Oladeinde et al., 2012). Children who slept under insecticide-treated mosquito nets had higher haemoglobin values in comparison to those who didn’t sleep under insecticide-treated mosquito nets. This was expected since mosquito nets shield against malaria parasites that would have otherwise reduced the iron level in the blood (Oladeinde et al., 2012). The current study reported that (93.7%) of children slept under insecticide-treated mosquito nets. The figure is higher than KDHS, (2014) which was (77%). There was, however, no significant relationship between sleeping under mosquito nets and the haemoglobin level. This was expected since mosquitoes might have infected the children before bedtime while in the sitting or dining room.

Periodic deworming for the organisms like helminths and schistosomiasis bilharzia can improve children micronutrient status. Hookworm infection is one of the most important parasitic diseases in humans in terms of disability adjusted life years (DALYs) lost, outranking schistosomiasis (Suchdev et al., 2014). Much of the burden of hookworm is due to extra-corporeal iron loss and interventions to treat hookworm infection have demonstrated significant improvements in hemoglobin levels (Gier et al., 2014).

The majority of the children in the present study were dewormed every 3 months an indication that the majority of caregivers had better knowledge in line with deworming practices thus, translating in few ringworm infections among the children. About 7 out of 10 children in the present study received deworming medication (Table 4.18). This rate vary with KDHS, (2008) where a much lower value was recorded (4 out of 10
children) received deworming medication. This trend might have been due to improved education of the caregivers since the majority of respondents had attained secondary education from the present study. Helminthic infection results in a global burden of disease exceeding conditions such as malaria and tuberculosis. The children under five years are the most affected, resulting in impairment of childhood educational performance. The majority of the children did not have the helminthic infection in the current study.

Children are considered to have received all basic vaccinations if they have received: BCG vaccination against tuberculosis; three doses of DPT vaccine to prevent diphtheria, pertussis, and tetanus (or three doses of pentavalent, which includes DPT and 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. The Kenyan immunisation programme considers a child to be fully vaccinated if the child has received all basic vaccinations and three doses of pneumococcal vaccination (UNICEF, 2013).

Child vaccination is vital for children 0-5 years. From the present study, there was (96.1%) immunization coverage (including children who had completed immunizations and those who had not completed but were compliant to the immunization schedule. This contrasted with both (77%) for KDHS, (2008) and 71% for KDHS, (2014). This difference might be due to the fact that the present study was done in a hospital unlike in KDHS studies that were based in homesteads thus much more likely to capture people who fail to go to the hospital due to religious reasons, ignorance or gated communities. There was a significant positive relationship between haemoglobin levels
observed with health hence, the second null hypothesis that stated “The IDA status of the children aged 6-23 months is not related to their health” was rejected and we conclude that ‘The IDA status of the children aged 6-23 months is related to their health.'
CHAPTER 6: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of findings

This study aimed at establishing the prevalence of iron-deficiency anaemia and its determinant factors in children aged 6-23 months attending a well-baby clinic at Thika level 5 Hospital, Kiambu County, Kenya.

The prevalence of IDA from the study was high (73.2%) hence a concern for public health action. The mean haemoglobin values from the present study were found to be (8.3 ± 2.3g/dl) which were below the recommended threshold. The high prevalence of IDA indicates that the IDA condition was severe in children attending the well-baby clinic at Thika Level 5 Hospital being far above the national level of (34.5%). There is, therefore, a concern for public health action concerning iron status in Thika west Sub County. A greater proportion of children failed to meet the cutoff values for red cell indices of MCV and RCW.

The magnitude of under-nutrition was very high among the children based on wasting, stunting and underweight and it increased with age for all the three indices. Prevalence of wasting was (18%) and stunting (6%) which were above the WHO acceptable threshold levels for developmental areas. Consumption of iron rich foods together with complementary feeding practices from this study fell below the recommendations. The frequency of feeding of the children was appropriate, however, the dietary diversity of the meals was inadequate in terms of variety (of 4 or more out of 7 food groups) and composition of iron-rich foods making many children not to attain the minimum acceptable diet. Additionally, the consumption vitamin A-rich foods was low. On the whole, the complementary feeding practices in Thika Level 5 Hospital fell below the
recommendations because of the relatively low percentage of children who attained the minimum dietary diversity and the low prevalence of minimum acceptable diet among children 6-23 months old. Despite the fact that a larger percentage of caregivers attained secondary school education and above, one of the gap identified included maternal/caregiver knowledge related to iron rich foods and also inadequate finances among the caregivers to purchase nutritious food.

The common occupation of participants was wage employment and small scale businesses resulting in low-income levels and consequently improper feeding practices due to lack of adequate income to purchase appropriate food. Sanitation in this area was unsatisfactory with a larger proportion disposing of their waste in the open near their homesteads and also living in areas containing stagnant water. Significant gaps identified under sanitation were a lack of knowledge regarding treatment of stagnant water and also inadequate knowledge regarding proper waste disposal methods.

The health of the participants in terms of the immunization coverage was satisfactory with only a few children who were not immunized. Morbidity burden in terms of malaria and helminthic infection was evident. The high burden of morbidity could be linked to most participants residing near stagnant water sources, inadequate waste disposal practices such as disposal of household rubbish in the open close to the homesteads and human waste disposal in the bushes with close proximity to human surroundings. Determinants of IDA from the study included; age of the child, education of the mother or 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 practice, helminthic infection and immunization.

6.2 Conclusions

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.
6.3 Recommendations for policy and practice

Since the crisis in Thika west, Sub County is of access other than availability, food stamps to offset the high food prices should be prioritized. Also, Thika west sub county government should recruit nutritionists to provide nutrition education targeting mothers with under five year children attending WBC in all hospitals and markets in Thika west sub county on issues like intake of affordable but nutrient adequate meals. There should be also an intensification of food fortification with iron.

a) The pipeline of therapeutic nutrition commodities should be secured in Thika west Sub County to provide intervention for all severely and moderately malnourished children, regardless of HIV status. Intensification of growth monitoring where by an infant’s weight and height measurements, as well as the age, should be taken in all health facilities, (public and private) and the mothers be updated on the infant’s progress. Those found to be wasted, stunted and underweight should be referred to the nutrition clinic for further monitoring and management.

b) Aggressive awareness campaigns should be organized by Thika west sub-county health department together with other organizations working on child survival programmes through recruitment of trained facilitators targeting mothers with under five year children attending a WBC in all Hospitals and markets in Thika west sub county. Topics to be discussed should include infant and young child feeding practices, promotion of dietary practices that increase iron bioavailability such as soaking, fermentation, sprouting and germination of legumes before cooking. Also encouraging domestication of animals like chicken, goat, and rabbit known for their high bioavailable iron.
c) Thika west Sub County in conjunction with Ministry of Industrialization should put up policy on creation of income to enable mothers and caregivers to access microfinance credit facilities that would strengthen their resource base hence meeting their health and nutrition needs.

d) Thika west sub county health department should put programmes in place to ensure that public health officers, inspect Thika west sub-county, per homestead to ensure each homestead disposes domestic waste in the proper way and that each homestead has a toilet. In addition, organizing aggressive campaigns through recruitment of trained facilitators who are health workers targeting markets and chiefs barazas to educate mothers and all residents on issues such as proper sanitation, clean water, proper drainage and clearing of bushes.

e) Awareness campaigns should be organized by Thika west sub county health department through recruitment of trained health workers, targeting mothers attending well baby clinics to educate them on the importance of deworming and how to identify and handle malaria symptoms in young children also, implementing policy to ensure that all children aged 6-23 months should undergo routine screening for IDA in well baby clinics and if found iron deficient they should be given iron supplementation until the HB levels return to normal. It is important that childhood diseases are identified and treated. Parents and caregivers should be given education by trained facilitators mainly health workers on the importance of seeking medical care during infant illness.
6.4 Recommendations for research

i. There is a need to assess malarial anaemia and its determinants in Thika west sub-county in children aged 6-23 months.

ii. There is need to carry out a follow up study on the relationship between nutritional status and IDA along with associated factors in children from birth up to 10 years by recruiting both children born underweight and those with a normal weight as a control subjecting all of them to similar nutrition and feeding conditions and doing a periodic assessment of their IDA, nutritional status and associated factors periodically as they develop to establish any link between nutritional status and IDA and possible effect on their development milestones.
REFERENCES


APPENDICES

APPENDIX A: INTRODUCTORY NOTE

How are you?

My name is Neddy Lwile Wangusi; I am a postgraduate student of Kenyatta University School of Applied Human Sciences. I am carrying out a study on the prevalence of iron-deficiency anaemia with its related key factors in children aged 6-23 months attending a Well Baby Clinic at Thika level 5 hospital, Kenya

The aim of the study is to identify the prevalence of iron deficiency anaemia and its possible causes in Thika District so that I can forward my findings and recommendations to the relevant authorities so that they can positively handle this situation.

My study targets children attending Well Baby Clinic in this Hospital during my study period. Regards. I would like to know if you agree to participate. 1=Yes 2= No. If yes I kindly sign below.

Signature:........................................................

By Names .................................................. Date..........................
APPENDIX B: KITAMBULISHO

Hujambo?

Mimi Kwa majina naitwa Neddy Lwile Wangusi: Mimi ni mwanafunzi wa somo la Masters katika chuo kikuu cha Kenyatta University Shule ya Applied Human Sciences.
Nafanya utafiti kuhusu Kiwango cha upungufu wa damu unaosababishwa na madini ya iron ikiambatana na mambo yanayochangia hiyo hali Kwa watoto walio na umri wa miezi 6-23 wanaotembelea clinic ya watoto katika Thika level 5 hospital –Kenya.

Utafiti huu una lengo lakuwasilisha matokeo na mapendekezo ya utafiti kwa mashirika husika ndipo wakabiliane na matokeo haya kikamilifu.

Utafiti wangu utahusu watoto umri ya miezi 6-24 wanaotembelea clinic ya watoto Kwa muda wa utafiti wangu.

Kila laheri. Ningelipenda kujua Kama utashiriki Kwa zoezi hili. 1=Ndio 2= La. Kama ndio weka sahihi. ..........................................................
Na   Majina…………………………………….Tarehe…………………………………..
APPENDIX C: INFORMED CONSENT

Greetings

I would like to request your permission to include your child as one of the participants in my study. If you consent you will be interviewed and there after blood specimen taken from your child to be tested for iron level. The procedure will be short however with mild pain. This test is vital because it will reveal the iron status of your child which is an important mineral required for growth and incase of any shortfalls you will be given nutrition counseling free of charge however, in case where the iron levels are extremely low, apart from nutritional counseling you will be referred to a clinician for medication. Participant confidentiality will be assured and the decision to participate in this study will be at your discretion.

Your response will be taken and will be used for the sole purpose of this study. The results of the study will however be availed to any interested respondents. Do you accept to participate. 1=Yes 2=No

If yes I kindly request you to sign below.

Signature………………………………………………

Date……………………………………………….

Name of guardian……………………………………

Name of child…………………………………………
APPENDIX D: KUJULISHWA KWA MZAZI AU MLEZI

Hujambo?

Ningependa kuomba ruhusa yako ili nimjumuishe mtoto wako kwa utafiti ninaofanya.Ukikubali utajibu maswali machache kisha mtoto wako atatolewa damu .Mtoto atahisi uchungu mdogo ingawa zoezi hili litachukua mda mchache.

Damu itakayo chukuliwa itapimwa ili kubaini kiwango cha damu ya mtoto ya mtoto . Mtoto wako akibainishwa kuwa kiwango chake cha damu ni chini, tutakuelimisha bure kuhusu yale unapaswa kufanya kuhusu lishe .Lakini ikiwa hiki kiwango ni chini zaidi tutakuelekeza kwa daktari baada ya kujadiliana nawe ili ampe matibabu.

Matokeo ya damu yatawekwa siri pia uamuzi wa kushiriki katika hili zoezi ni wako binafsi.

Majibu kuhusu maswali tutakayouliza yatatumika Kwa utafiti huu pekee.Yule anayetaka majibu atapatiwa.

Kama unakubaliana na haya weka sahihi.

Sahihi………………………………………

Tarehe………………………………………

Jina la mzazi au mlezi wa mtoto……………………………………

Jina la mtoto……………………………………
APPENDIX E: STRUCTURED INTERVIEW SCHEDULE, FFQ AND 24 HOUR
RECALL

PREVALENCE AND DETERMINANT FACTORS OF IRON-DEFICIENCY
ANAEMIA IN CHILDREN 6-23 MONTHS ATTENDING THIKA LEVEL-5
HOSPITAL KIAMBU COUNTY, KENYA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>District Name</td>
</tr>
<tr>
<td>1.2</td>
<td>Questionnaire number</td>
</tr>
<tr>
<td>1.3</td>
<td>Respondent ID</td>
</tr>
</tbody>
</table>
| 1.5 | Interview results  
1=Completed  
2=Partially done  
3=Not done |
| 1.6 | Enumerators’ names  
1.  
2. |
| 1.7 | Date of interview |
**CHILD IDENTITY**

Fill in for children 6-23months

<table>
<thead>
<tr>
<th>Child ID</th>
<th>Sex</th>
<th>Age in months</th>
<th>Height of the child (To the nearest 0.1cm)</th>
<th>Weight of the child (To the nearest 0.1kgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Who is present in HH today)</th>
<th>Relationship type</th>
<th>Main occupation mother/caregiver</th>
<th>Highest level of education attained</th>
<th>Main Sources of income Give only 2 (See codes below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Child</td>
<td>2=Adopted/fostere d Child</td>
<td>3=Other relation</td>
<td>1=Employed</td>
<td>2=Waged labor</td>
</tr>
<tr>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**Codes**

1=Farmer                     5=Small own business
2=Casual waged labor        6=None
3=Formal waged labor         7=others
4=Food crop production
### Iron Level

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Haemoglobin level</td>
</tr>
<tr>
<td>4.2</td>
<td>Complete blood count</td>
</tr>
<tr>
<td>4.3</td>
<td>Mean cell volume (MCV)</td>
</tr>
<tr>
<td>4.4</td>
<td>Red cell count (RDC)</td>
</tr>
<tr>
<td>4.5</td>
<td>Red cell count (RDC)</td>
</tr>
<tr>
<td>4.6</td>
<td>Red cell width (RDW)</td>
</tr>
</tbody>
</table>

### Helmithic Infection

<table>
<thead>
<tr>
<th>Does your child have any ring Worm infestation On any body part?</th>
<th>Have you ever dewormed your child?</th>
<th>How often do you deworm your child? (For those 1 year and above)</th>
<th>Did your child suffer from Fever in the last 2 weeks?</th>
<th>Which medications was the child given?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yes</td>
<td>1. Yes</td>
<td>1=Every 3 months</td>
<td>1. Yes</td>
<td>1=Antimalaria drug</td>
</tr>
<tr>
<td>2. No</td>
<td>2. No</td>
<td>2=Every 6 months</td>
<td>2. No</td>
<td>2=Other drugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3=None of the above</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>5.2</td>
<td>5.3</td>
<td>5.4</td>
<td>5.5</td>
</tr>
</tbody>
</table>

### Immunization Coverage

<table>
<thead>
<tr>
<th>Has child received BCG?</th>
<th>Has child received Penta 1 and OPV 1</th>
<th>Has child received Penta 2 and OPV 2</th>
<th>Has child received Penta 3 and OPV 3</th>
<th>Has child received Measles immunization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
</tr>
<tr>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
</tr>
<tr>
<td>3=Yes (scar)</td>
<td>3=No</td>
<td>3=No</td>
<td>3=No</td>
<td>3=No</td>
</tr>
<tr>
<td>4=NO</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
</tr>
<tr>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3</td>
<td>6.4</td>
<td>6.5</td>
<td>6.6</td>
<td>6.7</td>
</tr>
</tbody>
</table>
SANITATION IN THE CHILDREN’S HOMES

<table>
<thead>
<tr>
<th>Question</th>
<th>1=Composite pit</th>
<th>2=In the open near the homestead</th>
<th>3=Other place (specify)</th>
<th>1=pit latrine</th>
<th>2=Flash toilet</th>
<th>3=Any other (specify)</th>
<th>1=Yes</th>
<th>2=No</th>
<th>1=Once per month</th>
<th>2=Twice per month</th>
<th>3=Other specify</th>
<th>4=Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where do you dispose your household waste?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where do you go for long and short calls?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does any exposed water surface exist near your homestead?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you sleep under a mosquito net?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often do you treat your mosquito nets?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FOOD FREQUENCY QUESTIONNAIRE

I would like you to think about the last 7 days what you fed your child?

<table>
<thead>
<tr>
<th>Code</th>
<th>Commodity</th>
<th>Number of days the food was eaten during the last 7 days</th>
<th>Total quantity consumed over 7 days (Estimated with the units listed below the table)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Eggs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Liver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Lean red meat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Poultry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Seafood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Iron fortified cereals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Nuts and seeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Legumes and pulses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Whole grain products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Green leafy vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Dried fruits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unit for quantity codes

1=Cup 250ml
2=Grams
3=Litres
24 HRS RECALL

Please think back from when you woke up yesterday morning up to the time you went to sleep at night. What you fed your child.

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Quantity of ingredients in household Measures</th>
<th>Total amount eaten in household measures</th>
<th>Total amount weight in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unit for quantity codes

1. =Cup 250ml
2. =Grams
3. = Litre
APPENDIX F: MPANGILIO YA MASWALI KUHUSU CHAKULA MASAA 24
YALIYO PITA NA PIA SIKU SABA ZILIZOPITA

KIWANGO CHA UPUNGFU WA DAMU UNAOSABABISHWA NA MADINI YA IRON IKIAMBATANA NA MAMBO YANAYOCHANGIA HIYO HALI KWA WATOTO UMRI YA MIEZI 6-23 WANAOTEMBELEA CLINIC YA WATOTO KATIKA THIKA LEVEL 5 HOSPITAL KIAMBU COUNTY, KENYA

<table>
<thead>
<tr>
<th>1.1</th>
<th>Jina la wilaya</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>Nambari ya kijitabu cha mahojiano</td>
</tr>
<tr>
<td>1.3</td>
<td>Kitambulisho cha Mhojiwa</td>
</tr>
<tr>
<td>1.4</td>
<td>Matokeo ya mahojiano</td>
</tr>
<tr>
<td></td>
<td>1=Yalikamilika</td>
</tr>
<tr>
<td></td>
<td>2=Yalikamilika nusu</td>
</tr>
<tr>
<td></td>
<td>3=Hayakufanyika</td>
</tr>
<tr>
<td>1.5</td>
<td>Siku ya Mahojiano</td>
</tr>
</tbody>
</table>
### KITAMBULISHO CHA MTOTO

#### KWA WATOTO WA UMRI WA MIEZI 6-23

<table>
<thead>
<tr>
<th>KITAMBULISHO</th>
<th>JINSIA</th>
<th>Umri kwa miezi</th>
<th>Urefu wa mtoto (karibu 0.1sentimita)</th>
<th>Uzito wa mtoto Karibu 0.1kilo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### MAISHA YA KAWAIDA NA MBINU YA MAPATO YA PESA

<table>
<thead>
<tr>
<th>Jinsia</th>
<th>Uhusiano</th>
<th>Kazi mama au mlezi wa mtoto</th>
<th>Kiwango cha juu cha Masomo</th>
<th>Kazi inayoleta pesa nyumbani (Chagua mbili kati ya kazi hapo chini)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Mwanamke</td>
<td>1=Mtoto wakuzaliwa</td>
<td>1=Kazi ya kulipwa mwisho wa mwezi</td>
<td>1=Shule ya msingi</td>
<td>1=Shule ya mbili kati ya kazi hapo chini</td>
</tr>
<tr>
<td>2=Mwanamume</td>
<td>2=Mtoto mrithiwa Child</td>
<td>2=Kibarua</td>
<td>2=Shule ya upili</td>
<td></td>
</tr>
<tr>
<td>3=Uhusiano mwingine</td>
<td>3=Biashara</td>
<td>3=Masomo ya ziada</td>
<td>3=Ingine (angazia)</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>3.2</td>
<td>3.3</td>
<td>3.4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Alama;

1=Mkulima
2=Kibarua
3=Kazi ya kulipwa mwisho wa mwezi
4=Ukulima wa mimea
5=Biashra ya kibinafsi
6=Asiyefanya kazi yeyote
7=Kazi nyingine (Angazia)
## KIWANGO CHA IRON

| 4.1 | Kiwango cha damu nyekundu mwilini |
| 4.2 | Hesabu yote ya damu mwilini       |
| 4.3 | Kiwango cha kati cha chembechembe mwilini |
| 4.4 | Kiwango cha chembechembe nyekundu mwilini (RDC) |
| 4.5 | Upana wa chembechembe nyekundu mwilini |

## MAAMBUKIZO YA MINYOO

<table>
<thead>
<tr>
<th>Je mtoto wako ana ugonjwa wa shilingi kwenye sehemu yeyote mwilini?</th>
<th>Je, unampa mtoto wako dawa za minyoo baada ya muda upi? (kwa wale watoto wana umri wa mwaka moja na zaidi)</th>
<th>Mtoto wako amewahi patwa na joto majuma mawili ya yaliyopita?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Ndio</td>
<td>1=kila baada ya miezi tatu</td>
<td>1=Ndio</td>
</tr>
<tr>
<td>2=La</td>
<td>2=kila baada ya miezi sita</td>
<td>2=La</td>
</tr>
<tr>
<td></td>
<td>3=Tofauti ilivyo hapo juu(Angazia)</td>
<td></td>
</tr>
</tbody>
</table>

| 5.1 | 5.2 | 5.3 | 5.4 | 5.5 |

## MAELEZO KUHUSU CHANJO YA WATOTO

<table>
<thead>
<tr>
<th>Has child received BCG?</th>
<th>Has child received Penta 1 and OPV 1</th>
<th>Has child received Penta 2 and OPV 2</th>
<th>Has child received Penta 3 and OPV 3</th>
<th>Has child received Measles immunization?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
<td>1=Yes(card)</td>
</tr>
<tr>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
<td>2=Yes(recall)</td>
</tr>
<tr>
<td>3=Yes (scar)</td>
<td>3=No</td>
<td>3=No</td>
<td>3=No</td>
<td>3=No</td>
</tr>
<tr>
<td>4=NO</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
<td>4=Don’t know</td>
</tr>
<tr>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
<td>5=Don’t know</td>
</tr>
</tbody>
</table>

| 6.1 | 6.2 | 6.3 | 6.4 | 6.5 |


**USAFI NYUMBANI MWA WATOTO**

<table>
<thead>
<tr>
<th>Unatupa wapi uchafu wa nyumbani?</th>
<th>Je unaenda wapi haja kubwa au ndogo</th>
<th>Kuna maji wazi iliyo karibu nyumbani mwako</th>
<th>Je unalala ndani ya mosquito net?</th>
<th>Ni mara ngapi unaosha na kuweka dawa kwenye mosquito net?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Kwa shimo la uchafu</td>
<td>1=Choo ya shimo</td>
<td>1=Ndio</td>
<td>1=Ndio</td>
<td>1=Mara moja kwa mwezi</td>
</tr>
<tr>
<td>2=Mahali wazi karibu na nyumbani</td>
<td>2=Choo ya ndani ya flash</td>
<td>2=La</td>
<td>2=La</td>
<td>2=Mara mbili kwa mwezi</td>
</tr>
<tr>
<td>3=Mahali pengine(angazia)</td>
<td>3=Mahali pengine(angazia)</td>
<td>3=Ingine(angazia)</td>
<td></td>
<td>3=Ingine(angazia)</td>
</tr>
</tbody>
</table>

7.1 7.2 7.3 7.4 7.5

**MASWALI KUHUSU CHAKULA KILIVYOLIWA SIKU SABAZILIZOPITA**

Nataka ufikirie kuhusu chakula ulichokula siku Saba zilizopita

<table>
<thead>
<tr>
<th>Nambari</th>
<th>Chakula</th>
<th>Nambari ya siku chakula kilicholiwa</th>
<th>Kiwango kilicholiwa kwa siku saba (Vipimo vime onyeshwa kwenye orodha hapo chini)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Mayai</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Maini</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Nyama</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Nyama ya ndege</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Samaki</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Nafaka iliyoongezwa iron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Mbegu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>Maharagwe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Vyakula bila maganda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Mboga za kijani kibichi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Matunda yaliyo kaushwa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1= Kikombe milimita 250
2=Gramu
3=Lita
**CHAKULA ULICHOKULA MASAA 24 YALIYOPITA**

Fikiria kuanzia vile uliamka Jana hadi usiku ulipoenda kulala.

<table>
<thead>
<tr>
<th>Saa</th>
<th>Chakula</th>
<th>Vipimo vya chakula kwa viwango cha nyumbani</th>
<th>Kiwango kilicho liwa kwa vipimo vya nyumbani</th>
<th>Viwango vyote kwa gramu</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inayojaa mkono</td>
<td></td>
<td></td>
<td>8=Glasi</td>
</tr>
<tr>
<td>2</td>
<td>Kiamsha kinywa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Chakula cha alasiri</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Chakula cha jioni</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Kiburudisho</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1=Kikombe milimita 250  
2=Chakula cha alasiri  
3=Chakula cha jioni  
4=Kiburudisho  
5=Lita  
6=Kipande  
9=Kiwango kingine (angazia)
APPENDIX H: KENYATTA UNIVERSITY RESEARCH AUTHORIZATION LETTER

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

Our Ref: H60/12696/09
DATE: 6th February, 2013

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
F.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION WANGUSI NEDDY LWILE – REG. NO. H60/12696/09

I write to introduce Ms. Wangusi Neddy Lwile who is a Postgraduate Student of this University. She is registered for M.Sc degree programme in the Department of Foods, Nutrition and Dietetics.

Ms. LWILE intends to conduct research for a proposal entitled, “Prevalence of Iron-Deficiency Anaemia and Related Factors in Children aged 6-24 Months attending well Baby Clinic at Thika Level 5 Hospital, Kenya”.

Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: PEAN, GRADUATE SCHOOL

JMO/rwm
APPENDIX I: ETHICAL CLEARANCE LETTER

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711578
Email: kuerc.chairman@kun.ac.ke
kuerc.secretary@kun.ac.ke
Website: www.kun.ac.ke

Our Ref: KU/E/COMM/81/154

Neddy Lwalle Wangusi
School of Applied Human Sciences
Kenyatta University
P. O. Box 43844, Nairobi.

Dear Ms. Neddy,

APPLICATION NUMBER FKTU/100/189 OF 2013 – 'PREVALENCE OF IRON-DEFICIENCY ANAEMIA AND ITS DETERMINANT FACTORS IN CHILDREN AGED 6-24 MONTHS ATTENDING WELL BABY CLINIC AT THIKA LEVEL 5 HOSPITAL, KENYA'- VERSION 2

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic, 'Prevalence of Iron-Deficiency Anaemia and its Determinant Factors in Children Aged 6-24 Months Attending Well Baby Clinic at Thika Level 5 Hospital, Kenya’ version 2 dated 1st April 2013.

2. APPLICANT

Neddy Lwalle Wangusi
School of Applied Human Sciences
Kenyatta University
P. O. Box 43844, Nairobi.

3. SITE

Thika Level 5 Hospital, Kenya

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines, and is of the view that against the following elements of review,

(i) Scientific design and conduct of study,
(ii) Recruitment of research participant,
(iii) Care and protection of research participants,
(iv) Protection of research participant's confidentiality,
(v) Informed consent process,
(vi) Community considerations.

AND APPROVED that the research may proceed for a period of ONE year from 18th April 2013
5. ADVICE/CONDITIONS

i. Progress reports are submitted to the Kenya University Ethics Review Committee (KU-ERC) every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
iii. Notify the KU-ERC of any amendments to the protocol.
iv. Submit an electronic copy of the revised proposal to KU-ERC.

When replying, kindly quote the application number above.

If you accept the advice, conditions and advice and conditions given please sign in the space provided below and return one copy to the undersigned.

PROF NICHOLAS E. OIKONYO
CHAIRMAN, KENYATA UNIVERSITY ETHICS REVIEW COMMITTEE

I, [Name], [Role] _______________________________ accept the advice given and will fulfill the conditions therein.

Signature: _______________________________ Dated this day ______ of (month), _________ 2013.

cc: Vice-Chancellor
    Director, Institute for Research Science and Technology

[Signature]

APPENDIX J: RESEARCH AUTHORIZATION LETTER FROM NCST

REPUBLC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241439, 254-020-2673150
Mobile: 0711 738 707, 0733 404 245
Fax: 254 020-2213252
When replying please quote
secretary@ncst.go.ke

Our Ref: NCST/RCD/12A/013/52

Date: 9th May, 2013

Nedyo Lwile Wangusi
Kenya University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application dated 25th April, 2013 for authority to carry out research on “Prevalence of Iron-deficiency Anaemia and its determinate Factors in Children aged 6-24 months attending well baby clinic in Thika level 5 Hospital, Kenya.” I am pleased to inform you that you have been authorized to undertake research in Thika District for a period ending 30th June, 2013.

You are advised to report to the Medical Superintendent, Thika Level 5 Hospital before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

DR. M. K. RUGGUT, PhD, HSC,
DEPUTY COUNCIL SECRETARY

Copy to:
The Medical Superintendent,
Thika Level 5 Hospital
APPENDIX K: RESEARCH PERMIT

THIS IS TO CERTIFY THAT Prof./Dr./Mr./Mrs./Miss./Institution Naddy Lywe Vangus of (Address) Kenyatta University P.O.Box 43844-0100, Nairobi has been permitted to conduct research in the Location Thika District Central Province on the topic: Prevalence of Iron Deficiency Anemia and its Determinant Factors in Children aged 6-24 months attending well baby clinic in Thika level 5 Hospital, Kenya.

Research Permit No.: NCSR/PRCD/124/0364
Date of Issue: 8th May, 2013
Fee received: KSH. 1,000

Signature

Secretary General
National Council for Science & Technology