IRON DEFICIENCY ANAEMIA AND COGNITIVE DEVELOPMENT OF
PRESCHOOL CHILDREN (4-5 YEARS) IN GOSHI LOCATION, MALINDI
DISTRICT, KENYA.

BY

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anaemia and cognitive

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DEDICATION

I dedicate this thesis to my beloved daughter Amani, my parents Jumwa and Karisa and to the loving memory of my brother Gerald Mitsanze.
ACKNOWLEDGEMENT

The writing up of this thesis took more than my individual effort to accomplish. I hereby take this opportunity to thank all those whose invaluable contribution made this achievement possible. First and foremost, I would like to greatly thank my principal supervisor Dr. Judith Kimiywe for her time and patience in constantly and consistently guiding me through all the phases of my research work. I also acknowledge the help I got from my other supervisor, the late Dr. Richard K’Okul. I especially feel indebted to him for his great support as I commenced on this course.

Many thanks go to my father Alfred Karisa and mother Juliana Jumwa for nurturing my abilities and believing in me; and to all my siblings for their support in the course of doing this work. I would also like to acknowledge the help I received from Dr. Otube Khayota of School of Business, and the other lecturers of the Department of Foods, Nutrition and Dietetics at Kenyatta University. I further extend my gratitude to the children involved in this study, their parents, teachers, staff of Malindi District Hospital and the field workers for their invaluable assistant during the data collection process.

Finally I would like to greatly thank Eliphas for his love, support and dedication in the course of doing this work. Above all, I thank God for making all this possible.
ABSTRACT

Iron deficiency anaemia is associated with comparatively poor performance in tests of mental and motor development in infants and toddlers and of intelligence and cognitive function in preschool children (Stoltzfus 2001). This study was aimed at investigating whether there was any association between iron deficiency anaemia and cognitive development of preschool children 4 to 5 years in Goshi location, Malindi District. The justification for this study came from studies done by Lozoff 2006 that have demonstrated that children who are anaemic perform poorly in tests that measure cognitive/intelligence level. Iron deficiency anaemia among the children was determined through dietary intake of iron rich foods using a 24 hour recall and food frequency questionnaires. Anthropometric measurements were also taken on the children. This was aimed at determining those that were normal, moderately underweight and severely underweight. Assessment of pallor of the palms and nail beds was done so as to assess anaemia status among the children. Haemoglobin analysis was further done on 15 children to verify the results of palmar pallor. Cognitive abilities of the children were determined by their performance on cognitive tests scores. The tests consisted of the Ravens' progressive matrices, the Peabody picture vocabulary testing and the one word picture vocabulary. Classroom observation was on the children in order to determine the extent to which they were able to pay attention to classroom tasks. Data was analysed using the Statistical Package for Social Sciences (SPSS), and was presented using tables and graphs.

Results indicated that iron deficiency anaemia was associated with cognitive abilities of preschool children in this area of study. Children who were non anaemic and well nourished had higher cognitive test scores as opposed to those who were severely anaemic and underweight. Pallor of the palms and nail beds was found to be an independent significant measure of iron deficiency anaemia especially severe iron deficiency anaemia. Dietary intake of foods that were rich in iron was found to influence body iron stores and hence presence or absence of anaemia among children. Nutritional status of the children was found to be a significant measure in predicting anaemia status because the children who were severely underweight were also found to be severely anaemic. Measure of vocabulary, picture recognition of simple nouns, sequence, perceptual and comprehension abilities were found to be significant measure of cognitive development among preschool children. Attention span to classroom tasks was also found to be a useful tool in measuring cognitive development. Intervening variables such as parents’ economic status and literacy level were found to influence nutritional status and presence or absence of anaemia, and in general cognitive development of their children.
### ABBREVIATIONS/ACRONYMS

<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>IDA</td>
<td>Iron Deficiency Anaemia</td>
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<tr>
<td>Hb</td>
<td>Haemoglobin</td>
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<td>SES</td>
<td>Socio-economic status</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<td>r</td>
<td>Pearson’s product moment correlations</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>USDA</td>
<td>United States Daily Allowance</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<tr>
<td>UNICEF</td>
<td>United Nations Children Education Fund</td>
</tr>
<tr>
<td>ACC/SCN</td>
<td>United Nations Administrative Committee on Coordination/Sub Committee on Nutrition</td>
</tr>
<tr>
<td>MoH</td>
<td>Ministry of Health</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>RDA</td>
<td>Recommended Daily Allowance</td>
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<td>IQ</td>
<td>Intelligence Quotient</td>
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CHAPTER ONE

1.1 INTRODUCTION

Iron deficiency affects 20% to 50% of the world’s population, making it the most common nutritional deficiency (Stoltzfus, 2001). In developing countries, about half of all cases of anaemia in women and children result from iron deficiency, but other important and often coexisting contributors include malaria, hookworm infestation, HIV, and other deficiencies in other nutrients such as lead and folates (Black, 2003). Iron deficiency is a systematic condition with many consequences. Anaemia is just one manifestation of iron deficiency, and there are forms of mild to moderate iron deficiency in which anaemia is absent but tissue function is impaired.

In children, iron deficiency is the most prevalent haematologic disorder. It develops slowly and produces few acute symptoms. As the deficiency worsens, children become pale and weak, eat less, and tire easily. They gain weight poorly, and may have frequent respiratory and intestinal infections (Lozoff, 2006). The most worrying association is that between iron deficiency and impaired development in behaviour, cognition, and psychomotor skills in preschool and school children. Over the past three decades, many studies have confirmed this relation, but whether iron deficiency is the sole cause of these deficits remains unclear. Studies done have excluded a definitive causal link of these deficits because anaemia is associated with many other disadvantages such as poverty, low birth weight, malnutrition, poor education among mothers, and lack of stimulation in the home; all of which affect child development (Raloff, 2004).

Majority of studies evaluating cognitive performance and iron deficiency have focussed on individuals who have iron deficiency anaemia. A consistent finding in different countries is that severe, chronic iron deficiency in infancy identifies
children with poorer cognitive function and lower scores in school achievement tests, suggesting that irreversible abnormalities result from a deficiency at a critical period of growth and differentiation of the brain (Lansdown and Wharton, 1995). However there is little evidence to implicate iron deficiency without anaemia in causing developmental outcomes. Central nervous system iron normally decreases before restriction of red cell production suggesting that cognitive effects of iron deficiency may precede the haematologic effects of anaemia. Furthermore, the prevalence of iron deficiency without anaemia is much greater than the prevalence of iron deficiency with anaemia, indicating the potential for a greater public health problem (Morey, 1998).

1.2 Problem statement
Children who do not get enough iron in their diet do worse on mental ability tests than children whose iron needs are being met (Lozoff, 2006). A lack of iron can affect children long before they become anaemic. Many studies point to the critical biochemical role that iron plays in brain development and function (Pollit, 1993). The association of iron deficiency anaemia and lower mental and motor developmental test scores in early childhood is well described and has been recently reviewed (Stoltzfus and Pillai, 2002).

There are fewer published data, however, on cognitive achievement in iron deficient preschool and school-aged children and adolescents; thus the relationship between iron status and cognitive functioning for older children is less clear (Grantham-McGregor, 2003). In most developing countries, most cases of anaemia in children results from iron deficiency, but other important and often co-existing contributors
include malaria, hookworm infestation, HIV, and deficiencies in other nutrients such as vitamin A, C and folates.

There have been increased efforts to develop improved interventions involving dietary education, programs that link the use of fortification and supplementation to prevent and control iron deficiency anaemia. However, too little progress has been made towards the global elimination of iron deficiency anaemia. Part of the reason for this lack of action is that iron deficiency anaemia has few overt symptoms and that the effects of iron deficiency anaemia on mental retardation can not be isolated from a variety of other socio-economic, environmental and psychological factors which act together in ways that compound and obscure the effects of an individual factor (Grantham-McGregor and Ani, 2001). There is also lack of widespread knowledge of its serious and often permanent consequences to the cognitive development of young children.

According to the National Micronutrient Survey report 1999, less than 50% of children under 5 years in Coast province were found not to consume foods that are rich in iron and other micronutrients. The most common sources of iron and other micronutrients in this area are from locally grown green leafy vegetables. These are however not prepared and cooked properly resulting in loss of vital nutrients. Red meats and liver are quite expensive and beyond rich for most people in this area. Nuts and cereals are not usually regularly consumed unless they are in season or cheaply available in the local market.

This explains the high levels of iron deficiency and anaemia in this area.
1.3. Objectives of the study

1.3.1 General objective

- To investigate the relationship between iron deficiency anaemia and cognitive development of preschool children in Goshi location Malindi District.

1.3.2 Specific objectives

- To determine the prevalence of IDA among preschool children in the area of study as influenced by dietary intake of iron rich foods
- To assess the level of cognitive development of the children through performance on cognitive tests.
- To determine the relationship between IDA status and cognitive abilities among the children.

1.4 Study hypotheses

- Iron deficiency anaemia is influenced by intake of iron rich foods among the children
- Cognitive abilities among the children are determined by performance on intelligence tests
- There is a relationship between IDA and cognitive abilities of the children

1.5 Assumptions of the study

- Iron deficiency is severe in the area of study
- Children’s cognitive abilities are low in the area of study
1.6 Significance and anticipated outcome

This study aimed at determining whether there was a causal link between iron deficiency anaemia and cognitive development of preschool children in the area of study. Findings from the study would help suggest appropriate preventive measures for controlling iron deficiency and anaemia early in life. If dietary intake of iron rich foods is found to influence body iron stores among children, then parents would be encouraged to feed their children with iron rich foods. Consequently, if iron deficiency anaemia is found to influence cognitive abilities among children, then intervention programs can be initiated to help reverse the situation for the children who are found to be iron deficient.

1.7 Limitations of the study

Methodological difficulties in that mild to moderate iron deficiency is harder to obtain because its physical manifestations are subtle and that there are no proper screening guidelines for evaluation for iron deficiency without anaemia (Morey, 1998)

There are many environmental, genetic and psychological factors that are associated with iron deficiency anaemia and cognitive development among children especially in developing countries that often obscure the effects of an individual factor.

1.8 Conceptual framework

1.8.1 Causes of iron deficiency anaemia

Poor dietary intake of iron rich foods, which is compounded by inhibiting factors such as vitamin A deficiency, which leads poor absorption of iron in the blood. Infectious diseases such as acute bacterial, parasitic and viral infections, malaria, diarrhoeal diseases and acute respiratory infections lead to iron deficiency anaemia.
Other causes are chronic diseases of infection and non-infection origin, which affect iron metabolism directly.

Physiological factors such as growth spurts in early childhood, environmental pollutants such as bi- and tri-valent metal which interfere with haemoglobin formation, and socio-economic and cultural factors such as high prevalence of food poverty and inequitable availability, accessibility and affordability of health care services have all aggravated the problem of iron deficiency anaemia among children.

This is demonstrated below.

**Figure 1. causes and effects of iron deficiency anaemia**

| Poor dietary intake of iron rich foods, deficiency of vitamin A, C, and folates | Infectious diseases, chronic diseases, malaria, HIV/AIDS | Low socio-economic status, physiological factors, environmental factors |


1.9 Definition of terms

**Haemoglobin:** It is an iron containing component of red blood cells; that is needed for oxygen transport. Its level in the blood depends on age, sex, and physiology; so that standards vary.
Anaemia: It is an abnormally low haemoglobin level due to pathological condition. Iron deficiency is one of the most common, but not the only cause of anaemia.

Iron deficiency: It is functional tissue iron deficiency and the absence of iron stores with or without anaemia. Iron deficiency is usually the result of inadequate bio available dietary iron, increased iron requirement during a period of rapid growth (pregnancy and infancy), and/or increased blood loss such as gastrointestinal bleeding due to hookworm or urinary blood loss due to schistosomiasis.

Iron deficiency anaemia: Iron deficiency when sufficiently severe causes anaemia.

Cognition: Relates to knowledge and in particular to how knowledge is acquired, organized and used by people and animal (Eysenck and Keane, 1990). It has broad application and refers to activities such as thinking, reasoning and problem solving and to the underlying psychological processes that they reflect; perception, attention, learning, memory and so forth.

Intelligence: It is the capacity to learn from experience that applies the ability to behave adaptively, or function successfully, within particular environments (Sternberg and Salter, 1982).

Intelligence Quotient (IQ): It is a statement about an individual’s actual performance in relation to that typical for the normative sample, and for such a comparison to be meaningful, the individual must be drawn from the population from which the normative sample is drawn (Satler, 1982).

Pallor: It is an unusual paleness of the skin. It’s a sign of anaemia (MoH/WHO/UNICEF, 2002).

Attentional capacities: It is the capacity to learn from experience that applies the ability to behave adaptively, or function successfully, within particular environments.

Nutritional status: This is the overall condition of health of an individual which is influenced by intake and utilization of nutrients. Nutritional status is assessed using
anthropometrics measurements such as height for weight, weight for age, and age for height. These three indices show three conditions, that is, underweight, stunting and wasting.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
In this chapter, several variables relating to iron deficiency anaemia and cognitive development among preschool children were discussed. These included:

2.2.0 Intelligence, cognition and mental processes
Cognition relates to knowledge and in particular to how knowledge is acquired, organized and used by people and animals. It has broad application and refers to activities such as thinking, reasoning and problem solving and to the underlying psychological processes that they reflect; perception, attention, learning and memory and so forth (Eysenck & Keane, 1990). Intelligence is generally regarded as the capacity to learn from experience which implies the ability to behave adaptively, or function successfully, within particular environments (Sternberg & Satler, 1982).

Theories of intelligence can be grouped into two classes, psychometric and information processing theories (Sternberg and Satler, 1982). Psychometric theories, which are based on the study of differences between individuals, seek to understand intelligence in terms of a set of hypothetical constructs called factors. The factors are derived from the analysis of test scores using certain statistical procedures. Psychometric theories consider the mind to be made up of a series of factors of which individuals differ and on which they can be measured. In contrast, information processing theories attempt to understand intelligence in terms of the mental processes which contribute to task performance.
2.2.1 The Piaget's theory of intelligence

The Piaget's theory is an account of the way in which thinking develops from birth to maturity (Piaget, 1952). By acting on the world of objects and events that are encountered in the course of development, the child constructs ways of knowing and understanding the world. Piaget identifies four stages or periods in the development of thought. In the first sensorimotor period, from birth to about two years, understanding of the world is based on the actions the child performs in the course of manipulating objects, moving around and becoming familiar with the environment. In the second preoperational period, from two years to about seven years, the child develops ways of representing or thinking about the world, in particular, language. In the third concrete operational period, from seven to about eleven years, children begin to make sense of the world by constructing relations and making logical connections between concrete objects and events. In the fourth formal operational period, from eleven years on, reasoning or thinking is no longer limited to the concrete world of the here and now.

To understand this relationship, Piaget uses some theoretical concepts. He refers to intelligence as a particular instance of biological adaptation. Adaptation refers to the relationship between a living organism and its environment. Human interactions or transactions with the environment lead to an understanding and knowledge of the world and it is this process that Piaget calls intelligence. Based on the idea that intelligence is a means of adaptation, Piaget distinguishes between two adaptive functions, assimilation and accommodation (see figure 2). These two functions are complementary. Assimilation occurs when information is understood in terms of existing knowledge or understanding. Accommodation occurs when existing knowledge or understanding changes in order to make sense of new information.
2.3 Role of iron on the brain

Lack of iron can affect children long before they become anaemic. A causal link between iron deficiency anaemia and delays in child development may be mediated by a variety of direct and indirect pathways; the most obvious are associated decreases in haemoglobin concentrations and oxygen delivery to tissues. Many studies point to the critical biochemical role that iron plays in brain development and function. Researchers have found in rodents that during development of the brain region called hippocampus, iron deficiency limits the number of connections between nerve cells (Beard 2006). The cells are thus not getting enough information.

Insufficient iron in early life also reduces myelin, the fatty material that surrounds many nerve fibres. With less myelin, there is a reduction in the speed with which information travels along nerve fibres (Beard 2006). In the case of muscle-triggering neurons, which are heavily sheathed with myelin, a lack of iron could result in less
control of movements. These and other changes that iron deficiency causes in the brain are the factors contributing to the long-term cognitive and social-emotional effects that researchers are finding (Lozoff 2006). A consistent finding is that severe, chronic iron deficiency in infancy identifies children with poorer cognitive function and lower scores in school achievement tests, suggesting that irreversible abnormalities result from a deficiency at a critical period of growth and differentiation of the brain (Lozoff 2006).

2.4.0 Causes of iron deficiency anaemia

Iron deficiency anaemia has long been understood to result from the interaction of multiple aetiological factors that lead to an imbalance between the iron requirements of the body and the amount of iron absorbed (International Nutrition Foundation, 1999). Iron deficiency, which is widespread in many developing countries, is associated with many nutritional deficiencies, certain parasitic infections and is also prevalent in children with protein-energy malnutrition. It has been linked clinically with impaired attentiveness, poor coordination, slightly impaired scores on developmental assessment, poor concentration and fatigue in children.

Iron deficiency anaemia is caused by factors that include:

2.4.1 Nutritional factors: The main determinants are intake and bioavailability factors. The former relates to iron content in food while the later relates to its absorption in which the presence of inhibiting and enhancing ingredients make significant contribution to the iron transfer from the intestines. The moieties that are well described in literature include calcium, phytates and phenolics. In contrast, vitamin C and animal products (meat and fish) enhance absorption of iron. Other facilitatory interactions include pre-consumption hydrolysis of phytates through
sprouting and fermentation (Garrow and James, 1993). In addition, at tissue level, vitamin A deficiency has been shown to inhibit mobilization of depot iron. Intake and bioavailability of other haematinics namely copper, cobalt, vitamins B\textsubscript{12}, B\textsubscript{6}, folic and nicotinic acids, and riboflavin must also be factored into the framework.

2.4.2 Infectious diseases: The effects of acute bacterial, parasitic and viral infections on erythropoiesis, haemolysis, catabolism and food appetite are widely documented. The undisputable ones include malaria, diarrhoeal diseases, acute respiratory infections, HIV/AIDS, TB and hepatitis B and C.

2.4.3 Chronic diseases: Chronic diseases of infection and non-infection origin affect iron metabolism directly but at different levels. Parasitic diseases that are of public health significance in Kenya namely helminthic, schistosomiasis, filariasis, leishmaniasis, trypanosomiasis and amoeba are known to cause and aggravate anaemia. Non-infection inflammatory conditions such as rheumatoid arthritis, malignant tumours and chronic renal failure are also associated with anaemia both directly and indirectly (Gibson, 1990). Genetic conditions affecting haemoglobin, mainly sickle cell disease and trait, and thalassaemia traits are important contributory factors (Gibson, 1990).

2.4.4 Physiological factors: In view of the central role that iron plays in body functions, increased physiological demand due to pregnancy, menstrual flow and growth spurts in early childhood and adolescence is universally recognized. The interaction between risk enhancement attributed to these demands and predictors described above presents important points of infection.
2.4.5 Environmental factors: Environmental pollutants such as heavy bi- and tri-valent metals, including lead, copper, aluminium and calcium also precipitate IDA. Unlike calcium, which is likely to interfere with absorption of iron, these heavy metals are known to interfere with Haemoglobin formation through substitution of the iron in the haeme molecule (Garrow and James, 1993). Excepting preliminary data from pilot activities on lead exposure, the public health importance of these pollutants is poorly documented in Kenya.

2.4.6 Socio-economic and cultural factors: High prevalence of food poverty and inequitable availability, accessibility and affordability of health care services and poor sanitation levels especially in poor households, and inadequate knowledge and skills to reduce risk of developing anaemia in the general population are fundamental issues in the anaemia discourse.

2.5 Assessment of nutritional status

Nutritional status is the overall condition of health of an individual which is influenced by intake and utilization of nutrients (Whitney and Rolfes, 1992). To diagnose malnutrition or to identify individuals at risk of becoming malnourished, one can assess dietary intake, look for clinical symptoms and signs or rely on anthropometrics, biochemical or functional indicators of nutritional status. Nutritional status can be assessed using anthropometric indices such as height-for-weight, weight-for-age, and height-for-age. These indices can be used as indicators of long and short term nutritional status.

Children’s nutritional status is a reflection of their overall health. When children have access to adequate food supply and are not exposed to repeated illness, they reach
their growth potential and are considered well nourished. In a well nourished population, there is a standard distribution of height and weight for children under five. Under nourishment in a population can be gauged by comparing children to this standard distribution. Each of the three nutritional status indicators are expressed in standard deviation units (z-scores) from the medium of the reference population. Weight for age is a measure of both acute and chronic malnutrition.

Children whose weight for age is more than 2 standard deviations below the medium of the reference population are considered moderately or severely underweight while those whose weight for age is more than 3 standard deviation below the medium are classified as severely underweight (Pollit, 2005). Height for age is a measure of linear growth. Children whose height for age is more than 2 standard deviations below the medium are considered as severely stunted. Stunting is a reflection of chronic malnutrition, which results from failure to receive adequate nutrition over a long period and recurrent/chronic illness. Children whose weight is more than 2 standard deviations below the medium of the reference population are classified as moderately or severely wasted while those who fall more than 3 standard deviations below the medium are severely wasted. Wasting is usually the result of a recent nutritional deficiency. The indicator may exhibit significant seasonal shifts associated with changes in the availability of food or disease prevalence (Pollit, 2005).

2.6 Dietary assessment of iron rich foods (food frequency and 24 hour recall questionnaires)

Dietary assessment, while an indirect and limited approach for establishing levels of iron nutrition in a population, can be useful in determining overall dietary iron intake and identifying common dietary patterns that may enhance or inhibit iron absorption.
This can be done by using food frequency questionnaires, focussed group interviews with target groups and direct and indirect participatory observation of the individuals under study (Scrimshaw, 1992). The food frequency questionnaire is commonly used in nutrition surveys to obtain estimates of the typical food intakes of large numbers of people in a given population. The assessor asks the respondent to recount the frequently eaten or drunk items over a certain period of time (Whitney and Rolfes, 1992). The 24 hour recall questionnaire is where the assessor asks the respondent to recall all the foods and drinks consumed for the last 24 hour period.

2.7.0 Assessment of iron deficiency anaemia

Majority of anaemia in children in developing countries is due to iron deficiency, malaria, and infections diseases (Stoltzfus and Chwaya, 2000). Several diagnostic tools can be used for screening iron deficiency anaemia. These are:

2.7.1 Haemoglobin concentration

This involves the analysis of red cell content. The World Health Organization has differentiated cut-off criteria for haemoglobin by age, sex and physiological status (Lind and Hernell, 2004). It is given as non anaemic 9-11g/dl, moderately anaemic <8g/dl and severely anaemic <5g/dl. Drops of whole blood are dispensed to make a blood film that is used to determine haemoglobin concentration.

2.7.2 Haematocrit (packed cell volume)

Haematocrit gives the red cell index. The World Health Organization has established a single and universal cut-off point of less than 33% when using haematocrit. Haematocrit is an immediate, instantaneous and inexpensive test, requiring a minimal blood sample.
2.7.3 Serum ferritin

It gives the iron storage index. The World Health Organization gives a cut-off of 12 micro grams per litre. It is however expensive to carry out and needs larger volumes of blood (Lind and Hernell, 2004).

2.7.4 Pallor of palms and nail beds

Severe Pallor

Severe pallor is proposed as a simple innovative indication of severe anaemia that avoids the need for laboratory assessment. To date, testing of the anaemia algorithms has focussed on the sensitivity and specificity of pallor for the detection of severe anaemia (MoH/WHO/UNICEF, 2002). To assess anaemia severity among children, one can look for palmar pallor. Pallor is an unusual paleness of the skin. It is a sign of anaemia. To see if the child has pallor, one can look at the skin of the child’s palm. The child’s palm is held open by gently grasping it from the side. The fingers should not be stretched backwards, as this may cause pallor by blocking the blood supply. The colour of the child’s palm is then compared with that of the person and also with the palms of other children. If the skin of the child is pale, the child has palmar pallor. If the skin of the palm is very pale that it looks white, the child has severe palmar pallor (MoH/WHO/UNICEF, 2002).

In studies done in Siaya, Kenya, health workers found that palmar pallor was 63 percent specific for the detection of moderate anaemia (haemoglobin less than 8g/dl), while severe palmar pallor was 60 percent sensitive and 98 percent specific to detect severe anaemia (haemoglobin less than 5g/dl). Of the anatomic sites tested palmar pallor had the best combination of specificity and sensitivity for detecting severe and moderate anaemia (Zucker, Perkins, Jafari, et al., 1997).
2.8.0 Assessment of cognitive development among children

2.8.1 Peabody Picture Vocabulary Testing

This test is designed to measure a subject’s receptive/hearing vocabulary ability. It was originally published in 1959 by America Guidance Service. The third edition of this test was standardized in 1995 and published in 1997. The Peabody Picture Vocabulary Test-Revised is an individually administered, norm-referenced power test of hearing vocabulary which is available in two forms. Each form contains 5 items followed by 175 test items arranged in order of increasing difficulty. Each item has four simple, black and white illustrations arranged in a multiple choice format. The subject’s task is to select the picture considered to illustrate best the meaning of a stimulus word presented orally by the examiner.

This test is designed for persons 2.5 to 40 years of age who can see and hear reasonably well. Testing requires only 10 to 20 minutes, because the subject must answer only about 35 to 45 items of suitable difficulty. Scoring which is rapid and objective is accomplished largely while the test is being administered. Raw scores are usually converted to age referenced norms (Dunn, 1981).

2.8.2 Expressive One Word Picture Vocabulary Testing (2000)

This test measures a child’s verbal expression of languages by asking the child to make word-picture associations. In administration, the examiner shows the child pictures and the child provides names for those pictures. In addition to providing information about how a child processes language, the test provides information about speech defects, learning disorders, auditory processing, English fluency or bilingual child and auditory-visual-verbal association ability. The test can be administered in 10 to 15 minutes and can be scored in 5 minutes or less (www.wikipedia.com).
2.8.3 Raven's Progressive Matrices

These are multiple choice tests of abstract reasoning, originally developed by Dr. John C. Raven in 1938. In each test item, a candidate is asked to identify the missing segment required to complete a larger pattern. Many items are presented in the form of a 3x3 or 2x2 matrix, giving the tests its name. The test measures the ability to think clearly and make sense of complexity, which is known as educative ability and the ability to store and reproduce information, known as reproductive ability. This test is widely used in both research and clinical settings with children, the elderly, and patient populations for whom processing of language may need to be minimized. It has adequate standardization, is easy to use and cheap (Raven, Raven and Court, 2003).

2.8.4 Wechsler Intelligence Scale for Children, 3rd. ed. (WISC-III) 1991

The WISC-III is an individual test that does not require reading or writing. Verbal subtests are oral questions without time limits except for arithmetic. Performance subtests are nonverbal problems, all of which and some of which allow bonus points for extra fast work. This test can be used with children between 4 and 6 years. The verbal component of the test assesses intellectual skills. The performance component provides information about children’s non-verbal intellectual skills and also allows educators to assess the intellectual prowess of children who have speech or language disorders (Wechsler, 1991).

2.9 Evidence of causal link between iron deficiency anaemia and cognitive development among children

The evidence for an effect of iron deficiency on mental development comes from studies on the role of iron in neural development and function of the brain, and from
epidemiological studies on the relationship between anaemia and performance on
cognitive tests, sometimes in the context of an intervention (Pollit, 1993). Studies
done in rural Zanzibar have shown marked improvements in motor and language
developments after a few weeks to months of oral iron supplementation in children
with very low initial haemoglobin concentrations. This clearly shows that
replenishing iron can positively influence development even in children with severe
anaemia and iron deficiency (Stoltzfus 2001).

2.10 Summary

Pallor of the palms and nail beds was used to assess anaemia severity because of its
inexpensive nature and reliability. Body iron stores were determined by assessment of
dietary intake of iron rich foods. One Word Picture Vocabulary Testing, Raven’s
Progressive Matrices and Peabody Picture Vocabulary Testing were used to test both
cognitive and intelligence level of the children.
CHAPTER THREE

METHODOLOGY

3.1 Research Design

The study was a descriptive survey research. The study involved selecting children both boys and girls of between 4 and 5 years, and observing their behaviour in terms of cognitive and attention capacities; in relation to their anaemia status. A total of 150 children were included in the study. Assessment of palmar pallor and nail beds, nutritional status and dietary intake of iron rich foods were done. The children were then categorised into groups according to their anaemia status. These were then compared to their cognitive level based on their performance in tests measuring intelligence, and their general classroom behaviour.

3.2 Study Area

The study was carried out in three sublocations in Goshi location, Malindi District, Kenya. Malindi District was carved out of Kilifi District in 1996. According to the 1999 population and housing census, the District had a total population of 215,552 persons. This figure was projected to increase to 374,194 persons by the year 2008. The District has an absolute poverty of 59.1% for the rural area and 66.3% for the urban area. Average household income is 20.3% for agriculture, 37.25% for rural self employment, 14.4% for urban self employment and 12.8% for wage employment. Total number of unemployed people is 41,423 (Malindi District Development Plan 2002-2008)

The study area is rural, almost all individuals are from the Mijikenda community. Languages spoken are Giryama and Kiswahili. The locals are mostly peasant farmers.
They also keep dairy cattle, goats and poultry. The area experiences limited food resources with occasional droughts and food shortages.

### 3.3 Study Population and Sample

The study population was 10 preschools in Goshi location. 150 preschoolers, 75 boys and 75 girls were selected from the 10 preschools. Since the study was analytical, and had to be carried out within a short period of time with limited funds, the sample size had to be small and manageable and at the same time, be as representative as possible. The ages of the children were determined from the school register and rounded off to the nearest 1.0 year. Preschoolers who were between 4 and 5 years old were appropriate for the cognitive tests used in this study and assessment of haemoglobin level and palmar pallor.

### 3.4 Sampling Procedures

Multistage sampling was used to arrive at the desired sample size.

**Figure 3: Multistage sampling**

```
Simple random sampling used to select one location

<table>
<thead>
<tr>
<th>Purposive sampling to select sublocation</th>
<th>3 Sublocations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple random sampling preschools</td>
<td>10 preschools</td>
</tr>
<tr>
<td>Purposive sampling to select preschoolers</td>
<td>150 preschoolers, 75 boys, 75 girls</td>
</tr>
</tbody>
</table>
```


Purposive sampling was used to select three sub locations from this location. This was because these sub locations had a big population as compared to the other...
sublocations; and also because their prevalence of micronutrient deficiency among the under fives was slightly higher than the rest (National Micronutrient survey report, 1999). Equal numbers of boys and girls were included so that the sample could be as representative as possible, and permit generalizations.

3.5 Recruitment and training of field assistants

Three research assistants were recruited so as to help in data collection. These were form four leavers who were from the area and could speak the local language fluently. They were trained on how to take anthropometrics measurements and also on classroom observation of the children.

3.6 Data collection procedures

The researcher had to obtain a permit from Malindi District Education Office before carrying out the study. The area chief was notified of the intention of carrying out the study by the researcher and approved the research. The researcher also had to obtain permission from the Head teachers of the ten preschool included in the study. The parents of the preschoolers who had been included in the study were notified, and gave an informed consent before the study on their children was carried out. The researcher in collaboration with a paediatric nurse from Malindi hospital did a haemoglobin analysis for at least 3 children from each preschool so as to determine if pallor of palms and nail beds were independent predictors of anaemia. Parents had to give consent before their children could go through the haemoglobin analysis. The children had to be willingly to go through the test.
3.7 Data collection instruments

The following instruments were used to collect data:

Cognitive tests such as the Peabody Picture Vocabulary Test where a child is given a word/noun for example a mango and is supposed to choose one picture from a set of four pictures that best illustrates that word. The other test was the Raven’s Progressive Matrices where a child is given sets of pictures with missing pieces for example car, cow, cup, and for each picture, he is required to pick one piece from a set of pieces and complete each figure. The third test used was the One Word Picture Vocabulary Test. This test measures verbal comprehension abilities where the child is given a picture for example chair and is asked to provide a name for it. The above tests were selected because they were appropriate for the age of the subjects, they are reliable and adaptable to the cultural environment. They also take a short time to administer.

The other instruments that were used were a Ministry of Health manual for assessing palmar pallor, sterilized needles and slides for collecting blood for haemoglobin analysis (red cell content), food frequency and 24 hr recall questionnaires and scales for taking anthropometric measures.

3.8 Data collection

3.8.1 Anaemia status of the children (measured by pallor of palms and nail beds)

Pallor of the palm and nail beds was done in order to assess haemoglobin level and hence anaemic status of the children. The researcher had to rely on physical and clinical signs to detect severe anaemia, due to the expensive nature of the laboratory analysis of the blood. The researcher in collaboration with a paediatric nurse from
Malindi hospital did a haemoglobin analysis for at least 3 children from each preschool so as to determine if pallor of palms and nail beds were independent predictors of anaemia.

The children’s palms were held open by gently grasping them on the side. The palm of each child was examined and then compared with that of the examiner and also with the palms of the other children. If the skin of the child was found to be pale, the child had palmar pallor. If the skin of the child was very pale that it looked like white, the child had severe palmar pallor. The MoH/WHO/UNICEF 2002 cut-offs were used to categorize the children into non anaemic haemoglobin level 9-11 g/dl, moderately anaemic haemoglobin level <8 g/dl and severely anaemic haemoglobin level <5 g/dl.

3.8.2 Haemoglobin analysis

Haemoglobin concentration (red cell content) was done on 15 children. Small sterilized needles were used to puncture the fingers. Drops of whole blood (haemoglobin solution) were dispensed immediately on a slide to make a blood film that was used to determine the red cell content. MoH/WHO/UNICEF 2002 cut-offs were used to categorize the children as non anaemic haemoglobin level 9-11 g/dl, moderately anaemic haemoglobin level <8 g/dl and severely anaemic haemoglobin level <5 g/dl.

3.8.3 Cognitive assessments

Testing was carried out in the schools. Three types of tests were being used, that is the Ravens progressive matrices, the Peabody Picture Vocabulary and the One Word Picture Vocabulary Learning. The selection of common shapes and pictures and the
appropriate words to be used were selected in collaboration with the preschool teachers. Each test consisted of 5 items. During the testing, the child was made to sit on a desk at a secluded place and was presented with the test item. Each test item took about 5 minutes, hence the child was tested for about 30 minutes in total. For each item, the child was given either very good, pass or fail. Scoring sheets for each child were used to record the results. The children were categorized as those who scored above average (>50%), average 50% and below average (<50%).

3.8.4 Observation of classroom behaviour

The children’s behaviour in the classroom was observed in order to ascertain the extent to which they were able to attend to classroom tasks. Studies done by Patti Harrison have shown that a child’s actual behaviour in the classroom and at home is often a better indicator of the child’s ability than an abstract intelligence test. With a time sampling procedure 0 to 10, the observers observed each child during a normal learning session and coded whether the child was attentive to the teachers instructions, or was talking with another child or was off task completely. Observations were recorded on a scoring sheet for each child and was rated as very attentive 7-10, attentive 4-7 and less attentive 0-4.

3.8.5 Dietary intake of iron rich foods

Dietary intake of iron rich foods of the children was assessed using a 24 hour recall and food frequency questionnaires. The questionnaires were administered to mothers or care givers of the parents. For the 24 hour recall, the mother/care giver was asked to recall all the foods that had been given to the child the last 24 hours. The food frequency questionnaire consisted of the most commonly eaten foods in this area, and the respondent was asked to say how often they consumed these foods. The emphasis
was on foods that were rich in iron for example red meat, liver, green leafy vegetables and nuts. The researcher computed a nutrient data base composed of carbohydrates, vitamins, proteins, fats and minerals. Standard recipes for foods consumed were also computed. The data collected was used to calculate the nutritional status of the children and their average consumption of foods that were rich in iron. The cut off for body iron stores was $< 10 \text{ mg RDA}$ (Whitney and Rofles 1992).

3.8.6 Measures of physical development

Anthropometric measures were taken for all children. The ages of the children were established from the school register. Age of the children was determined from the school register to the nearest 1.0 years. The children’s weights were measured with a weighing scale. Excess clothing and foot wear were removed. The child was asked to stand on the middle of the scale with feet together. Reading was rounded off to the nearest 0.1 kg.

Height was taken with a portable device consisting of a metal foot plate, a head plate, and a retractable steel tape. The subject was asked to remove shoes and to stand on the foot plate with feet together. Reading was taken and rounded off to the nearest 1.0 cms. Basal metabolic index was calculated from the children’s anthropometric measurements and anthropometric z scores computed. Stunting was defined as height for age z score $<-2.0$, wasting as weight for height z score $<-2.0$, and underweight as weight for age z score $<-2.0$. 
3.9 Data Analysis

Pearson’s Product Moment Correlations (Pearson’s r) were used to compute the scores on cognitive tests and attention capacities, with those of anaemia and nutritional status. Pearson’s r were used because the data being analysed had been ranked in categories (for example anaemia status been ranked as non anaemic, moderately anaemic and severely anaemic; cognitive performance as above average, average, below average; intake of iron rich foods as well nourished, moderately nourished, under nourished). It also enabled the researcher to tell by how much these scores differed. Since some of the variables being studied could not be manipulated for example anaemia status, the correlations enabled generate of causal hypothesis.

The value of Pearson’s r is obtained by the formula below:

\[ r = \frac{(N\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{(N\Sigma X^2 - (\Sigma X)^2)(N\Sigma Y^2 - (\Sigma Y)^2)}} \]

Where \( N \) is the sample size, \( X \) are the values of the dependent variables and \( Y \) are the values of the independent variables.
CHAPTER FOUR
DATA ANALYSIS RESULTS AND DISCUSSION

4.1 Age and sex of the children

Children between 4 and 5 years were selected for the study. Their ages were determined from the school register. They were purposeful selected due to the nature of the intelligence tests because tests such as the Ravens progressive matrices are for use with children above 4 years. 15 children were selected from each of the 10 preschools, hence the total number of children was 150. Of the 150 children included in the study, half of them would be male and half of them female. This was because the sample size was small, and it had to be as representative as possible. This would also help in drawing comparisons between the performance of boys and girls.

4.2 Anthropometric measures of the children

Table 4.1. Means of children’s physical measures

<table>
<thead>
<tr>
<th>Physical measures</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean (n = 150)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>4</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>87</td>
<td>104.2</td>
<td>95.5</td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>12.07</td>
<td>18.2</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Table 4.1 above shows that the mean age of the children was 4.5 years. Maximum height of the children was 104.2 cm, and the minimum height was 87 cm. The maximum weight of the children was 18.2 kg, and the minimum weight was 12kg. According to the weight-for-height wall chart by MoH/WHO/UNICEF, 2002, slightly over half of the children (51%) were well nourished (18 kg weight-for-110 cm height), 20% were moderately nourished while 29% were undernourished with weight-for-height between 14kg-100 cm, and 12.5 kg -90 cm respectively.
4.3 Characteristics of the parents

Majority, that is, 145 (96.6 %) of the parents interviewed on the food frequency and
24 hour recall questionnaires were the children’s mothers.

4.4 Parents’ marital status and family size

The community where the study was done is largely matrimonial hence most of
parents were married. The families were mostly nucleus, with between 4 and 8
children.

4.5 Parents’ educational level

78 mothers (51 %) interviewed had not attended any formal schooling. 23 mothers
(15%) interviewed had attained some secondary school, although most of them
claimed not to have finished secondary school. 49 mothers (31%) had attained some
primary school education Obtaining the literacy level of the mothers was important
because it tends to influence the kinds of exposure the children get at home, how
frequently children attend school and also the age at which children get to start going
to school. Mothers who are more educated have knowledge on balanced diets and
feed their children on more healthy foods as opposed to those who are less educated.
4.6 Parents economic activities

The children’s mothers were further interviewed on their economic activities. Over half of the mothers, that is, 81 (54.1%) said they were engaged in small scale farming because they had not attended school. They mainly grow maize, cowpeas, cassava and also keep poultry, goats and some cows. The rest, that is, 69 mothers (45.9%) were either employed or operating small scale businesses such as selling food stuffs and second hand clothes in the local market. Those that had some secondary school education were employed in the local primary school and youth polytechnic.
4.7 Children’s cognitive test performance

122 children (81.4%) scored average and above on all the tests measuring cognitive abilities. Only 22 (18.6%) of the children scored below average. Their performance on the cognitive tests was also compared to that of class work and end of term examinations. There was some similarity in the performance in that most of the children who passed the cognitive tests also passed their class work and examinations. There was no big difference in the children’s performance among the schools.

Table 4.2. Distribution of children’s performance on cognitive tests by school

<table>
<thead>
<tr>
<th>School</th>
<th>Percentage score on cognitive test performance</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;average</td>
<td>average</td>
</tr>
<tr>
<td>Kakuyuni</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Mijomboni</td>
<td>53.3 (8)</td>
<td>20 (3)</td>
</tr>
<tr>
<td>Baguo</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Al-Faith</td>
<td>60 (9)</td>
<td>26.6 (4)</td>
</tr>
<tr>
<td>Mijomboni Pefa</td>
<td>46.6 (7)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Madunguni</td>
<td>53.3 (8)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Goshi</td>
<td>53.3 (8)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Kalia papo</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Kavunyalalo</td>
<td>33.3 (5)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Kwaupanga</td>
<td>40 (4)</td>
<td>40 (4)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46.7</strong></td>
<td><strong>34.7</strong></td>
</tr>
</tbody>
</table>

4.8 Attention capacities of the children

This was to help ascertain how attentive the children were to classroom tasks. The reason for measuring attention capacities was to determine if there was any discrepancy between their performance on the cognitive tests battery and their attention capacities.

The results were similar to those of performance on cognitive tests. Most children were attentive to classroom tasks.
Table 4.3. Distribution of children’s mean scores on classroom attention span by school

<table>
<thead>
<tr>
<th>School</th>
<th>Mean Percentage score on attention capacities</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very attentive</td>
<td>Attentive</td>
</tr>
<tr>
<td>Kakuyuni</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Mijomboni</td>
<td>53.3 (8)</td>
<td>13.3 (2)</td>
</tr>
<tr>
<td>Baguo</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Al-Faith</td>
<td>60 (9)</td>
<td>26.6 (4)</td>
</tr>
<tr>
<td>Mijomboni Pefa</td>
<td>46.6 (7)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Madunguni</td>
<td>53.3 (8)</td>
<td>33.3 (5)</td>
</tr>
<tr>
<td>Goshi</td>
<td>53.3 (8)</td>
<td>26.6 (4)</td>
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<td>Kalia papo</td>
<td>46.6 (7)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Kavunyalalo</td>
<td>33.3 (5)</td>
<td>40 (6)</td>
</tr>
<tr>
<td>Kwaupanga</td>
<td>26.6 (4)</td>
<td>40 (6)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46.7</strong></td>
<td><strong>34.7</strong></td>
</tr>
</tbody>
</table>

4.9 Anaemia status of the children (measured by pallor of palms and nail beds)

The results of the children’s pallor of the palm and nail beds were used to categorize them as those that were non anaemic (Hb 9-11 g/dl), those that were moderately anaemic (Hb < 8 g/dl) and those that were severely anaemic (Hb < 5 g/dl) based on the cut offs provided by the ministry of health manual on assessment of haemoglobin status.

Figure 4.3 above indicate that 17% of the children were severely anaemic, while 33% were found to be non anaemic.
4.10 Children’s intake of iron rich foods

Dietary intake data was used to ascertain whether the children were consuming foods that were rich in iron. They were classified as those children who were well fed with iron rich foods (> 10 g RDA), and those that were moderately to poorly fed with foods that were rich in iron (< 10g RDA).

**Figure 4.4**

Classification of children by intake of iron-rich foods

- Moderately nourished: 40%
- Sufficient: 37%
- Severely undernourished: 23%

Figure 4.4 above shows that 37% of the children consumed foods that were rich in iron, 40% moderately consumed iron rich foods, as opposed to 23% did not consume diets that were rich in iron.

4.11.1 Haemoglobin analysis

Analysis of red cell concentration was done on 10% of the sample size. Results indicate that there was a correlation between anaemia status measured by palmar pallor and the haemoglobin concentration of the children, hence palmar pallor is a useful tool in assessing anaemia status.
4.11.2 Cooking methods of commonly eaten foods

A check list was used to ascertain the methods the mothers use when cooking vegetables and other foods. It was observed that most mothers were overcooking their green vegetables, some to almost one hour hence destroying the nutrients.

4.12:0 Measure of relationships between variables being studied

Pearson’s product moment correlations were used to compare the means of the variables under study. Pearson’s r were used because the data being analysed had been ranked in categories for example, cognitive performance as above average, average, below average; intake of iron rich foods: well nourished, moderately nourished, under nourished. It also enabled the researcher to tell by how much the scores differ. Since some of the variables for example anaemia status could not be manipulated, the correlations enabled the researcher to generate causal hypothesis (Leavit, 1992).

The value of Pearson’s r is obtained by the formula below:

\[
 r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)}}
\]

Where N is the sample size, X are the values of the dependent variables and Y are the values of the independent variables.

4.12.1 Variables under study

Independent variables being explored were iron deficiency anaemia, demographic characteristics of the parents (mothers) e.g. economic activity, educational level, socio economic status. Dependent variables were performance on cognitive tests and attention capacities.
4.12.2 Correlation between children’s dietary intake of iron rich foods and their nutritional status

The data on intake of iron rich foods by the children was correlated with that of their nutritional status. There was a positive correlation between the children’s nutritional status, and their body iron stores from their consumption of iron rich foods.

<table>
<thead>
<tr>
<th>Intake of iron rich foods</th>
<th>Nutritional status</th>
<th>Pearson’s r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal z=&gt;-2.0</td>
<td>Moderately undernourished z=-2.0</td>
</tr>
<tr>
<td>well nourished n=37%</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Moderately undernourished n=40%</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Severely undernourished n=23%</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Total 100%</td>
<td>51</td>
<td>20</td>
</tr>
</tbody>
</table>

n = number of children
r = correlation coefficient* = significant, p ≤ 0.01

Table 4.4 above shows that 51% of the children had normal nutritional status, 20% were moderately undernourished, as opposed to 29% who were severely malnourished.

Correlations indicate that 37% of children who consumed foods rich in iron were healthy r =.18, as opposed to 23% who severely lacked foods rich in iron as they were also severely malnourished (r =.34). Nutritional status is thus a useful indicator for assessing anaemia status among children.

4.12.3 Correlations between children’s anaemia status and cognitive performance

Results of assessment of palmar of pallor and nail beds for the children were grouped into 3 categories, that is, those who were non anaemic (Hb 9-11 g/dl), moderately anaemic (Hb <8g/dl) and severely anaemic (Hb <5g/dl). Studies have indicated that the prevalence of mild to moderate iron deficiency anaemia which is most common and wide spread, is harder to assess and the clinical manifestations are subtle. On the other hand, severe iron deficiency anaemia is fairly easy to obtain.
In order to determine if the effects of iron deficiency anaemia on cognitive abilities were similar across the whole range, the children were divided into three groups based on their performance on the cognitive tests battery: above average (>50%), average (50%), and below average (<50%). There was positive relationship between children's anaemia status and performance on cognitive tests.

Table 4.5. Correlation between the number of children per respective haemoglobin level (anaemia status) and performance scores on cognitive tests

<table>
<thead>
<tr>
<th>No. of children per IQ test score level</th>
<th>No. of children per respective anaemia status</th>
<th>Pearson's r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non anaemic</td>
<td>Moderately anaemic</td>
</tr>
<tr>
<td>Above average: n = 60</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Average: n = 50</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Below average: n = 40</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Total(Σn) 150</td>
<td>45</td>
<td>70</td>
</tr>
</tbody>
</table>

n = number of children  
r = correlation coefficient  
* = significant, p ≤ 0.01  
IQ = cognitive

Information on the table above indicate that a total of 110 children scored average and above, out of which 45 were non anaemic, as opposed to 40 children who scored below average, out of which 35 were severely anaemic. Since verification with haemoglobin analysis was only done on 10% of the sample size, causal hypothesis has been only generated on non anaemic and severely anaemic children. Children who were non anaemic had high scores r (45) = 0.15*, p < 0.01, as compared to those who were found to be severely anaemic r (35) = 0.11*, p <0.01.

The 5 children who scored below average and were not severely anaemic probably did not fully understand the tests instructions, or were not motivated to participate. No conclusions were drawn for the children who were found to be moderately anaemic, because of the limitations encountered in assessing them. The researcher is thus recommending further research on the same using analysis of serum ferritin.
4.12.4 Correlations between children’s intake of iron rich foods and their anaemia status

A 24 hour recall and food frequency questionnaires on dietary intake of iron rich foods was used to gather information on the children’s consumption of foods that were rich in iron. The information collected was then correlated with the haemoglobin levels of the preschool children. The results of the tests on pallor of palms and nail beds were positively associated with dietary intake of iron rich foods by the children. Children who consumed foods that were rich in iron had higher haemoglobin levels (Hb 9-11 g/dl), r(60) = 0.18*, and were hence non anaemic, as opposed to those who did not consume foods that were rich in iron, and thus were anaemic (Hb < 5 g/dl), r(35) = 0.14*.

Table 4.6. Number of children as per intake of iron rich foods and nutritional status correlated, and their haemoglobin level (measured by pallor of palms and nail beds)

<table>
<thead>
<tr>
<th>Nutritional status and intake of iron rich foods correlated</th>
<th>No. of children at respective Hb levels (anaemia status)</th>
<th>Pearson’s r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well nourished n = 60</td>
<td>Hb 9-11 g/dl 25</td>
<td>r(60) = 0.18*</td>
</tr>
<tr>
<td>Moderately nourished n = 55</td>
<td>Hb &lt; 8 g/dl 30</td>
<td>r(55) = 0.21*</td>
</tr>
<tr>
<td>Under nourished n = 35</td>
<td>Hb &lt; 5 g/dl 5</td>
<td>r(35) = 0.14*</td>
</tr>
<tr>
<td>Total (Σn) 150</td>
<td>45 70 35</td>
<td></td>
</tr>
</tbody>
</table>

n = number of children  
r = correlation coefficient  
* = significant, p ≤ 0.01  
Hb = haemoglobin level

The information on the table above indicate that only 40% of the children consumed diets that were rich in iron and were mostly non anaemic. However, results of the correlations above also indicated that some of the children who were well nourished with iron rich foods were also found to be anaemic. This phenomenon could have been caused by some intervening variables that are associated with low haemoglobin levels and anaemia. These
variables include diseases like malaria, sickle cell anaemia and hook worm infections, and insufficient vitamin A which interfere with the absorption of iron in the body. In essence therefore, dietary intake of iron rich foods should not be the only indicator used for assessing the level of haemoglobin and consequently the iron deficiency anaemia status of children, as suggested in studies done by Pollit, 1993.

4.12.5 Correlation between children’s intake of iron rich foods with their cognitive development (as portrayed by performance on cognitive tests)

In order to determine if dietary intake of iron rich foods was associated with the cognitive development of preschool children, Pearson’s r were computed between the score on the cognitive tests, with the dietary intake of iron rich foods measures. All the measures of the dietary intake of iron rich foods (well nourished, moderately nourished, under nourished) were positively associated with the cognitive test scores of the children.

<table>
<thead>
<tr>
<th>No. of children as per nutritional status and dietary intake of iron rich foods level</th>
<th>No. of children as per cognitive test performance level</th>
<th>Pearson’s r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Above average</td>
<td>Average</td>
</tr>
<tr>
<td>Well nourished n = 60</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Moderately nourished n = 55</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Under nourished n =35</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total (150)</td>
<td>60</td>
<td>50</td>
</tr>
</tbody>
</table>

n = number of children
r = correlation coefficient
* = significant, p ≤ 0.01

From table 4.7 above the measures of dietary intake of iron rich foods (well nourished, moderately undernourished, severely undernourished) were positively associated with children’s cognitive test scores. Some children who were severely undernourished still scored high in the cognitive test. This could be due to the fact
that schooling make the children more familiar with the matching task and kinds of representations used in the verbal meaning test.
CHAPTER 5

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Iron deficiency anaemia is associated with comparatively poor performance in tests of mental and motor development in infants and toddlers and of intelligence and cognitive function in preschool children (Pollit, 1995). This study was aimed at investigating whether there was any association between iron deficiency anaemia and cognitive development of preschool children 4 to 5 years in Goshi location, Malindi District.

The justification for this study came from studies done by Lozoff 2006 that have demonstrated that children who are anaemic perform poorly in tests that measure cognitive/intelligence level. Studies done by Stoltzfus in 2001 in rural Zanzibar noted that supplementation with oral iron tablets or liquid iron supplement (20 mg/ml ferrous sulphate) for about 12 months improved cognitive and motor development especially in children who were initially anaemic. The evidence of the link between iron deficiency anaemia and cognitive development comes from studies done by Beard 2006 that noted the significant role that iron plays in brain development. During the development of a brain region called hippocampus, iron deficiency limits the number of connections between nerve cells. Insufficient iron also reduces myelin, the fatty material that surrounds many nerve fibres. With less myelin, there is a reduction in the speed in which information travels along the nerve fibres.
5.2. Summary

The general objective of the study was

- To investigate the relationship between iron deficiency anaemia and cognitive development of preschool children in Goshi location Malindi District.

The specific objectives of the study were:

- to assess the level of cognitive development of preschool children using performance scores on cognitive tests,
- to determine the relationship between intake of iron rich foods and iron deficiency anaemia status of the preschoolers, and
- to determine the relationship between iron deficiency anaemia and cognitive abilities of the preschoolers.

The researcher hypothesised that:

- iron deficiency anaemia status of the children was influenced by dietary intake of foods that were rich in iron,
- children’s cognitive abilities were determined by their performance on intelligence tests,
- there was a relationship between children’s iron deficiency anaemia status and their cognitive abilities.

A descriptive cross sectional survey research was used to gather information on the study. Purposive sampling was used to select 150 children, half of which were male and half female. This is because the sample size was small due to the nature of the study, and it had to be as representative as possible so that generalizations could be drawn to all children in Goshi location. Observations were made on these children based on the objectives of the study. Iron deficiency anaemia among the children was determined and assessed through 2 processes:
Dietary intake of iron rich foods. This was determined by administering a 24 hour recall and food frequency questionnaires to the mothers of the children, where mothers were asked about the foods given to children with an emphasis of iron rich foods such as red meat, fish, liver, green leafy vegetables and nuts. This information was used to group children into three categories, i.e. those that were adequately fed with foods that were rich in iron, those that were moderately fed with foods that that were rich in iron, and those that were poorly fed with foods that were rich in iron. Anthropometrics measurements were taken on these children. This was aimed at determining those that were normal, underweight and severely underweight. Studies have shown that there is a correlation between the nutritional status and anaemia status among children as anaemic children eat poorly, gain less weight and are more to intestinal and respiratory infections (Stoltzfus 2001).

Assessment of pallor of the palms and nail beds. A ministry of health manual (MoH/WHO/UNICEF) used to assess anaemia among the children by examining their palms and nail beds. This was because the researcher had to rely on the clinical signs rather than the expensive laboratory tests to detect anaemia, especially severe anaemia. All the children went through the assessment of palmar pallor (Zucker JR, Perkins BA, Jafari H et al, 1997). Haemoglobin analysis was further done on 15 children (10% of total sample size). This were random volunteers, as none could not be forced to go through the blood tests. They were 3 from each school. Consent was obtained from their parents and school administration.
This was a way of assessing the reliability of using the palmar pallor and nail beds. It was also to help in determining moderate iron deficiency anaemia, which is difficult to assess using clinical signs as its physical manifestations are subtle.

Haemoglobin (red blood cell content) analysis was used because it is inexpensive, it is immediate, uses small volume of blood and its cut offs can be categorised in terms of sex, age and physiological characteristics as opposed to packed cell volume (haematocrit) and blood serum ferritin levels.

Cognitive abilities of the children were determined by their performance on cognitive tests scores. The cognitive tests were developed by the researcher in collaboration with the teachers. They were specific to this age group and cultural background. The tests consisted of the Ravens’ progressive matrices, the Peabody picture vocabulary testing and the one word picture vocabulary. They were administered to one child at time in the school compound. All the items were translated into the children’s mother tongue (kigiryama) Scoring was either pass or fail. Percentage scores were calculated and classified as above average, average, below average.

Classroom observation was on the children. This was to determine the extent to which they were able to pay attention to classroom tasks. This is because studies done have shown that real cognitive abilities of children can be measured by their sustained attention to classroom attention and activities, than an abstract intelligent tests. The children were classified as those that were very attentive, attentive and less attentive and percentage scores calculated.

Other variables that were also measured were parents educational level, economic activity, marital status and age. These were to determine if they had any relationship
to the children’s intake of iron rich foods and cognitive abilities (through exposure, school attendance,)

5.3 Implications of findings

Findings indicated that there was a positive relationship between dietary intake of iron rich foods and presence or absence of iron deficiency and anaemia. Children who were well nourished were found to be non anaemic as opposed to those who were underweight (undernourished). Assessment of pallor of the palms and nail beds showed that the children who did not consume adequate foods that were rich in iron were anaemic. These were also the ones who were underweight.

Since Hb analysis was only for very few children, the results were still positively associated with intake of foods that were rich in iron and the results of palmar pallor. This could however not be generalized to the entire sample size, they were only specific to these children.

On the performance of the children on the cognitive tests battery and classroom observation of attention span, results showed that children who were non anaemic had higher scores than those that were anaemic. This was the same case for the children who were well nourished as opposed to those that were underweight.

The difficulty in drawing conclusions was for the children who were moderately underweight and anaemic. First there was the problem of assessing them since the physical manifestations are somehow subtle. Some of these scored high on the cognitive tests battery and attention capacities. Others scored average, and some low. The researcher thus feels that she can not draw any conclusions on these, and is thus recommending further research on the same, using haemoglobin analysis of the entire sample size to determine their anaemic status.
Results showed that children who were from more literate mothers with more resources (working mothers, with large farms) had high scores on the cognitive test battery. They seemed to be more familiar with the shapes and corresponding nouns. This could be explained by the fact that their parents could be aware of eating balanced diets, more so in foods that are rich in iron. They could be also be more exposed (in terms of schooling materials, and school attendance).

5.4 Conclusion

In conclusion, the study found out that iron deficiency anaemia was associated with cognitive abilities of preschool children in this area of study. Children who were non anaemic and well nourished had higher cognitive test scores as opposed to those who were severely anaemic and underweight.

Pallor of the palms and nail beds was found to be an independent significant measure of iron deficiency anaemia especially severe iron deficiency anaemia.

Dietary intake of foods that were rich in iron was found to influence body iron stores and hence presence or absence of anaemia among children.

Nutritional status of the children was found to be a significant measure in predicting anaemia status, as the children who were severely underweight were also found to be severely anaemic.

Measure of vocabulary, picture recognition of simple nouns, sequence, perceptual and comprehension abilities were found to be significant measure of cognitive development among preschool children. Attention span to classroom tasks was also found to be a useful tool in measuring cognitive development.
Intervening variables such as parents’ economic status and literacy level were found to influence nutritional status and presence or absence of anaemia, and in general cognitive development of their children.

5.5 Recommendations

Based on the above findings, the researcher would like to recommend the following:

- More studies should be done on the effect of iron deficiency anaemia on cognitive development of preschool children. Emphasis should be placed on the effect of mild to moderate anaemia.
- Similar studies could be done with the inclusion of the effect home environment has on cognitive abilities of preschool children.
- In studies relation iron deficiency anaemia and cognitive development, intervening variables should also be studied. These include other nutrients that affect utilization of iron by the body e.g. vitamin A, C and proteins; diseases such as malaria, sickle cell anaemia, HIV and AIDS; and intestinal infections e.g. hookworm and thalassemia.
- Longitudinal studies could be done on the same topic that incorporate intervention strategies e.g. some subjects could be given iron supplements to determine if the effects of iron deficiency anaemia on cognitive development can be reversed.
- Mothers in the area of study should be educated on the importance of eating foods that are rich in iron, and their influence on the cognitive abilities of their children. Specifically, they should be made aware of cheap food sources of iron such as nuts and local green leafy vegetables. Moreover, these can be easily grown and hence they should be encouraged to start small kitchen gardens.
• Emphasis should also be placed on eating fresh fruits that are rich in vitamin C, foods that are rich in vitamin A and proteins. These help in the body’s full utilization of iron.

• Pregnant and lactating women should be encouraged to eat foods rich in iron. They should also be given iron supplements so as to boost their iron stores. This has been found to have a snowball effect on their young ones.

• Diseases such as malaria which is common in this area should be treated. People should be encouraged to sleep under mosquito nets. They should also keep their environments clean so as to get read of the breeding grounds for mosquitoes. Infections such as those caused by hookworms and thelassemia should also be treated. This is to avoid further depletion of iron stores.

5.6 Further research

• Similar studies need to be done with an emphasis on the effect of mild to moderate iron deficiency with or without anaemia on the cognitive development of preschool children.

• Similar studies could be done, but with the inclusion of other variables such as the role of home environment, duration of schooling, and intake of other nutrients.

• Intervention studies could also be done on the same, to find out if the effects of IDA on cognitive development can be reversed.
REFERENCES


Stoltzfus R. J., Chwaya H. M., (2000). Malaria, hookworms and recent fever are related to anaemia and iron status indicators in 0-5 year old Zanzibari children and these relationships change with age. *J Nutr 2000; 130:* 1724-1733


6.0 INTRODUCTION LETTER

Grace K Karisa,
Department of Foods, Nutrition and Dietetics,
School of Pure and Applied Sciences,
Kenyatta University,
P:O Box 43844,
NAIROBI.

Dear Respondent,

RE: INTERVIEW SCHEDULE:

I am a postgraduate student at Kenyatta University in Nairobi. I am pursuing a Master of Science Degree in Foods, Nutrition and Dietetics. My main aim of visiting you is to kindly request you to participate in a research I am carrying out on iron deficiency anaemia and cognitive development of preschool children (4-5yrs) in this location as part of the requirement of the course I am doing.

Your child was randomly selected to participate in this study. A total of 150 children are involved from different preschools in this location. I wish to request your candid cooperation in answering the questions I wish to ask you. I will treat the information you give me as confidential as possible, and will only use it for purposes of the study.

Thank you.

Yours sincerely,

Grace Karisa.
Grace Karisa  
Kenyatta University  
Registration No. DH60 / 7056 /01  
Department of Food, Nutrition and Dietetics

RE: CLEARANCE TO CARRY OUT A RESEARCH

You are hereby authorised to carry out a research on iron deficiency, anaemia and cognitive development of pre-school children in Goshi Location, Malindi District from April to October 2003.

MRS. BEATRICE M. MAKAU  
DISTRICT EDUCATION OFFICER  
MALINDI DISTRICT
## 6.1.0 Appendix 1

### 6.1.1 Demographic Information

Name of respondent-------------------Duration of residence in the area------------------years.

List all members of the household who usually live in the household starting with the head of the household.

<table>
<thead>
<tr>
<th>Name</th>
<th>Q1.1</th>
<th>Q1.2</th>
<th>Q1.3</th>
<th>Q1.4</th>
<th>Q1.5</th>
<th>Q1.6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age/DOB</td>
<td>Sex</td>
<td>Relationship to family head</td>
<td>Marital status</td>
<td>Education (highest level)</td>
<td>Main economic activities</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>F=1 M=2</td>
<td>hh head=1 Wife=2 Husband=3 Son=4 Daughter=5 Other = 8 (specify)</td>
<td>S=1 M=2 D=3 Se=4 Coh=6 N/A=7</td>
<td>1=None 2=preschool 3=std1-4 4=std5-8 5=form1-4 6=Dip. 7=univer. 8=others (specify)</td>
<td>1=farmer 2=housewife 3=cas/labour 4=teacher 5=civil ser 6=student 7=business 8=unemployed 9=others (specify)</td>
<td></td>
</tr>
</tbody>
</table>

S = Single  SE = Separated  M = Married  Coh = Cohabiting  Oth = Others
6.2.0 Appendix 2
6.2.1 Health information form

1. Which illnesses are of greatest concern in this household? (Number them in order of importance).

1. Malaria  
2. Diarrhoea  
3. Intestinal worms  
4. Others (specify).

2. For these illnesses where is treatment usually sought from first and last if not resolved? Please specify.

3. a) Has your child been ill during the last two weeks?

1. Yes  
2. No

b) If yes, please specify the kind of illness.

4 a) Do you experience any problems with your children’s feeding habits?

1. Yes  
2. No

b) If yes, please give some example.
### 6.3. Appendix 3
#### 24 hour recall questionnaire

<table>
<thead>
<tr>
<th>Meal time</th>
<th>Dish</th>
<th>Ingredient</th>
<th>Description</th>
<th>Amount cooked</th>
<th>Preparation</th>
<th>Child</th>
<th>Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6.4.0 Appendix 4

**Food frequency questionnaire**

<table>
<thead>
<tr>
<th>Foods category</th>
<th>Typical number of times it is consumed/period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wet season</td>
</tr>
<tr>
<td>Name of food</td>
<td>Weekly</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
</tr>
<tr>
<td>Cassava</td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td></td>
</tr>
<tr>
<td>Vegetable</td>
<td></td>
</tr>
<tr>
<td>Fruits</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td></td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
</tr>
<tr>
<td>Cooking fat/oil</td>
<td></td>
</tr>
<tr>
<td>Fish</td>
<td></td>
</tr>
<tr>
<td>Bread</td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td></td>
</tr>
<tr>
<td>(white/black</td>
<td></td>
</tr>
</tbody>
</table>
6.5 Appendix 5  
Clinical observation record sheet for recording palmar pallor

The researcher will observe the palms of the child to look for pallor. This will be recorded on a piece of paper, for pallor or no pallor.

<table>
<thead>
<tr>
<th>Preschool</th>
<th>Clusters (4-5yrs)</th>
<th>N</th>
<th>Pallor%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Palms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nail beds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.6. Appendix 6
Record sheet for anthropometry measures for 150 preschool children in 10 preschools

<table>
<thead>
<tr>
<th>4 years</th>
<th>4.5 years</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt/ht</td>
<td>Wt/ht</td>
<td>Wt/ht</td>
</tr>
<tr>
<td>Wt/age</td>
<td>Wt/age</td>
<td>Wt/age</td>
</tr>
<tr>
<td>Ht/age</td>
<td>Ht/age</td>
<td>Ht/age</td>
</tr>
</tbody>
</table>
6.7.0 Appendix 7
Cognitive development tests (Attached)

6.7.1 Raven’s Progressive Matrices
6.7.2 Peabody picture vocabulary

Draw the following items:

1. Mango

2. Orange

3. Banana
6.7.3 One-word picture vocabulary testing
6.8 Appendix 8

Malindi District Map
6.9 Appendix 9  Workplan for carrying out the study

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>First draft proposal</td>
<td>June 2002</td>
</tr>
<tr>
<td>Second draft proposal</td>
<td>September 2002</td>
</tr>
<tr>
<td>Final draft proposal</td>
<td>December 2002</td>
</tr>
<tr>
<td>Proposal writing</td>
<td>Jan – May 2003</td>
</tr>
<tr>
<td>Proposal presentation at department</td>
<td>June 2003</td>
</tr>
<tr>
<td>Correcting proposal after presentation</td>
<td>July - September 2003</td>
</tr>
<tr>
<td>Proposal submission</td>
<td>October 2003</td>
</tr>
<tr>
<td>Data collection</td>
<td>October - January 2004</td>
</tr>
<tr>
<td>Data cleaning and coding</td>
<td>Jan – March 2004</td>
</tr>
<tr>
<td>Data analysis</td>
<td>April – June 2004</td>
</tr>
<tr>
<td>Report writing</td>
<td>July 2004</td>
</tr>
<tr>
<td>Presentation of findings</td>
<td>August 2004</td>
</tr>
<tr>
<td>First draft thesis</td>
<td>October 2004</td>
</tr>
<tr>
<td>Second draft thesis</td>
<td>January 2005</td>
</tr>
<tr>
<td>Thesis submission</td>
<td>April 2005</td>
</tr>
<tr>
<td>Thesis defence</td>
<td>July 2005</td>
</tr>
</tbody>
</table>
## 6.10 Appendix 10
### Budget for carrying out the study

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (kshs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typing &amp; printing proposal</td>
<td>3,200</td>
</tr>
<tr>
<td>Photocopying the proposal</td>
<td>1,200</td>
</tr>
<tr>
<td>Photocopying the research instruments (Interview schedule,</td>
<td>2,000</td>
</tr>
<tr>
<td>observation guides, Intelligence tests score sheets, flow diagrams)</td>
<td></td>
</tr>
<tr>
<td>Hiring assessment materials</td>
<td>30,000</td>
</tr>
<tr>
<td>3 research assistants @ 3000 per month for 3 months</td>
<td>60,000</td>
</tr>
<tr>
<td>Transport for principal researcher / research Assistants @ 3000 for 3 months</td>
<td>36,000</td>
</tr>
<tr>
<td>Data analysis (SPSS)</td>
<td>10,000</td>
</tr>
<tr>
<td>Typing/printing thesis</td>
<td>20,000</td>
</tr>
<tr>
<td>Photocopying thesis</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>193,400</strong></td>
</tr>
</tbody>
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