FACTORS CONTRIBUTING TO RICKETS AMONG CHILDREN UNDER-FIVE YEARS:

CASE STUDY OF ISHIARA AND EMBU HOSPITALS, EMBU COUNTY

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A Dissertation Submitted in Partial Fulfilment of the Requirements for the award of Master of Science Degree in Applied Human Nutrition in the University of Nairobi

2018

DECLARATION

I MUCHUKA NAHASON MURIITHI declare that this is my original work and has not been submitted to any other institution for any award.

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Course Name: **MSc. IN APPLIED HUMAN NUTRITION**

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DEDICATION

This work is dedicated to my lovely Mom, Joyce Muchuka and other family members for their continuous support. I love you all.

ACKNOWLEDGEMENT

I gratefully acknowledge the marvellous inputs of my supervisors, Prof. Wambui Kogi-Makau, Dr. Angela A. Andago and Prof. Samuel K. Mbugua for their enormous support and guidance throughout the research duration.

More thanks goes to the University of Nairobi for having granted me the opportunity to pursue my master's degree in Applied Human Nutrition from their institution. I extend special thanks to the entire department of food science, nutrition and technology and its staffs who assisted me in one way or another.

Special gratitude goes to ministry of health Embu County and Ishiara level 4 hospital management for granting me a study leave to undertake this degree programme. I also thank my research assistants, Amina Mwendendi, Jane Wereri and Linnet Njoki for excellent work in data collection. This work would not have succeeded without the cooperation of the respondents who sacrificed their time during the interviews.

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ABBREVIATIONS

BMD – Bone mineral density

Cm - Centimeter

COCs – Combined oral contraceptives

DMPA- Depot medroxyprogesterone acetate

g – Grams

GIT – Gastro intestinal tract

KDHS- Kenya demographic and health survey

MCH – Maternal child health

mg- Milligrams

OR- Odds ratio

RDA – Recommended dietary allowances

SPSS- Statistical package for social sciences

USA – United States of America

UK – United Kingdom

WHO- World health organisation

OPERATIONAL DEFINITIONS

Complementary foods – these are foods introduced to all infants after attaining age of six months which should be timely, adequate, safe and properly fed to complement breast milk.

Dietary intake – daily eating patterns of individual including specific foods and nutrients consumed and relative quantities.

Depo-Provera – is a modern method of family planning, a contraceptive injection containing medroxyprogesterone acetate.

Family planning – is the practice of controlling the number of children in a family and the intervals between their births, particularly by means of artificial contraception or voluntary sterilization.

Nutrition status – the condition of the body in those respects influenced by diet; the levels of nutrients in the body and the ability of those levels to maintain normal metabolic integrity. They are assessed by nutrition indicators (weight for height, age for weight and height for age z-scores).

Phytates – substances found in cereals that inhibit iron, zinc and calcium absorption.

Preconception family planning method – is the family planning methods used by women before pregnancy to control the interval between their births or to prevent pregnancy.

Rickets – a disease that is associated with growing bone that occurs in children as results of lack of mineralized matrix at the growth plates comes about as a results of deficiencies of vitamin D or calcium or combined deficiency of both elements.

Risk factors – are also the contributing factors. This is any attribute characteristic or exposure of individual that increases the likelihood of developing a disease or condition.

Sunbathing – it is the act of exposing the child directly to open sunlight.

ABSTRACT

Rickets is a significant problem which requires a special attention as Kenyan hospitals are continuing to record increased cases. The purpose of this study was to generate new knowledge on the factors that contribute to rickets in children under-five years old. The objective of the study was to determine the dietary intake of calcium, vitamin D and nutrition status as well as the exposure to sunlight practices and family planning methods used by the mothers in preconception period. A case control study was conducted among children under-five years old with and without rickets and their mothers seeking health services at Embu and Ishiara hospitals in Embu county. Data was collected using structured questionnaires and entered, cleaned and analysed using SPSS version 20. Weight for Height, Weight for Age and Height for Age Z-scores were used for nutrition assessment. Results showed that rickets was higher among households with family size of more than 4 members ($p=0.012$), children introduced early to complementary feeding (OR=2.5), consumption of low dietary intake of vitamin D and lack of exposure to sunlight ($p=0.001$, OR=9.8). Rickets was higher with decreasing duration of exposure to sunlight and among children who were fully dressed. The most frequently consumed vegetables by the children with rickets was spinach (91%) and those who consumed for more than three days in a week had higher likelihood of having rickets (OR = 2.5). Underweight ($p=0.017$), wasting ($p=0.009$) and Depo-Provera ($p<0.001$) predisposed children to rickets. Children from mothers who used Depo-Provera as method of family planning for more than one year during preconception period were more likely to have rickets (OR=15.5). In conclusion, demographic and socio-economic status, non-exposure to sunlight and poor exposure practices to sunlight, nutrition status and the type of family planning used by the mother in preconception period were predisposing factors to rickets

CHAPTER ONE INTRODUCTION

1.1 Background Information

Rickets is one among the causes of disability in low income countries. In African, Middle Eastern and Asian countries, rickets remains prevalent. However there has been an increase in prevalence in high income countries like the United State America, United Kingdom, Netherlands, Denmark, Australia and New Zealand, mainly in dark skinned immigrant population (Hsu *et al.*, 2017). Traditionally, rickets has been associated with vitamin D yet, despite sufficient sunlight, rickets is still prevalent in many tropic countries. In some countries like Algeria, Egypt, Turkey and the Middle East, deficiency in vitamin D has been clearly demonstrated as the cause, which is due to the cultural practices which restrict the exposure of sunlight on the skin and UV radiation to the mother and breastfed infant (Pettifor, 2014). It has been observed that dietary calcium deficiency also caused rickets in South Africa, Bangladesh, India, and Nigeria and even in the United States(Hsu *et al.*, 2017).

In developing countries, rickets is as a result of different causes and continues to be a major pediatric concern (Pettifor, 2013). Developed countries also have not been spared from this disease and it is an emergent problem in United States of America (USA) (Hsu *et al.*, 2017). A hospital based study in Bangladesh found that rickets was among the major clinical manifestation of malnutrition in children (36%) and affected both sexes equally with males (37%) and females (33%) (Ejaz and Latif, 2010). Prevalence of rickets in China, Algeria and Nigeria were 40.7%, 18% and about 2.4 – 14.9% respectively among 6 –24 months old children (Bereket, 2003).

Mothers attending maternal child health clinic perceives that Depot medroxyprogesterone acetate (DMPA) as a contributing factor to rickets and there is need to establish whether there is relationship. DMPA is an intramuscular injectable contraceptive administered after every three months. Over nine million women use it in the whole world, mostly in the United States of America and United Kingdom (Kyvernitakis *et al.*, 2017). DMPA type of family planning has a significant bone mineral density loss in women of reproductive age and is associated with fracture risk which increases with the length of use (Kyvernitis *et al*, 2016). Due to this demineralization, the researcher is relating it with the perceptions of mothers that this method of family planning could be contributing to rickets.

Nearly 58% of married women of the age between 15 to 49 years in Kenya use different methods of family planning (KDHS, 2014). Modern methods of contraception are more commonly used at rate of 55% than the tradition methods which rates at 5%. Of the modern method injectable are the most widely used at rate of 26% in Kenya and 31% in Embu County, followed by implants at 10% and pills at 8% in Kenya. (KDHS, 2014)

Protein-energy-malnutrition which is widespread in developing Countries is strongly associated with vitamin D deficiency rickets. There is need for provision of adequate quantities of mineral elements required for building bones, otherwise no amount of vitamin D that would promote normal bone development. (Peacock,2010). Calcium is a major mineral in bones and it low intake by children in developed countries often results from low intake of dairy products (Oramasionwu *et al.*, 2013). Markedly, deficiency or reduced availability of dietary calcium and vitamin D predispose children to nutritional rickets (Akpede *et al.* 2001). Formation of strong

bones in children requires combination of nutrients including Vitamin D and calcium, in appropriate amounts (Whitney *et al,* 2001).

Trends in rickets have only been documented in a few African countries (WHO, 2000). Thus, more current studies need to be conducted. Whitney *et al*. (2001) further states that, rickets still affect many children particularly in Sub Saharan Africa where tropical climate would be expected to be protective. Only scanty data in hospital records exist on the situation of nutritional rickets in Kenya. Previously, hospital records indicated that rickets were persistent problem in Kenyan communities as children too short for their age visiting health facilities are often suspected to have rickets (Nyakundi *et al,* 1994). This study therefore, will assess the association of rickets with complementary foods and the preconception family planning methods of their mothers among the children under-five years in Ishiara and Embu hospitals, Embu County so that health care providers in the study area may devise proper intervention strategies. Obtained data shall probably indicate the need for causal research in family planning methods as factor in rickets.

1.2 Statement of the Problem

Kenyan hospitals continue to record increased cases of rickets. For example, premature infants who have rickets at the age of 6 months in Kenya is about 60% (Bereket, 2003). About 100 cases of rickets are observed in Kiambu district hospital every month, and the same trend has continued to be observed in Kenyatta National Hospital with 2-3 cases of rickets recorded daily (Bwibo, 2003). Additionally, an increased trend was noted in Embu where rickets clinical signs were not observed in 1980's study. However, studies carried out later in highland parts in 2000

to 2003 showed that about 7% of children aged 1 -4 years had clinical rickets (Neumann and Bwibo, 2008). Traditionally, rickets has been associated with vitamin D deficiency yet, despite sufficient sunlight in most of the months of the year the problem continues to be a challenge. Mothers who attend maternal child health clinic from the hospitals of study expressed concern on the increase in rickets in their children. The problem has particularly been related with the children of mothers who used Depo Provera as their method of family planning prior to conception with the child. The allegation has however not been clearly elucidated.

1.3 Justification

Rickets is a rising significant problem where special attention is required. Children are increasingly coming to the hospital showing signs which have been diagnosed as rickets. Rickets is among of the causes of disability in low income countries. Kenya being one of them there is need to find out the contributing factors to be able to provide prophylactic as opposed to therapeutic management services for rickets in children. A study in Nigerian children (Hsu *et al.*, 2017) hypothesized the maternal bone density as risk factor in rickets given the influence of maternal factors on fetal and infant skeletal growth. There is no data to relate rickets with preconception family planning of the mothers of these children given that family panning methods are likely to influence the maternal bone mineral density; fetus depends on the mother for all nutrients.

1.4 Aim of the Study

The aim of this study was to contribute towards reduction of prevalence of rickets in children under-five years in Embu County, Kenya.

1.5 Purpose of the Study

The purpose of study was to generate new knowledge on the factors that contribute to rickets in children in Embu County, Kenya.

1.6 Objectives

1.6.1 Main objectives

To determine the factors contributing to rickets among children under-five years seeking health services in Ishiara and Embu hospitals.

1.6.2 Specific objectives

1. To determine demographic and socio-economic characteristics of the household of the children under-five years.
2. To determine dietary intake of calcium, oxalates, vitamin D and the nutrition status of children under-five years.
3. To establish factors influencing children under-five years old on exposure to sunlight.
4. To establish the types of family planning methods used by the mothers in the preconception period.

1.7 Hypotheses

1. There is no significant association between rickets and complementary foods in children.
2. There is no relationship between rickets and the risk factors.

1.8 Beneficiaries of the study

Table 1.1 The beneficiaries of the study

Beneficiary	How
Children	Improved infant and young child nutrition care
Mothers	Understand preventive measures to rickets
Government	Know the risk factors to rickets to be able to strengthen the current programmes on infant and young child to include preventive care towards rickets.
Researchers	Get new knowledge on risk factor to rickets and explore on it.

CHAPTER TWO: LITERATURE REVIEW

2.1 History of Rickets

Scientific literature on rickets began in the year 1645. David Whistler with his thesis concerning the disease of English children (rickets) indicated that the disease (rickets) had notable effect on social and industrial life(Zhang *et al*., 2016). In Kenya, cases of rickets were first documented between 1926 and 1930 at a hospital in central Kenya. With the discovery of vitamin D, rickets was largely eliminated via preventive fortification of milk and infant formulas, therapeutic vitamin D, and exposure to sunlight. However, a resurgence of rickets was reported in northern latitudes, cold climates, and even in southern latitudes with ample sunshine. Several factors contribute to rickets, among them calcium deficiency particularly from milk and dairy products, minimal sources of animal foods, vitamin D deficiency, high fibre intake and limited exposure to sunlight. (Bwibo *et al*, 2013)

2.2 Definition and Overview of Rickets

Rickets is a childhood disorder that occurs due to nutrient deficiency of either primary deficiencies of vitamin D or calcium or combined deficiency of both elements (Fischer, Thacher and Pettifor, 2008). In African, Middle Eastern and Asian countries, rickets remain highly prevalent. However, there has been increased prevalence among high incomes countries such as United States, United Kingdom, Netherland, Denmark, Australia and New Zealand, mainly in dark skinned immigrant population (Hsu *et al.*, 2017).

Traditionally, rickets has been associated with vitamin D. Yet, despite sufficient sunlight, rickets is still prevalent in many tropical countries. It has been observed that dietary calcium deficiency

also caused rickets in South Africa, Bangladesh, India, and Nigeria and even in the United States(Hsu *et al.*, 2017).

Evidence from several tropical countries indicates that many children with rickets have adequate vitamin D status, based on the normal serum 25-hydroxyvitamin D values found in the majority of children. Reports of calcium deficiency as a cause of rickets in these children have originated from South Africa, Nigeria and Bangladesh. Though most reports are limited to these three countries, calcium-deficiency rickets likely occurs in many tropical countries, but may be misdiagnosed as vitamin D deficiency in the absence of laboratory measurement of 25-hydroxyvitamin D. Calcium-deficiency rickets was first reported and is still occasionally described among American and European children whose milk intake is restricted (Hsu *et al.*, 2017).

2.3 Clinical Signs and Symptoms of Rickets

Symptoms of rickets include: late teething and walking, delayed sitting, poor weight gain, big forehead, bowed lower extremities, rough skin on the stomach and feet, persistence fever and diarrhoea and hypersensitive feet (Billoo *et al*, 2009).

2.4 Predisposing Factors

They are potential contributor to development of rickets. They include: lengthy duration of breastfeeding, limited exposure to sunlight and limited dietary intake of calcium rich food and vitamin D deficiency (Lucia *et al*, 2003)

2.4.1 Breastfeeding

It is known that the best nutritive food for infants is human milk (Kramer and Kakum, 2004). Breastfed infant to a mother who had low concentration of maternal vitamin D in pregnancy is associated with rickets. Calcium concentration in breastmilk is lowered with increasing duration of lactation. Generally, prolonged breastfeeding is known contributing factor for rickets due to the low concentration of vitamin D in breastmilk and its declining calcium concentration with duration of lactation (Hsu *et al.,* 2017).

In developing countries, breastfed infants highly depend on UV radiation to ensure their vitamin D status since pregnant and lactating women status for vitamin D is mostly poor as result of low 25-OHD concentration in neonates as well as low vitamin D content in breastmilk (Pettifor, 2014). There has been an increased incidences of rickets among breastfed infants (Henderson, 2005). USA study found that low serum vitamin D concentration had been associated with 23% of children aged 7 months (Zieger, Hollis, Nelson and Jeter, 2006). It has been associated that breastfeeding in absence of vitamin D supplementation to be major predictor of deficiency in vitamin D in infants. When maternal status of vitamin D are adequate concentration of vitamin D by the end of the second month of life decreases to a value associated vitamin D deficiency (Pettifor, 2008)

2.4.2. Exposure to sunlight and rickets

Vitamin D deficiency is a known cause of rickets, which could be as result of limited sun exposure especially for those living at mid or high latitude areas. Exposure to sunlight in tropical and subtropical regions is generally abundant, but deficiency in vitamin D may arise due to risk

factors like covering skin for various reasons such as religious or cultural reasons, darker skin pigmentation and may be atmospheric pollution (Jones *et al.*, 2017).

2.4.3 Anti-Nutrients

Many factors influence the absorption of calcium such as the presence of substances which forms insoluble complexes with it. Phytates and oxalates are anti-nutrients found in some foods or diet consumed by Infants and children (Krittaphol *et al.*, 2006).

2.4.3.1 Phytates

Cereals, nuts, legumes and seeds contains phytates in their husks which can form insoluble calcium-phytate in the GIT (Krittaphol *et al.*, 2006). Phytates present in foods, inhibit the bioavailability of minerals although to some extent it also depends on food processing and cooking methods (Gibson, perlas and Gibson, 2015). For example, phytate concentrations were highest in complementary foods based on unrefined cereals and legumes (approximately 600mg/100 g dry weight), followed by refined cereals (approximately 100mg/100 g dry weight) and then starchy roots and tubers (< 20mg/100 g dry weight) (Gibson *et al.*, 2010).

Diet high in phytates and oxalates increases the level of fecal calcium lowering the concentration of calcium in the gut (Whitney *et al*. 2001). Hence, children who depends on such foods for their mineral intake, such as those in developing countries are prune to mineral deficiencies (Hurrell, 2003). In India, rachitic children were found to consume diets high in phytates (Harinarayan, Ramalakshmi and Venkataprasad, 2004). According to a comparative study in India, the rural subjects had a significantly lower intake of dietary calcium and a significantly higher dietary

phytate/calcium ratio. The conclusion of the study was that, there was reduced bioavailability of calcium in gut due to insufficient dietary calcium intake attributable to high phytates/calcium ratio (Harinarayan, Ramalakshmi and Venkataprasad, 2004). It has been observed that rickets dominated in Nigerian children who had diet high in levels of phytates that inhibited calcium absorption (Thacher *et al.*, 2009). South Africa and Nigerian diets are associated with high content of unrefined cereals, which raises the possibility of dietary constituents such as phytates impairing calcium absorption (Pettifor, 2008). Regrettably, Pettifor reported in the Nigerian studies that quantification of phytates content in the foods consumed was impossible. Many children in Kenya are introduced to cereal based complementary diets which may contain phytates and oxalates (Neumann and Bwibo, 2008).

2.4.3.2 Oxalates

Moderate amount of soluble and insoluble oxalates are known to be found in leafy vegetables such as spinach (Brogren and Savage, 2003). A study conducted in India to assess the soluble and total oxalates content of selected leafy vegetables, indicated that spinach, purple and green amaranth had high levels of total oxalates (Radek and Savage, 2008). Excess oxalates can precipitate calcium in the bowel (Institute of medicine, 2010). To reduce this effect choice of vegetables should be varied during meal planning.

2.4.3.3 Dietary fibre

Notably, dietary fibre, such as cereal bran though has many health benefits can bind with calcium and prevent it from being absorbed (Institute of Medicine, 2010), if Consumed in high amounts by infants and children. High fiber intake raises the fecal calcium by limiting absorption

in the GIT. High consumption of dietary fiber may also bind small amounts of minerals in the GIT and hence impair their absorption. In particular, fiber binds the following minerals: zinc, calcium, and iron. High dietary fiber in children may make them full before their needs are met (Insel *et al*., 2010).

Data on consumption of some foods rich in anti-nutrients that could precipitate calcium in the GIT and their association with rickets is not well documented in Kenya. Therefore, this study aims at documenting foods consumed in Embu county and their association with rickets.

2.4.3.4 Complementary Foods

Poor complementary feeding practices lead to low dietary calcium and malnutrition (Gibson, Perlas and Gibson, 2015). Studies have shown that complementary feeding practices in many countries lead to inadequate supply of nutrients such as calcium and a relatively high amount of phytate (Gibson, Perlas and Gibson, 2015). Infants in many Kenyan communities are fed on cereal flour porridges to complement breast milk (Kimani-Murage *et al.*, 2011). These porridges absorb a large amount of water when mixed with water. These foods become bulky reducing food intake by a child often resulting in malnutrition (Inyang and Idoko, 2006). Inyang and Idoko (2006) also observed that in most parts of Africa, children are fed with mashed adult foods which may not be easily digestible compromising nutrients adequacy. These feeding practices may lead to inadequate calcium absorption in the body. The situation is further aggravated by diets already low in calcium.

Research has shown that a diet low in vitamin D and high in phytic acid can cause rickets due to low calcium available for absorption in the gut. Infants and children diets are often based on maize with limited contribution of animal foods leading to inadequate supply of nutrients such as calcium among 6 to 8-month old infants (Hotz and Gibson, 2001) in Africa.

Maize – legumes blends increase energy and nutrient densities in porridges (Ejigui *et al.*, 2007). Notably, it was found that meat consumption had a negative association with rickets (Dunnigan *et al.*, 2017). Furthermore, a study conducted in Kenya concluded that low intake of animal foods could contribute to rickets (Murphy and Allen, 2003). It is therefore of importance that children are fed on animal foods sources as they are rich in bone building elements. Milk is a good complementary food as it is a well-known source of calcium in infants. Unfortunately, some infants may experience allergy related to milk consumption due to lactose intolerance. This may result to calcium inadequacy and rickets as was reported in London (Fox et al., 2004). Poor feeding practices of too early or too late introduction of complementary foods has been reported in Africa and poses many risks that contributes to persistent malnutrition in children (Muhimbula and Issa-zacharia, 2010). Muhimbula and Issa-Zacharia (2010) also observed that most of these complementary foods were based on cereals porridge with inadequate or no vegetables and mostly lacking animal proteins. These poor complementary feeding practices among infants may have contributed to inadequate calcium and vitamin D resulting in development of unmineralized skeleton and rickets.

2.5 Causes of Rickets

Rickets is caused by either primary deficiencies of vitamin D or calcium or combined deficiency of both elements (Fischer, Thacher and Pettifor, 2008).

2.5.1 Vitamin D deficiency

There are different factors that influence vitamin D status. Among them includes lifestyles choices, environmental and genetic factors (Sowell, Keen and Uriu-adams, 2015). Vitamin D can be made available in human bodies through synthesis in the skin by the process that is dependent on sunlight exposure or through consumption of food rich in vitamin D such as egg yolk and oil fish (Jones *et al.*, 2017).

Vitamin D, which is a fat-soluble vitamin occurs naturally in two forms: cholecalciferol which is referred to as vitamin D3 and can be synthesized in skin epithelial cells through conversion of 7–dehydrocholesterol by ultraviolet B radiation from the sun, and vitamin D2 (ergocalciferol), which is commonly found in mushrooms and yeast and fortified foods and dietary supplements uses the synthetic form (Craviari *et al.*, 2008). After ingestion vitamin D undergoes hydroxylation in two steps. First, once in the liver, it gets converted to 25-hydroxy vitamin D (25[OH] D). The second hydroxylation occurs mainly in the kidney by the 1-hydroxylase enzyme, to convert 25[OH] to the biologically active 1, 25 dihydroxyvitamin D (1, 25[OH] 2D).

Vitamin D has hormone-like activity and regulates the functions of over 200 genes and is essential for growth and development of the body especially regulation of calcium absorption from intestine as well as direct actions on bone resorption.

Prevalence of rickets in South East Asia ranges from 15-18%. The diagnosis of Rickets is mainly clinical which manifests as skeletal deformities such as widening of the wrists (66.6%), widening of the costochondral junctions (rachitic rosary 36.66%), anterior bowing of the tibia and femur (8.33%), softening of the cranial bones (craniotabes 8.33%)2,5. The most known cause of rickets worldwide is deficiency of nutritional vitamin D. Generally, serum level of 25(OH) D less than 20mg/ml is considered as a vitamin D deficient state. Vitamin D deficiency is a worldwide problem. (Pettifor, 2004).

2.5.2 Dietary calcium deficiency

Among other combination factors, diet low in calcium has been thought to contribute in the causes of rickets (Pettifor, 2013). Calcium ranks fifth after oxygen, carbon, Hydrogen, and nitrogen, in the composition of the human body. Greater percentage (99%) of total calcium in the body is found in the skeleton and the remaining 1% is found in the teeth and soft tissues where it is distributed equally (Institute of Medicine, 2011). Particularly, calcium is not abundant in diets and low intakes are widespread in many populations as reported by different studies. For instance, a study found that intake of low sources of calcium foods were susceptive of rickets among African American children in USA and most had been on a complementary diet low in dairy products (Lucia *et al.*, 2003).

In addition, all Indian studies have uniformly documented low dietary calcium intake compared to RDA by Indian Council of Medical Research (Joshi, 2009). A comparative study in India, found that dietary calcium intake was insufficient in both rural and urban subjects compared to the RDA (Harinarayan and Ramalakshmi, 2015). A prospective analysis of Egyptian patients

with and without rickets showed that most patients had calcium insufficiency (Baroncelli *et al*., 2008). Similarly, studies in Bangladesh reported that insufficiency of dietary calcium consumed by children was thought to be the contributory cause to nutritional rickets (Craviari *et al.,* 2008) among children. Rickets as results of calcium deficiency has been reported in Nigeria where individuals were consuming between 100 to 300 mg/day of calcium, which is low in reference to RDA (Neumann and Bwibo, 2008). Additionally, scanty data suggest that some common causes of rickets are inadequate drinking of milk or lactose intolerance, consequently reducing calcium intake by infants and children. According to Whitney *et al.* (2001) calcium absorption is enhanced by lactose and stomach acid making milk a good source of calcium. Generally, populations with a low intake of milk and dairy products have a low total calcium intake (Black, Williams, Jones, and Goulding, 2002).

Low dietary intake of calcium was ruled out to be the cause of rickets among rural South African children and not deficiency in vitamin D (Pettifor, 2008) because children's diets were characteristically lacking dairy products. Their estimation of calcium intakes was about 200 mg/day which was significantly lower compared to that of non-rachitic subjects living in the same community. A Nigerian study reported that dietary calcium intake was low in both children with rickets and non-rachitic children at 217 mg and 214 mg respectively (Thacher *et al.*, 2000). A chronic dietary deficiency due to poor absorption depletes the savings account in bones not in blood (Whitney *et al*., 2001). Therefore, deficiency in dietary calcium has been shown to be major cause of rickets among children in developing countries where calcium intakes is characteristically low (Bener and Hoffmann 2010). About 8% of Kenyan children developed rickets after complementing human milk with inadequate calcium diet of cereals with minimal or

no milk sources or milk products (Neumann and Bwibo, 2008). This study was therefore conducted to compare mean intake of calcium between rachitic and non-rachitic study subjects at the MCH clinic as it was not known.

2.6 Family Planning

DMPA is an intramuscular injectable contraceptive administered after every three months, Over nine million women use it in the whole world, mostly in the United States of America and United Kingdom (Kyvernitakis *et al.*, 2017).

Nearly 58% of married women of the age between 15 to 49 years in Kenya are using a method of family planning. Modern methods of contraception are more commonly used at rate of 55% than the tradition methods which rates at 5%. Of the modern method injectable are the widely used at rate of 26% in Kenya and at 31% in Embu County. Followed by implants at 10% and pills at 8% in Kenya. (KDHS, 2014). Bone mineral density (BMD) measures quantity of calcium an individual has in a certain bone. Depo-Provera compromises bone mineral density by suppression of ovarian production of estradiol which is a sex hormone involved in the development of bone mineral density and attainment of peak bone mass (Clark *et al.*, 2006). Glucocorticoid (cortisols) is known to decrease intestinal calcium absorption and increase urinary calcium excretion at a higher dose; and since Depo-Provera is receptor agonist then it increases plasma cortisol and result in reduced calcium absorption and bone mineralization in the women who use it (Popoola, Omotosho and Amenkhienan, 1937).

Women using DMPA contraception have created a great concern due to potential negative effects attributed to bone health which comes about because of the prolonged hypoestrogenemic state regarding the potential negative effects on bone health. Among other sides effects includes: weight changes where some women put on weight while others reduce, some experiences prolonged heavy bleeding, elevated blood pressure, depression and allergic reactions which in most cases are rare. DMPA when administered at the recommended dose to women every 3 months inhibits the secretion of gonadotropins which in turn prevents follicular maturation and ovulation and results in endometrial thinning. This actions produces its contraceptive effects (Kyvernitakis *et al.*, 2017).

On the other hand, combined oral contraceptives (COCs) have showed that it may even raise estrogen exposure in women who already have deficit in estrogen in the later reproductive years and inhibits further bone loss (Toheed *et al.*, 2016). In absence of estrogen levels following DMPA Kaunitz *et al.* observed a significant decline in BMD of 5.16% at the total hip and of 5.38 at the lumbar spine after 240 weeks of treatment. The author elucidated the sustained negative effect of DMPA even after 96 weeks post treatment. Hence, the researcher will establish whether there is relationship between family planning and rickets as perceived by mothers attending health facilities.

2.7 Knowledge Gap

Despite, the increased recognition of rickets in Africa as a whole and Kenya specifically, there is deficient documentation of risk factors contributing to rickets. Sunlight exposure remains major source of vitamin D to infants but there is scanty documentation on when to start exposing the

infants. Policies have been put on dietary supplementation of vitamin D in most countries though the implementation of the policy is very minimal. Hence, most of pregnant mothers do not get vitamin D supplementation and calcium to help them cater for their new born. Investigations have not been carryout on the relationship between family planning and rickets despite the perceptions of mothers that they could be contributing to rickets.

CHAPTER THREE: STUDY DESIGN AND METHODOLOGY

3.1 Study Design

The study used a controlled case study design and focused on children under-five years with and without rickets. Eighty nine children with rickets and a similar number of children without rickets adding to a total of 178 children of ages between 0 to 59 months were selected for the study. Children with rickets formed the case group while those without served as control group.

3.2 Methodology

3.2.1 Study setting

The study was carried out in Embu County, Mbeere North Sub County at Ishiara hospitals and Manyatta Sub County at Embu hospital. Kirinyaga county, Kitui county, Tharaka Nithi county and Machakos county borders Embu county to the west, east, north and south respectively. Embu County occupies an area of 2,818 Km^2, and is divided into four sub counties namely Mbeere North, Mbeere South, Manyatta and Runyenjes.

It constitutes of highlands and lowlands that rise from about 515 m above sea level to over 4,570m above sea in North West part of the county, along Mt. Kenya. The county experiences two rain season between the month of March and June which is a long rainy season and between the month of October and December; the short rainy season. Agriculture is the main source of livelihood for the people living in Embu County. The people living in highlands areas depend on cash crops such as tea and coffee. Those living in low land areas grow food crops such as millets, legumes, sorghum and pawpaws. Ishiara is a sub county hospital in Mbeere North Sub County

which falls at the lowland part of the county, bordering Tharaka Nithi, Kitui and Machakos Counties. The hospitals serve the entire sub county and the neighbouring sub counties and counties.

Both hospitals have inpatient and out patients services. They have an integrated MCH services, well equipped laboratories and radiography services and functional theatres. Both hospitals have medical officers, clinical officers, nurses, nutritionists, occupational therapist and physiotherapist, and pharmacist.

Figure 3.1 Map of Embu County

3.2.2 Study population

The study population comprised of children 0 to 59 months both girls and boys with rickets and without rickets and their mothers seeking health services in Embu and Ishiara hospitals, at the MCH clinics and occupational therapy between July and August 2017. The age group was purposively selected because rickets affect mainly infants and children in early life.

3.2.3 Sample size determination

T5 Statistical formula by Fischer *et al*, (1991) was used to determine sample size with degree of accuracy set at 0.05.

$n=2Z^2\ pq/d^2$

n = the desired sample size

Z = the standard normal deviate set at 1.96 which corresponds to 95%

P = prevalence of rickets estimate at 3.4% (Theuri, 2012)

d =1-p

d^2 = the precision required for the estimate set at 5%

Hence: $n= (2 *1.96^2 * 0.034 * 0.966)/ 0.05^2 = 100$

Sample size was 100 children with rickets and 100 children without rickets adding up to 200 children. Due to the nurses strike at the time of study the sample size obtained was 178 children where half were children with rickets.

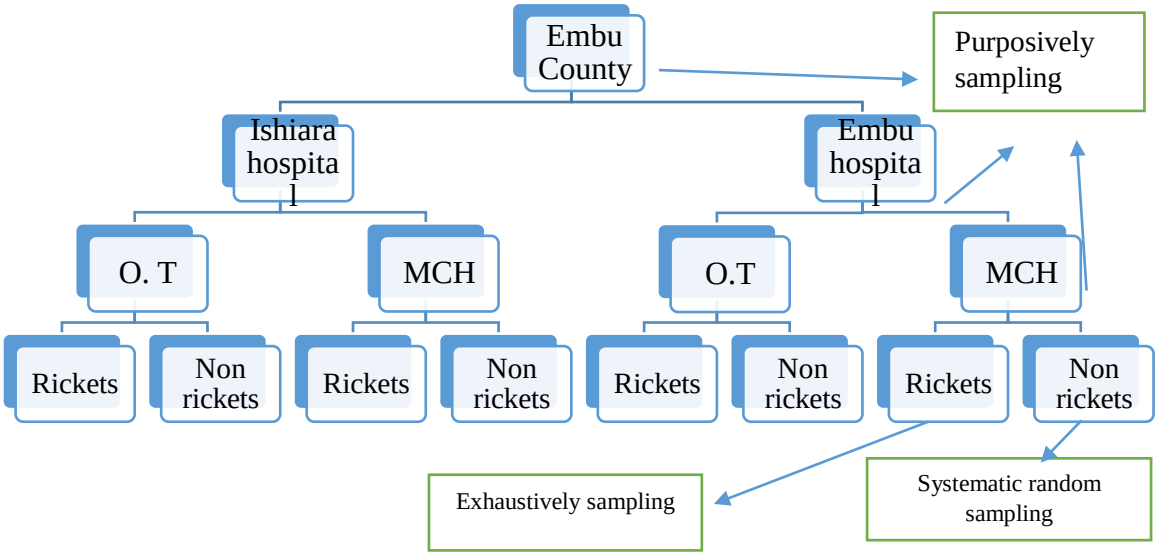
3.2.4 Inclusion Criteria

The respondents of the study included mothers willing to participate in the study and with children 0 to 59 months suffering from rickets and those not suffering from rickets attending Ishiara and Embu hospitals.

3.2.5 Exclusion Criteria

The mothers with children above 5 years, mothers who declined to participate in the study and mothers and children who did not attend Embu and Ishiara hospitals at the months of study were excluded for this study.

3.2.6 Sampling procedure



****Rickets - children with rickets and their mothers**

****Non rickets - children without rickets and their mothers**

Figure 3.2 Sampling schema

Figure 3.1 Illustrates sampling procedure. Embu county, Mbeere North and Manyatta sub counties were purposely selected. The two hospitals and the two clinics were also purposely selected. The number of children attending both MCH and Occupational therapy clinics was established from existing daily records, where the number of children attending per day (N) was divided by the target number of questionnaires per day (n), (N/n). This gave the ratio for administering questionnaires for the non-rickets cases per day. Children with rickets were exhaustively sampled.

3.2.7 Data collection techniques

Objective 1: To determine demographic and socio-economic characteristics of the household of children under-five years.

A detailed semi structured questionnaires (Appendix 2.) was used to collect data on demographic and socio-economics characteristics of the population under study. The variables included: age of the child and that of the mother, sex, marital status of the mother, number of the children they have, religion, education levels, occupation of the household head, the main sources of income and the amount of money spent on food. Questionnaire was administered by a trained enumerator.

Objective 2: To determine dietary intake of calcium, oxalates, vitamin D, and nutrition status of children under-five years.

A semi structured questionnaire (Appendix 2) was administered to mothers to obtain data on various feeding practices like breastfeeding, complementary feeding, and food frequency on calcium, oxalates and vitamin D rich foods.

A 24 hour recall was used to collect information on actual food intakes. The respondents were requested to recall all the foods and beverages consumed by the child in the last 24 hours. Then using this list as a guide the interviewer probed for more details of foods consumed including types e.g. ugali, amount in household measures, ingredients and methods of preparations for the food.

Anthropometric measurements were taken to determine the nutritional status of children under-five years. Weight measurements were taken with subjects wearing only light clothing. Body weight was taken using salter scale to the nearest 0.1 kg. The weight was taken twice and the average was calculated. The height/length of the index child was taken using height/length board. The readings were taken twice to the nearest 0.1 cm and average computed.

Mid upper arm circumferences were taken at the left upper arm to the nearest 0.1 cm.

Nutritional indicator such weight for height, weight for age and height for age was used to determine the nutritional status of the children under-five years.

Objective 3: To establish how young children are clothed, practices on exposure to sunlight and other contributing factors.

A semi structured questionnaire (Appendix 2) was used to obtain information from the mothers on how children were clothed when sunbathing and the use of napkins and baby carriers. A focus group discussion was used to get an in-depth information on children with rickets.

Objective 4: To establish the types of family planning methods used by the mothers in the preconceptional period.

A semi structured questionnaire (Appendix 2) was used to obtain data on the type of family planning methods used by the mothers under study population and duration of usage.

A key informant interview was conducted whereby a sub county nutritionist was contacted to obtain in-depth information on rickets within the sub county.

3.2.8 Ethical Issues

An introductory letter was acquired from the department of Food Science, Nutrition and Technology of the University of Nairobi. The ethical approval was acquired from Ishiara and Embu hospitals before the work began. Research assistants were trained on ethics in fieldwork such as confidentiality and professional conduct. Client informed consent was available for the respondents to sign (appendix 1).

3.2.9 Data Analysis

The statistical package for sciences (SPSS) version 20 was used for data entry, cleaning and analysis. A 24hour dietary recall data were analysed using Nutri-Survey 2007 software to determine whether the children are meeting their recommended dietary allowances (RDA). Anthropometric data measurements were analysed using ENA for SMART 2011.

Descriptive statistics such as percentages, means and frequencies were used to describe demographic and socio-economics characteristics of the population under study. Chi-square was computed to test the differences in categorised data where if the cell had less than five count Fischer exact test was used. For the cells that had more than five counts Pearson chi-square was used. Logistic regression was used to establish the likelihood of having a child with rickets from a mother who used Depo-Provera method of family planning; and also to establish the relationship of the way children are clothed and rickets.

CHAPTER FOUR: RESULTS

The results in this chapter are in accordance to the data collected from 178 respondents, where half of them were the mothers with children who had rickets while the other half were mothers with children who did not have rickets. Male children were 102(57.3%) and female were 76(42.7%). About fifty one percent (50.6%) of the male children and 49.4% of the female children had rickets. All the respondents were biological mothers of the children under the study. The data was collected within a duration of two months from Embu and Ishiara hospital in Embu county.

4.1 Demographic and socio-economic characteristics of the household of children under-five years.

4.1.1 Gender of household head and occurrences of rickets

Most of the households were headed by male 141(79.2%) and only few were headed by a female 37(20.8%). Figure 4.1 shows that 73(82%) of the children with rickets and 68(76.4%) of those without rickets were from households headed by male. Chi-square test (chi-square value 0.853, df: 1, p-value 0.356) showed that there was no significant difference in the occurrences of rickets between the children with rickets and those without rickets from the households headed by either gender.

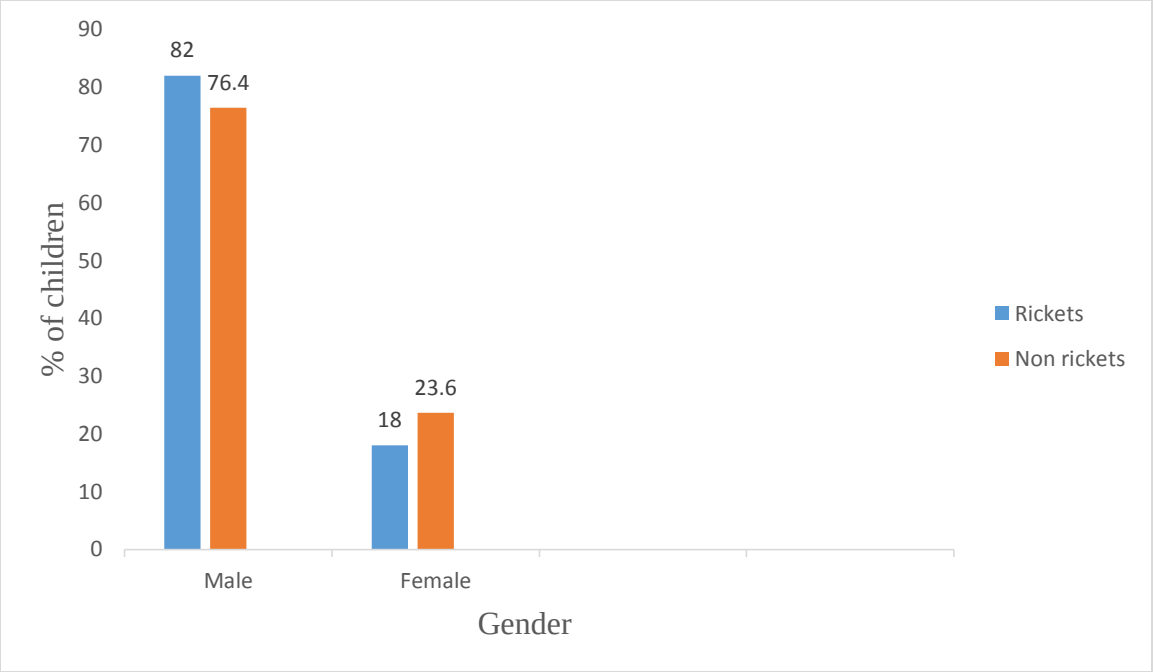


Figure 4.1 Occurrences of rickets by gender of the household head

4.1.2 Level of education of the respondent (mothers) and the occurrence of rickets

Data in table 4.1 show that most of the mothers had acquired secondary, tertiary or university education. It also shows that children from mothers who had completed primary education and those with tertiary education were more at risk. But the chi-square test (chi-square value 9.592, df: 5, p-value 0.088) did not show significant difference between the level of education and the occurrences of rickets. However, odds ratio shows that children from mothers who were primary school dropout were 1.1 times likely to have rickets, compared with children from mothers who had completed primary education and tertiary education who were 2.7 and 1.4 times likely to have rickets respectively.

Table 4.1 Level of education of the respondent and occurrences of rickets

Education level	Rickets n=89 %	Non rickets n=89 %	Statistic test
Primary dropout	**14.6**	**13.5**	**Chi- square value 9.592, df: 5,**
Completed primary	**23.6**	**10.1**	**p- value 0.088**
Secondary dropout	**10.1**	**13.5**	
Completed secondary	**16.9**	**27.0**	
Tertiary	**25.8**	**20.2**	
University	**9.0**	**15.7**	

4.1.3 Religion and the occurrences of rickets

Religious norms to some extent contribute to vitamin D deficiency due to the mode of dressing which covers a greater surface area of the body, hence, minimizing the body surface area exposed to sunlight. Table 4.2 shows that greater proportion 173(97.2%) of children were from Christian families and only 5(2.8%) were from other religions. Since Christians were the majority in the region, the greater percentages of children with rickets and those without rickets were from the Christian families and only a few were from other religions. The chi-square test (X^2 - 2.052, df: 2, p- value 0.358) computed showed that there was no association between religion and the occurrences of rickets among the study children.

Table 4.2 Religion and occurrences of rickets

Religion	Rickets n=89, %	Non rickets n=89, %	Total N=178, %	Chi- square test
Christian	95.5	98.9	97.2	Chi-square value 2.052, df: 2,
Muslims	3.4	1.1	2.2	p- value 0.358
Traditionist	1.1	0	1.1	
Total	100	100	100	

4.1.4 Family size and occurrences of rickets

The households were with minimum of 2 to a maximum of 8 household members. Table 4.3 shows that households with more than 4 household members were likely to have a child with rickets as compared to those with household less than four members. Odds ratio showed that children from household with more than 4 household members had 2.1 times likelihood of having rickets. This implies that there was higher likelihood of a child to have rickets if is from a family with household more than four members. Children from families with less than four members were 0.481 times likely to have rickets. This implies that there was less likelihood of a child from a family with household less than four to have rickets. Chi- square test (Chi-square value 16.313, df: 6, p- value 0.012) showed that there was an association between family size and the occurrences of rickets.

Table 4.3 Family size and occurrences of rickets

Family size	Rickets n- 89, %	Non rickets n-89, %	Chi-square test
2	1.1	13.5	X^2–16.313, df:6
3	36.0	41.6	p-value 0.012
4	34.8	28.1	
5	16.9	11.2	
6	4.5	4.5	
7	5.6	0	
8	1.1	1.1	
Total	100	100	

4.1.5 Occupation of the mother and the occurrence of rickets

Data in table 4.4 shows that most of the children were from the household whose mother's main occupation was self-employment 63(35.4%). A greater percentage of the children with rickets were from households whose mother's main occupation was self-employment, farming and salaried employment. Chi- square test (chi-square value 10.198, df: 4, p-value 0.037) showed that occupation of the mother had a significant association with the occurrences.

Table 4.4 Occupation of the mother and the occurrences of rickets

Occupation of the mother	Rickets n=89 %	Non rickets n=89 %	Total N=178 %	Statistic test
Salaried employment	15.7	23.6	19.7	Chi-square value 10.198, df: 4
Farmer	21.3	13.5	16.9	p- value 0.037
Self-employment	41.6	28.1	35.4	
Casual laborers	9.0	7.9	8.4	
Unemployed	12.4	27.0	19.7	

4.1.6 Marital status of the respondents (mother) and occurrences of rickets

Table 4.5 shows that the highest number of the respondents 145(81.5%) were married mothers where 76(85.4%) had children with rickets and 69(77.5%) had children without rickets. 27(15.2%) were single mothers among which 11(12.4%) had children with rickets and 16(18.0%) had children without rickets. A smaller proportion of the mothers were widowed/separated 6(3.4%) where 2(2.2%) had children with rickets and 4(4.5%) had children without rickets. Chi- square test (chi-square value 1.931, df: 2, p-value 0.381) showed that there was no association between marital status of the respondent and the occurrences of rickets.

Table 4.5 Marital status of the mothers and occurrences of rickets

Marital status	Rickets n=89, %	Non rickets n=89, %	Totals N=178, %
Married	85.4	77.5	81.5
Single	12.4	18.0	15.2
Widow/separated	2.2	4.5	3.4
Total	100	100	100
Chi-square test (X^2 – 1.931, df: 2, p-value 0.381)			

4.1.7 Age of the respondents and the occurrences of rickets

Figure 4.2 shows that higher proportion of the respondent (mothers) were within the ranges of 25 – 29, and 30 – 34 and with 29(32.6%) and 22(24.7%) for the children with rickets and 29(32.6%) and 23(25.8%) for the children without rickets respectively. A chi-square test showed that there was no association between the age of the mother and occurrences of rickets.

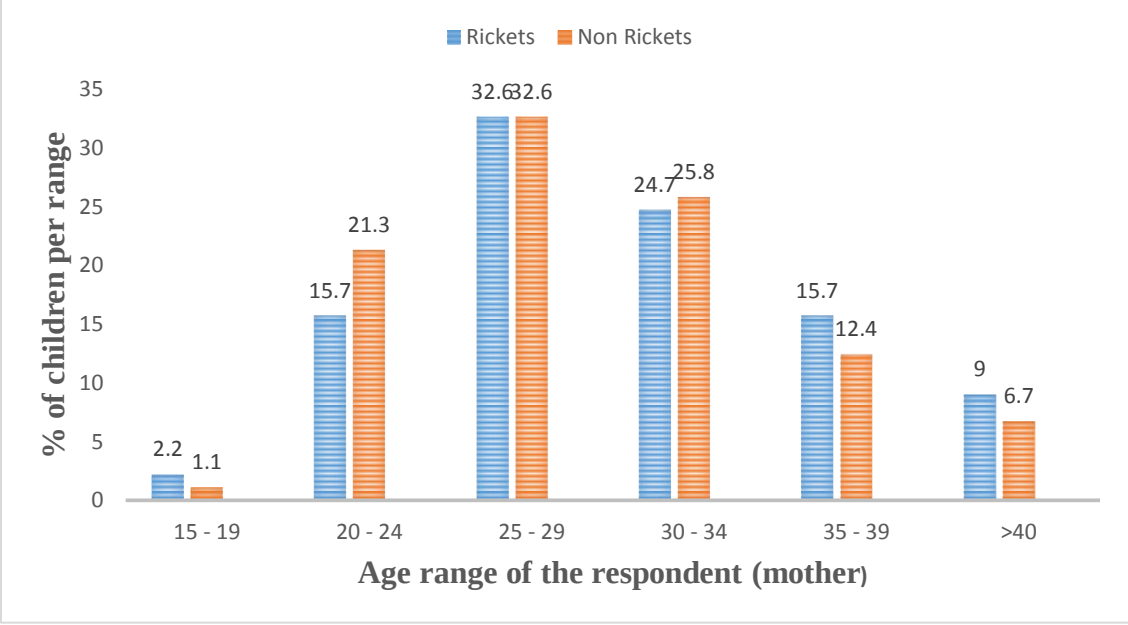


Figure 4.2 Age of the respondents and occurrences of rickets

4.1.8 Gender of the index child and the occurrences of rickets

Table 4.6 shows that male and female children sampled were 102(57.3%) and 76(42.7%) respectively. Male children with rickets were 45(50.6%) and 57(64.0%) without rickets. Female children with rickets were 44(49.4%) and 32(36.0%) without rickets. Chi- square test (chi-square value 3.307 df: 1, p-value 0.69) showed that there was no significant difference between gender and the occurrences of rickets.

Table 4.6 Gender of the index child and occurrences of rickets

Gender	Rickets n=89, %	Non rickets n=89, %	Total N=178	Chi-square test
Female	49.4	36.0	42.7	Chi-square value 3.307, df:1,
Male	50.6	64.0	57.3	p-value 0.69
Total	100	100	100	

4.1.9 Age of children and occurrences of rickets

The mean age of the children under study was 19.3±10.6 months. The youngest child sampled was 5 months while the oldest was 58 months. Independent T-test showed that children with rickets had mean age of 21.3±10.7 months while those children without rickets had a mean age of 17.4±10.1 months. There was no relationship between age of children with rickets and those without rickets in the occurrence of rickets.

Table 4.7 Age of children and occurrences of rickets

Age group in months	Rickets n=89, %	Non rickets n=89, %	Total N=178, %	T- test
< 6	2.2	0.0	1.1	t_{176}=2.942,
6 – 17	39.3	58.4	48.9	P=0.088
18 – 29	36.0	36.0	36.0	
30 – 41	19.1	0.0	9.6	
42 – 53	3.4	2.2	2.8	
54 – 59	0.0	3.4	1.7	

4.1.10 Household income and the occurrences of rickets

Income level of the households explains to some extent the quality of feeding and health seeking behaviour of the household's members. Table 4.8 shows that large proportion of the respondent 104(58.4%) were from the families earning a monthly income of up to Ksh. 15000. Only a small proportion of the respondent 27(15.2%) were from families earning a monthly income of more than Ksh. 30,000. Greater percentages 77(86.5%) of the children with rickets were from the families earning monthly income of less than Ksh. 30,000. and smaller percentages 12(13.5%) of the children with rickets were from the household earning more than Ksh. 30000. Independent T-test ($t_{0.966}$=0.55, p=0.552) showed that there was no significance difference between household income and occurrence of rickets.

Table 4.8 Household head income and the occurrences of rickets

Income range in Ksh.	Rickets n=89 ,%	Non rickets n=89, %	Total N=178, %	Independent T-test
0 – 5000	10.1	28.1	19.1	$t_{0.966}$=0.55, p-value 0.552
>5000 - 15000	43.8	34.8	39.3	
>15000 - 30000	32.6	20.2	26.4	
>30000	13.5	16.9	15.2	

4.1.11 Place of residence and occurrences of rickets

Table 4.9 shows that a greater percentage of the respondent lived in either self-owned homes 78(43.8%) or rented houses 81(45.5%) and only smaller percentage 19(10.7%) of the respondent were hosted by parents or relatives for free. Children with rickets who were from the families that lived in self-owned houses were 35(39.3%), rented houses 45(52.8%) and hosted by parents or relatives for free 7(7.9%). Children without rickets from self-owned houses were 43(48.3%), rented houses 34(38.2%) and hosted by parents or relatives were 12(13.5%). A chi-square test (chi-square value 4.223, df: 2, p-value 0.121) showed that there were no significant differences between the place of residences and the occurrences of rickets.

Table 4.9 Place of residences and occurrences of rickets

Place of residence	Rickets n=89, %	Non rickets n=89, %	Total N=178, %	Chi-square test
Self-owned	39.3	48.3	43.8	Chi-square value 4.223, df:2,
Hosted by parents or relative for free	7.9	13.5	10.7	p-value 0.121
Rented house	52.8	38.2	45.5	

4.2 Dietary intake of calcium, oxalates, vitamin D and the nutrition status

The section focus on breastfeeding, dietary intake of key nutrient like calcium and vitamin D and the assessment of nutrition status of the children.

4.2.1 Dietary practices and breastfeeding

4.2.1.1 Initiation of breastfeeding after birth and the occurrences of rickets

Table 4.10 shows that most of the mothers 107(60.1%) initiated breastfeeding within the first 30 minutes after birth; this is good health practice. Majority 50(56.2%) of children with rickets were not initiated breastfeeding within the first half hour after birth as compared to those without rickets 21(23.6%). 1(1.1 %) of the children with rickets never breastfed. The difference observed after chi-square test computations (chi-square value 20.602, df: 4, p-value 0.000) between the two groups was very significant, showing that children who were not initiated breastfeeding within the first half hour of birth were more predisposed to rickets as compared to the ones who were initiated breastfeeding within the first half hour of birth.

Table 4.10 Initiation of breastfeeding after birth and occurrences of rickets.

Breastfeeding Starting time	**Rickets n=89, %**	**Non rickets n=89, %**	**Totals N= 178, %**	**Chi-square test**
First 30 minutes	43.8	76.4	60.1	X^2- 20.602, df: 4,
>30min to 1 hour	22.5	7.9	15.2	p-value 0.000
>1hour to 24hrs	13.5	7.9	10.7	
After 24 hours	19.1	7.9	13.5	
Note: totals could not add up to 100 percent because those who never breastfed are shown separately				

4.2.1.2 Breastfeeding status and the occurrences of rickets

Most of the children were breastfeeding at the time of the study as shown at the table 4.11. Children who presented with rickets and were still breastfeeding at the time of study were 52(58.4%) and only 37(41.6%) of the children not breastfeeding presented with rickets. A chi-square test (chi-square value 1.173, df: 1, p-value 0.279) showed that there existed no relationship between breastfeeding status and the occurrences of rickets.

Table 4.11 Breastfeeding status and the occurrences of rickets

Breastfeeding status	**Rickets n=89, %**	**Non rickets n=89, %**	**Total N=178**
Breastfeeding	58.4	66.3	62.4
Not breastfeeding	41.6	33.7	37.6
Statistical test	**X^2- 1.173, df: 1, p-value 0.279**		

4.2.1.3 Exclusive breastfeeding and the occurrences of rickets

Table 4.12 shows that majority of the children under the study were exclusively breastfed for six complete months; this is good health practice and only few were not exclusively breastfed. Greater percentage of those children with rickets and those without rickets were exclusively breastfed, however, there was statistical difference (X^2= 5.591, df: 1, p-value 0.018) between the two groups in relation to exclusive breastfeeding. Odds ratio showed that children who were not exclusively breastfed had 2.264 times likelihood of developing rickets while those who were exclusively breastfed had 0.442 times likelihood of developing rickets. This implies that children who were not exclusively breastfed had higher chances of having rickets as compared to those exclusively breastfed.

Table 4.12 Exclusive breastfeeding and the occurrences of rickets

Breastfeeding	**Rickets n=89 %**	**Non rickets n=89 %**	**Totals N=178 %**	**Chi- square test**
Exclusively	65.2	80.9	73.0	Chi-square value 5.591, df: 1,
Not exclusively	34.8	19.1	27.0	p-value 0.018
Totals	100	100	100	

4.2.1.4 Introduction of complementary feeding and the occurrences of rickets

Data in table 4.13 shows that a greater percentage of children with rickets were introduced to complementary feeding before completion of six months as compared to those without rickets where only few were introduced to complementary feeds before completion of six months. Among all the children in the study only one of the child was not on complementary feeding.

Chi-square test (chi-square value 10.136, df: 3, p-value 0.017) showed that there was significant difference between the early introduction of complementary feeding and the occurrences of rickets. Odds ratio test showed that children who were introduced to complementary feeding earlier before completion of six months after birth were 2.637 times likely to have rickets as compare to those exclusively breastfed for six complete months.

Table 4.13 Introduction of complementary feeding and the occurrences of the rickets

Introductory age of complementary feeding	**Rickets, n=89 %**	**Non rickets, n=89 %**	**Total**	**Chi-square test**
<2 months	3.4	.0	1.7	Chi-square value 10.136,
>2months to <7 months	31.5	16.9	24.2	df: 3, p-value 0.017
>7 months	64.0	83.1	73.6	

Note: percentages of children with rickets did not add up to 100 because those children who were not yet introduced to complementary feeding are shown separately.

4.2.1.5 First complementary foods or drinks and the occurrences of rickets

Figure 4.3 shows that majority of children from the mothers who were able to recall the foods or drinks they first introduced to their children, fed them on porridge. A chi-square test (chi-square value 9.299, df:8, p-value 0.318) showed that there is no relationships between the first type of food or drink introduced and the occurrences of the rickets. However, odds ratio showed that children whose first food was porridge were 2.0 times likely to have rickets. This shows a strong relationship between porridge and occurrences of rickets.

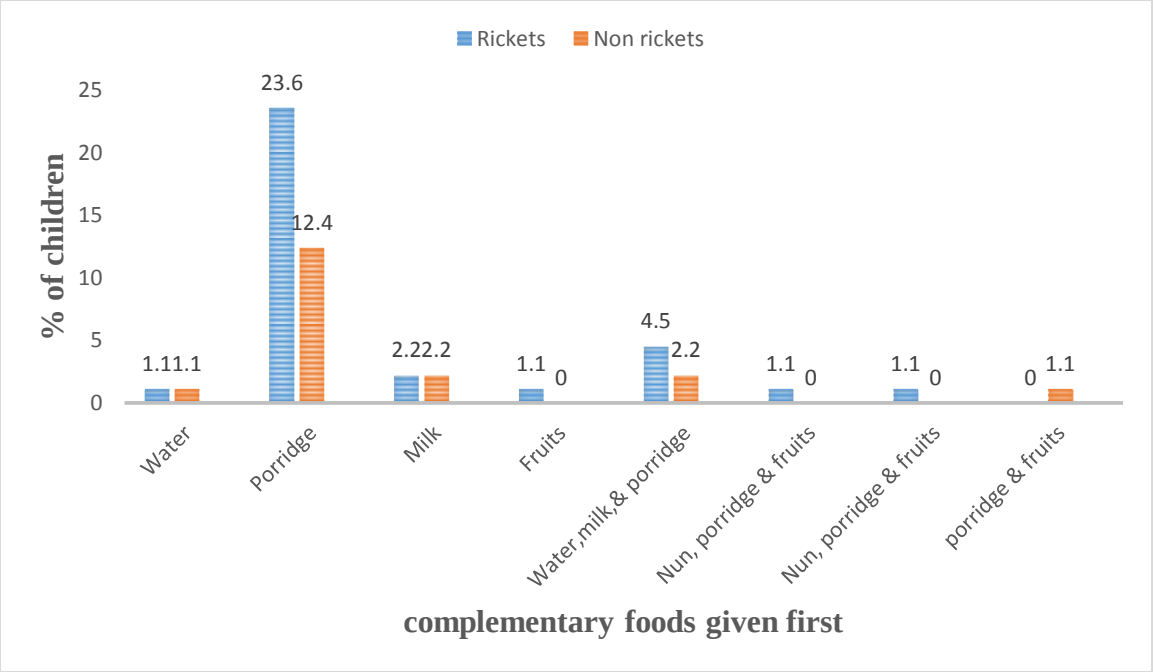


Figure 4.3 First complementary food and drinks and occurrences of the rickets

4.2.1.6 Distribution of children by porridge flour mixes

As shown in the table 4.14, most of the children were introduced to porridge made of mixture of flours from maize, sorghum and millet and from sorghum and millets only. Smaller percentages were introduced to a porridge flour with legumes. Some of mothers added omena to the porridge flours. It was noted that no mother introduced their children to a feed with a flour made from only one type of cereal.

Table 4.14 Distribution of children by porridge flour mixes

Type of flour	Rickets n=89, %	Non rickets n=89, %	Total N=178, %
Maize and legumes	12.4	2.2	7.3
Sorghum and legumes	2.2	0.0	1.1
Millet and legumes	4.5	2.2	3.4
Sorghum and millets	38.2	25.8	32.0
Maize, sorghum and millets	52.8	52.8	52.8
Maize, sorghum, millets and omena	16.9	9.0	12.9
Maize, sorghum, millets and legumes	9.0	2.2	5.6
Millets, soya and wheat	1.1	0.0	0.6

4.2.2 Nutritional status of children and the occurrences of rickets

Table 4.15 shows that 46(25.8%) of the children under the study were underweight, where among them 30(33.7%) were children with rickets and 16(18.0%) were children without rickets. Chi-square test (chi-square value 5.746, df: 1, p-value 0.017) showed that there was significant difference between the underweight children and the occurrences of rickets. Odds ratio also showed that children who were underweight were 2.320 times likely to develop rickets. Children who were stunted were 54(30.3%) with 26(29.2%) for children with rickets and 28(31.5%) for the children without rickets. In this case chi-square test (chi-square value 0.106, df:1, p-value 0.744) did not show significant differences between stunting and the occurrences of rickets. Odds ratio showed that children who were stunted were 0.899 times likely to have rickets. This

implies that there was less likelihood of child who was stunted to develop rickets. Children who were wasted were 36(20.2%) where 25(28.1%) were children with rickets and 11(12.4%) were children without rickets. Chi-square test (chi-square value 6.825, df: 1, p-value 0.009) showed that there was strong relationships between the children who were wasted and the occurrences of rickets. In addition, odds ratio showed that children who were wasted were 2.770 times likely to have rickets.

Table 4.15 Nutrition status and the occurrences of rickets

Nutritional status	**Rickets n=89, (%)**	**Non rickets n=89, (%)**	**Totals N=178, (%)**	**Odds ratio**	**P- value**
Underweight					
Yes	33.7	18.0	25.8	2.320	0.017
No	66.3	82.0	74.2		
Stunting					
Yes	26.2	31.5	30.3	0.899	0.744
No	70.8	68.5	69.7		
Wasted					
Yes	28.1	12.4	20.2	2.770	0.009
No	71.9	87.6	79.8		

4.2.3 Mean daily dietary intake of calcium and vitamin D and the occurrences of rickets.

Data collected using a 24hour recall tool was for 15% of the children under the study. Seventeen were children with rickets while 8 were children without rickets. Table 4.16 shows that the mean daily dietary intake of calcium was 687.9±197.7 mg (mean ±SD) and 749.6±231.1 mg (mean ±SD) for children with rickets and without rickets respectively (p-value=0.276) which showed no significant difference. The mean daily dietary intake for vitamin D was 1.4±2.0 µg for children with rickets and 0.4±1.1 µg for the children without rickets (p-value=0.024) this showed that there was a statistical difference between vitamin D intake and the occurrences of rickets.

Table 4.16 Mean daily dietary intake of calcium, phosphorus and vitamin D and the occurrences of rickets

Food nutrient	Rickets (n=17) mean ± SD	Non rickets (n=8) Mean ± SD	p-value
Calcium (mg)	687.9 ±197.7	749 ±231.1	0.276
Phosphorous (mg)	1182.9 ±502.4	1173.7 ±360.1	0.302
Vitamin D (µg)	1.4 ±2.0	0.4 ±1.1	0.024

4.2.4 Frequency of consumption of calcium and vitamin D foods and occurrences of rickets

Table 4.17 shows that 39(68.4%) and 18(31.6%) of the children with rickets had consumed milk and/or milk products for ≤3 times and >3 times per week respectively. Those without rickets 31(40.8%) were being fed on milk and/or milk products for ≤3 times while 45(59.2%) were fed for >3 times in a week. Chi-square test (chi-square value 9.975, df: 1, p-value 0.002) shows that there was highly significant difference between the occurrences of rickets and the frequency

consumption of milk and/or milk products. Odds ratio test showed that children who were fed on milk and/or milk products for ≤3 times per week were 3.2 times likely to develop rickets as compared to those who consumed for >3 times per week.

Spinach was the most consumed vegetable 101(56.7%). Table 4.16 shows that 41(51.2%) of the children with rickets consumed spinach for ≤3 times per week while 39(48.8%) of them consumed spinach for >3 times per week. Those children without rickets 60(73.2%) consumed spinach for ≤3 times per week while 22(26.8%) of them consumed for >3 times per week. Chi-square test (chi-square value 8.289 df: 1, p-value 0.004) showed that there was highly significant difference between the frequency consumption of spinach and the occurrences of rickets. Odds ratio test showed that children who consumed spinach for >3 times per week were 2.6 times likely to have rickets as compare to those who consumed spinach for ≤3 times per week.

Frequency consumption of oranges also showed a significant difference between the frequency consumption and the occurrences of rickets as the chi-square test (chi-square value 5.724, df: 1, p-value 0.017) showed.

Table 4.17 Frequency of consumption of calcium and vitamin D foods and occurrences of rickets

Food	Rickets (n=89) , %		Non rickets (n=89), %		p-value
	≤ 3 times	>3 times	≤ 3 times	>3 times	
Spinach	51.2	48.8	73.2	26.8	**0.004
Amaranth	55.3	44.7	58.4	41.6	0.691
Kales	84.8	31.1	78.3	21.7	0.281
Oranges	62.9	37.1	80.8	19.2	*0.017
Beans	69.0	31.0	82.1	17.9	0.063
Eggs	100	0	97.1	2.9	0.497
Liver	96.5	3.5	91.7	8.3	0.409
Meat	87.3	12.7	86.2	13.8	0.857
Milk and/or milk products	68.4	31.6	40.8	59.2	**0.002
Fish and/or fish oil	63.2	36.8	65.4	34.6	0.809
Wheat products	66.1	33.9	53.9	46.1	0.161

* significant at p<0.05, ** highly significant p<0.01

4.3 Selected care practices and rickets

This section focuses on the child care practices, which included exposure to sunlight, dress code, duration of exposure to sunlight and health seeking practices such as immunization and health care.

4.3.1 Sun basking and the occurrences of rickets

Most of the children under the study were exposed to sunlight 161 (90.4%) and only 17 (9.6%) were not exposed to sunlight for sun bathing. Figure 4.4 showed that a greater number of children who had rickets and those who did not have rickets were exposed to sunlight. Chi-square test (chi-square value 10.991, df: 1, p-value 0.001) showed that there was very significant difference between children with rickets and those without rickets in relation to sunbathing. Odds ratio showed that children who were not sunbathed were 8.8 times likely to develop rickets.

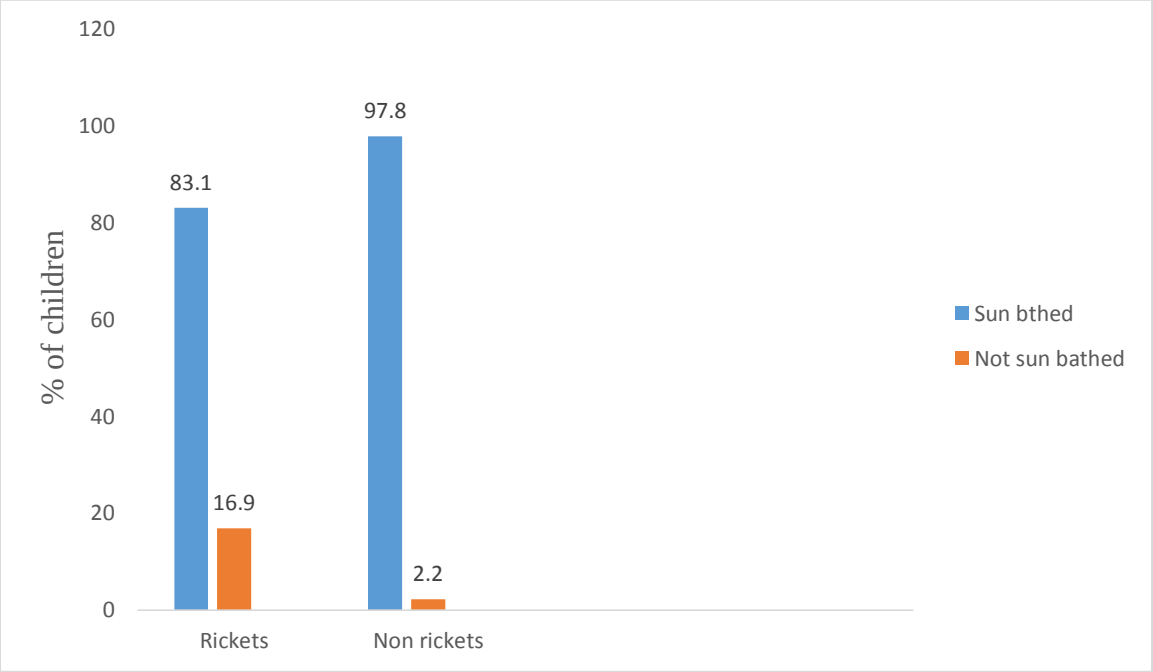


Figure 4.4 Sun basking and the occurrences of rickets

4.3.2 Dressing code while sun bathing and the occurrences of rickets

Table 4.18 shows that children under study were sunbathed while dressed differently. A smaller percentage of the children were exposed to sunlight while fully undressed. Most of the children

with rickets were exposed while dressed with pant and vest and fully dressed. Children who were fully dressed only exposed 19% of their body surface area to the sunlight as compared to those fully undressed who exposed 100% of their body surface area to the sunlight.

Chi- square test (Chi-square value 15.252, df: 3, p-value 0.002) showed that there was strong relationship between the way children were dressed while sun bathing and the occurrences of rickets. Odds ratio results show that the children who were sun bathed while fully dressed were 1.604 times likely to develop rickets. This shows that there were higher chances of these children to get rickets. Others who were exposed while fully undressed, with pant only and with pant and vest had the odds ratio showed that they were less likely to develop rickets.

Table 4.18 Dressing code while sun bathing and the occurrences of rickets

Sunbathing dressing code	% of body exposure to sunlight	Rickets n=89 %	Non rickets n=89 %	Odd ratios	Chi-square test
Fully undressed	100	6.7	11.2	0.571	X^2 – 15.252, df:3,
Pant only	94	11.2	14.6	0.740	p-value 0.002
Pant and vest	68	34.8	50.6	0.523	
Fully dressed	19	30.3	21.3	1.604	

Note: totals could not add up to 100 percent because those who were not sun bathed are shown separately

4.3.3 To establish relationships of rickets and clothing

Table 4.19 shows the odds ratio test for the children who were sun bathed with minimal clothing (pant only and pant and vest) and those sunbathed when fully dressed. It shows that children who were sun bathed with minimal clothing were 0.436 times likely to develop rickets as compare to those who were sunbathed when fully dressed. This indicates that children dressed on minimal clothing had lower changes for the occurrences of rickets.

Table 4.19 To establish relationships of rickets and clothing

Sunbathed with	Children with rickets	Children without rickets	Total
Minimal clothes (pant only and pant and vest)	40	58	98
Fully dressed	27	19	46

Odd ratio (Risk estimate is 0.436.)

4.3.4 Length of time basked and occurrences of rickets

Majority of the children were sunbathed, however, the length of time spent while sunbathing contributed to the occurrences rickets among the children. Table 4.20 shows that the lower the length of time spent by the children while sunbathing the higher the likelihood of the occurrences of rickets. Those children who were not exposed at all to sunlight were 8.8 times likely to have the rickets. Those exposed for more than 30 minutes had less likelihood of having rickets as showed by the odd ratio. Chi – square test (X^2- 12.666, df: 4, p-value 0.007) showed that there was significant difference between the length of exposure among the children with rickets and children without rickets and the occurrences of rickets.

Table 4.20 Length of time spent on basking and occurrences of rickets

Length of time	Rickets n=89 %	Non rickets n=89 %	Odds ratio
None	16.9	2.2	8.8
<15 minutes	14.6	12.4	1.2
>15 to 30 minutes	30.3	32.6	0.9
>30 minutes	38.2	52.8	0.5

4.2.5 Routine immunization and the occurrences of rickets

As shown in table 4.21, most of the children both of those with rickets and those without rickets were fully immunized and only a smaller percentages of the children were not fully immunized. Chi-square test (chi-square value 0.393, df: 1, p-value 0.531) showed that there was no significance different between immunizations and the occurrences of rickets.

Table 4.21 Routine immunization and the occurrences of rickets

Immunization	Rickets n=89, %	Non rickets n=89, %	Total N=178 %	Chi-square test
Fully immunized	86.5	83.1	84.8	Chi-square value 0.393, df: 1,
Not fully immunized	13.5	16.9	15.2	p- value 0.531
Total	100	100	100	

4.3.6 Morbidity status of children and the occurrences of rickets

Table 4.22 shows that more than half of the children studied 94(52.8%), reported to have been sick in the past two weeks at the time of study. Others did not have illnesses but they had come for follow up clinics. Most of the children with rickets reported to have been sick the past two weeks at the time of study as compared to those without rickets. Chi-square test (chi-square value 1.443, df:1, p-value 0.230) showed that there was no relationship between the presence of disease and the occurrences of rickets.

Table 4.22 Morbidity status of children and occurrences of rickets

Disease status	**Rickets**	**Non rickets**	**Total**	**Chi-square test**
Past 2 weeks	**n=89,**	**n=89,**	**N=178,**	
	%	**%**	**%**	
Sick	57.3	49.4	52.8	Chi-square value 1.443, df: 1,
Not sick	42.7	50.6	47.2	p-value 0.230
Total	100	100	100	

4.3.7 Illness of the studied children and the occurrences of rickets

Table 4.23 shows that most of the common diseases among children under the study were respiratory tract infections (RTIs) and followed by diarrhoea and/or vomiting and others. Chi-square test (chi-square value 3.566, df: 3, p-value 0.312) showed that there was no significant difference between the current illness of the child and the occurrences of rickets.

Table 4.23 Illness of the studied children and the occurrences of rickets

Diseases	Rickets n=89, %	Non rickets n=89 %	Total N=178 %
RTIs	40.4	32.6	36.5
Diarrhea and/or vomiting	12.4	7.9	10.1
Other unclassified	4.5	9.0	6.7
Not sick	42.7	50.6	46.6

Chi-square test (Chi-square value 3.566, df: 3, p-value 0.312)

4.4 Types of family planning methods used by the mothers in preconception period.

This section focuses on family planning practices during preconceptional period which included type of family planning used during preconception period by the mother and the duration used.

4.4.1 Family planning use during preconception period and rickets

Table 4.24 shows that greater number of mothers 112 (62.9%) under the study were using family planning before conception of the index child. About thirty seven percent 66 (37.1%) of the mothers did not use any kind of family during preconception period.

Table 4.24 Family planning method use during preconception and rickets

Family planning	Rickets n=89 %	Non rickets n=89 %	Total N=178 %
Yes	67.4	32.6	62.9
No	58.4	41.6	37.1

4.4.2 Occurrences of rickets by the type of family planning used during preconception period

Mothers used various types of family planning during their preconception period. Figure 4.5 shows that most of the children who had rickets, were from the mothers who had used Depo-Provera as method of family planning in their preconception period. For the mothers who used safe days as a method of family planning 3(3.4%), none of their children had rickets. A chi-square test (chi-square value 30.472, df: 6, p-value 0.000) shows that there was higher significant difference among family planning methods used in preconception period and the occurrence of rickets. This showed that a strong relationship existed between occurrences of rickets and types of family planning used during preconception period.

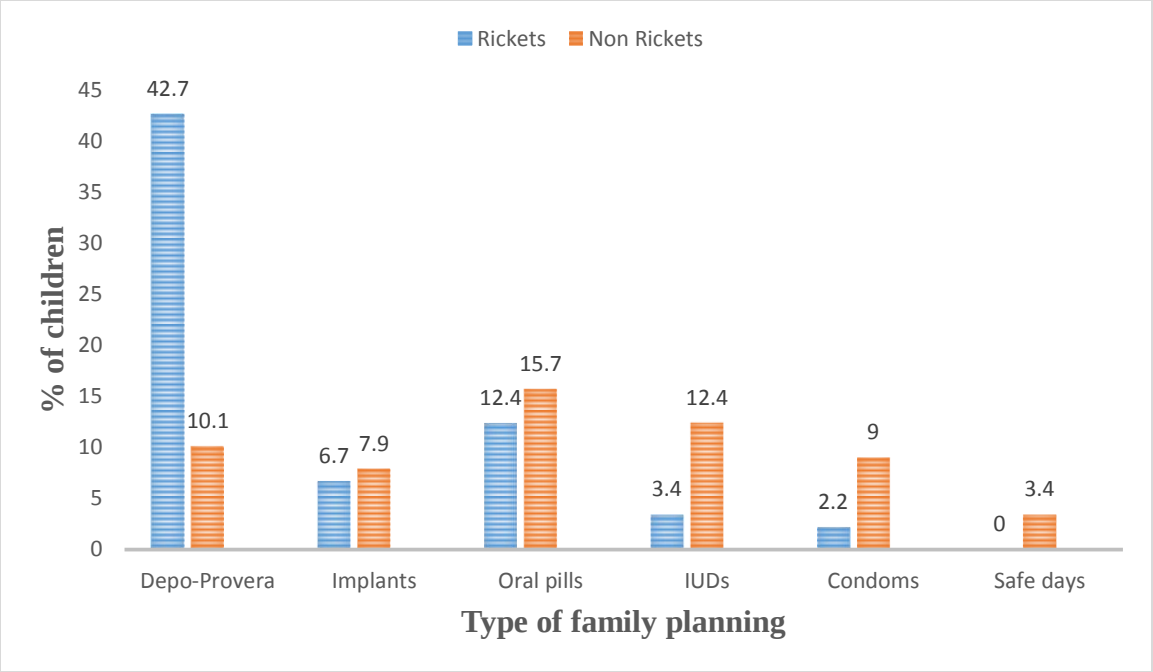


Figure 4.5 Occurrences of rickets by the type of family planning used during preconception period

4.4.3: To establish relationships of rickets and family planning methods

Table 4.25 shows the relationships of the occurrences of rickets and various types of family planning used during preconception period. Depo-Provera was the most used by the mothers with children who had rickets, and it shows very significance difference (p=0.000), while other methods used by mothers did not show any significance difference in the occurrences of rickets.

Odds ratio test showed that mothers who used Depo-Provera as method of family planning during preconception period were 6.6 times likely to have children who developed rickets as compared to those who did not use it. This implies that there was higher likelihood for the mothers who used Depo-Provera before conception to have a child who developed rickets. This justifies the observation by the mothers who attends ante-natal and postnatal clinics that, mothers

who used Depo-Provera as a method of family planning during preconception period had higher likelihood of getting a child who developed rickets. Other methods of family planning did not show significance in the occurrences of rickets.

Table 4.25: To establish relationships of rickets and various type of family planning used by the mothers during preconception period

Family planning	**Rickets n=89, %**	**Non rickets n=89, %**	**p- value**	**Odd ratio**
Depo-Provera	42.7	10.1	0.000	6.6
Oral pills	12.4	14.6	0.661	0.8
Implants	06.7	07.9	0.773	0.8
IUDs	03.4	12.4	0.048	0.2
Condoms	02.2	10.1	0.057	0.2

4.4.4 Depo-Provera use and occurrence of rickets

Figure 4.6 and figure 4.7 show that out of 47(26.4%) mothers who used Depo-Provera as a method of family planning during preconception period 38(80.9%) of their children developed rickets and only 9(19.1%) did not develop rickets. A greater number of children who developed rickets were of the mothers 30(63.8%) who had used Depo-Provera for more than one year. Odds ratio test shows that mothers who used Depo-Provera for more than one year during their preconception period were 15.5 times likely to have children who developed rickets as compare

to those who used less than one year (OR= 0.07). This implies that the longer the period one uses Depo-Provera the higher the likelihood of having child who develops rickets.

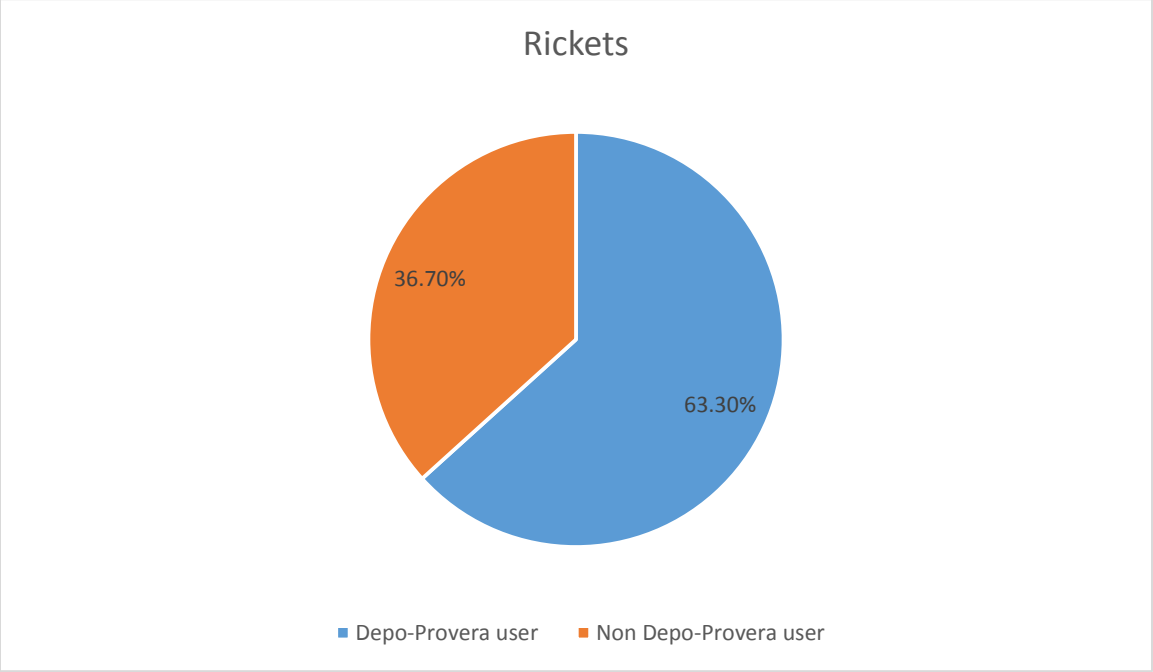


Figure 4.6 Use of Depo-Provera among the mothers

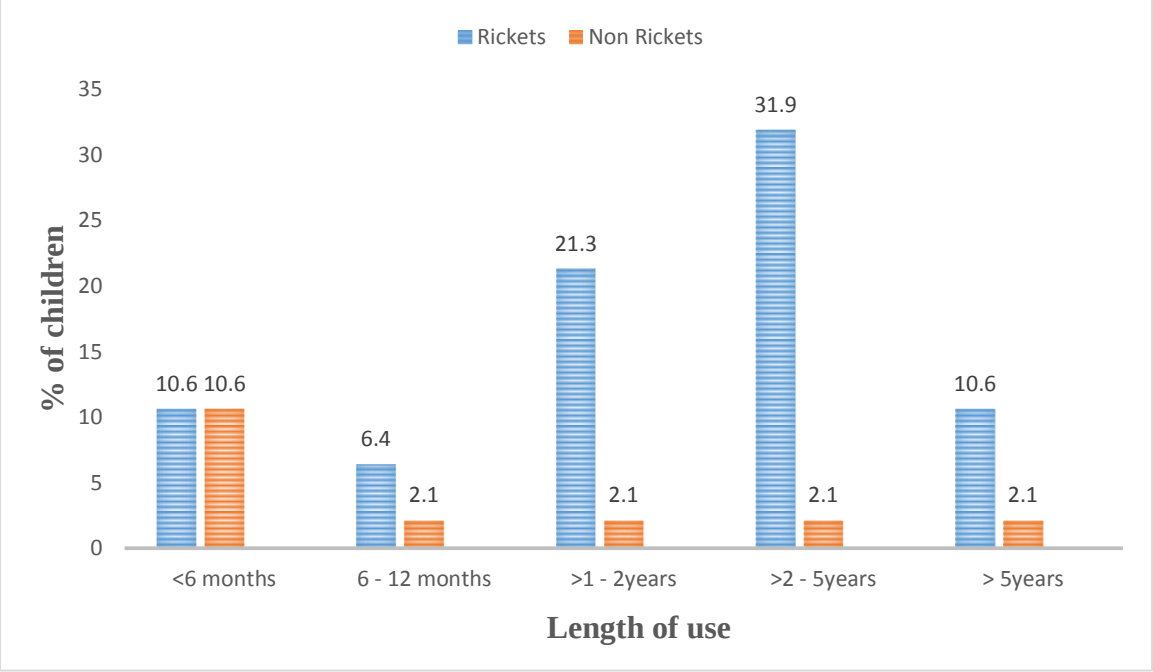


Figure 4.7 Length of use for Depo-Provera and occurrences of rickets

4.5 Determination of the factors associated with rickets in Embu County

The table 4.26 shows that adjusted odds ratio with 95% CI for an independent variables revealed that the factors to be associated with rickets were: sun basking and the duration of basking, use of Depo-Provera for more than one year, early introduction of complementary foods and lack of exclusively breastfeeding, high consumption of spinach and low use of milk and milk products, underweight and wasting, occupation of the mother and the family size.

4.26 Logistic regression model for risk factors to rickets among children under-five year

Variables	Beta	Sig	OR	95% C.I for OR Lower – upper
Use of Depo-Provera for more than 1 year	2.738	0.000	15.5	3.332-71.905
Sun basking	2.281	0.043	9.9	1.073-89.215
Depo-Provera use	1.895	0.000	6.7	2.902-15.255
Occupation of the mother				
Farmer	1.327	0.012	3.8	1.346-10.555
Self-employed	1.133	0.011	3.1	1.298-7.428
Wasting	1.031	0.016	2.8	1.209-6.509
Exclusively breastfed	0.937	0.026	2.6	1.117-5.837
Earl introduction of complementary feeding	0.923	0.018	2.5	1.173-5.405
Low consumption of milk and milk products	0.917	0.028	2.5	1.104-5.673
High consumption of spinach	0.898	0.044	2.5	1.024-5.886
Sun basking less than 15 minutes	0.868	0.024	2.4	1.121-5.065
Underweight	0.709	0.052	2.0	0.994-4.152
Household size	-.826	0.010	0.4	0.234-0.821
Sun basking while fully dressed	-2.526	0.006	0.1	0.013-0.479

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Socio-demographic and economic characteristic

This study indicated family size (more than four) and occupation of the mother (farming and self-employment) as socioeconomic and demographic risk factors to rickets. Non risk factors included religion, level of education of the mother, gender of the household head and child, household income and marital status of the mother.

5.1.1 Family size

Most of the households had a family size of 3 to 4 members for both groups, the study established a statistical difference between the family size and the occurrences of rickets. Odds ratio shows that household with more than 4 members had 2.1 times likelihood of having children with rickets. This can be attributed to increased family needs at the expenses of vulnerable family members including children under-five years of age. These results concur with those of a study conducted in Riyadh which found that children with rickets were from families with more family members. (Megeid and Karim, 2011), similarly a study in Bangladesh indicated that children with rickets were from the large families (Combs and Hassan, 2005).

5.1.2 Occupation of the mother

According to this study, there was relationship between the occupation of the mother and the occurrence of rickets. Occupation of the mother defines the total time spent with the child such that those busy in their self-employed business and those employed are expected to have limited

time to spend with their children; as this can affect the dietary intake and practices of their children as well as general quality of care.

5.1.3 Gender of the child

Information from the key informant interview for the health workers indicated that male children were more likely to have rickets than female children depending on their observation on the client they attend to with rickets within their various clinics. But on the contrary, the statistical results showed that there was no relationship between the gender of the child and the occurrences of the rickets. The ratio for male to female child was 1:1. These study results are inconsistent with the similar studies conducted at Kenyatta National Hospital (Kinuthia *et al*,1994) and in Kiambu county (Theuri *et al*, 2017) which indicated a slight difference between the gender and occurrences of rickets (ratio of 1.2:1) for male to female child. In addition, the study also differ with previous study that showed that boys were generally more affect than girls (Akpede *et al*. 2001). The study findings also differ with the study in Saudia Arabia which implied that boys are more prone to rickets (Al-Atawa *et al*, 2009).

5.1.4 Age of the respondents

Most of the respondent were young mothers of the age between 25 to 34 years old. The mean age of the mothers who had children with rickets was 30.1±5.8 (mean±SD) and those without rickets was 28.8±5.7 (mean±SD). This shows that these mothers are in the active age period where they are expected to work hard, as some are working and at the same time in school. This can limit their time and resources for their children and quality of care hence affecting nutritional status of their children. This could be expected to be a contributing factor to the development of rickets.

On the contrary the statistical results imply that age of the respondent is not a risk factor to rickets.

5.1.5 Level of education

The study findings show that children from mothers who were primary school dropout, who had attained primary education and tertiary education were more likely to have rickets. Although this gradient effect disappeared when adjusting for other independent variables; it merely reflects no association between rickets and level of education**.**

5.2 Dietary intake and breastfeeding

5.2.1 Breastfeeding

The study shows that there was a relationship between the exclusive breastfeeding and the occurrence of rickets. Children who were not exclusively breastfed had higher chances of having rickets compared to those exclusively breastfed. This could be because the breastmilk gives infant's nutritional requirement in the first 6 months of life and play an important role in keeping children healthy and early supplemental nutrition can have a negative influence of infant growth (Hoseini *et al.,* 2014). Therefore, lack of exclusive breastfeeding and delayed initiation of breastfeeding could be contributing factor to development of rickets. The study is in contrary with the previous studies which shows that rickets is common among breastfeeding infants (Pettifor,2008)

5.2.2 Complementary feeding

The study results showed that there was a relationship between early introduction of complementary feeding and the occurrence of rickets. This indicates that early introduction of complementary foods to infants predisposes them to rickets. This study is in line with a study conducted in Gaza strip that indicates that early introduction of complementary foods to infants predispose them to infections and rickets (Kanoa *et al*,2011). The findings differ with a similar study conducted at Al-Shatea Medical Clinic in Gaza city which indicates that early introduction of complementary feeding has protective effects against rickets. This could be attributed to immature digestive system which lead to poor digestion and may cause unpleasant reaction such as digestive upset, gas, constipation, infections and malabsorption. Digestion of fats, protein and complex carbohydrates is incomplete in infancy as compared to human milk which contains enzymes that aid digestion (Naylor and Marrow, 2001) this could lead to malabsorption of key nutrients and malnutrition hence leading to rickets.

5.2.3 Calcium and vitamin D rich foods

Spinach

The study results show that there was an association between the consumption of spinach and occurrence of rickets. This could be attributed to high levels of oxalates contained in spinach which could interfere with calcium absorption. A study in New Zealand showed that combining of spinach with calcium containing foods, oxalates binds the calcium making it unavailable (Brogen *et al*,2003) Higher preference use of spinach was noted through focus group discussion which was as result of majority of mothers feeling that spinach was more appropriate for the

children because of its softness and tenderness. In addition, some of the mothers had the knowledge that spinach contains calcium.

Milk and/or milk products

Milk and milk product are good sources of calcium for children. Milk contain lactose which in addition to increased stomach acid improve calcium absorption. According to this study, most of the children were fed on milk and/or milk products. The statistical results showed that there was a relationship (p-0.002) between milk and occurrences of rickets, indicating that the higher the frequency of consumption of milk the less likelihood that a child will develop rickets.

Porridge flour

Most of the children from both study groups, were fed on unfermented porridge from mixture of flours. The study finding show that introducing infants on porridge for the first time had significant difference between the two groups in relation to rickets. This concur with those of a study in Kiambu which found that feeding children on porridge made of multiple flours was risk factor to rickets (Theuri *et al*, 2017). However, further analysis for each mixture of flours did not show significant relationship with rickets. The most used flour was mixture of maize, sorghum and millets which was equally used in both groups at 52.8% and followed by mixture of sorghum and millets at 38.2% for the children with rickets. Cereals and legumes are known to have dietary phytate which can chelate and bind minerals ,hence forming insoluble complexes that lead to decrease in mineral absorption and bioavailability (Buddrick *et al.*, 2014).

Other foods

Consumption of other foods showed no association with rickets. These foods include animal foods that are rich in calcium and phosphorous, these are also best sources of proteins such as meat, eggs and liver; was much higher in children with rickets than those without rickets. This is consistent with a study done in Kiambu county (Theuri *et al*, 2017).

5.2.4 Mean intake of calcium

The study indicated that there was no relationship between calcium intake and occurrence of rickets. The mean calcium intake of the children with rickets was 687.9±197.7 (mean±SD) and 749±231.1 (mean±SD) for those without rickets. This shows that children with rickets had lower mean as compared those without rickets. Comparing to the food and nutrition board recommendation of 270 – 1000 mg per day of calcium children had adequate intake of calcium. Calcium deficiency has been reported as major cause of rickets in Africa (Thatcher et al, 2006). but, this study shows adequate mean intake of calcium for both children with and without rickets. This implies the possibility of leakage, where body does not fully utilise calcium; or low vitamin D and presence of oxalates could have impaired the absorption of calcium in the body and adversely affect bone mineralization. This study is in contrary to the study carried out in Nigerian children which found that mean calcium intake of the children with rickets and those without rickets were below the dietary reference intake (Graff *et al*, 2004). Study differs with a comparative study in India, which found that dietary calcium intake was insufficient to meet the RDA (Harinarayan and Ramalakshmi, 2015). The study findings also differ with those of a study done in Kiambu which showed that calcium intake of children was in adequate (Theuri *et al*, 2017).

5.2.5 Nutritional status of the children

The study showed a relationship between underweight and wasting and the occurrence of rickets. The study findings agree with those of a study carried out in Ethiopia and Nepal which found that underweight was strongly and independently associated with rickets (Singh *et al*,2009, Lulseged and Fitwi,1999). This implies that malnutrition is a predisposing factor for rickets. This could be attributed to poor food choices, poor feeding pattern and/or infections and food and nutrients interactions.

5.3 Care practices

5.3.1 Sun basking practices

The study showed an association between sun basking, dressing code while basking and the length of time spent while basking and the occurrences of rickets. The findings concur with those of a study in Saudia Arabia whose results show that more children (90%) with rickets lacked sun exposure (Al- Mustafa *et al*, 2007). Noteworthy, that the surface area of the skin exposed is directly associated with vitamin D synthesis in the skin (Roth *et al*,2005). Children dressed with minimal clothes (pant only and/or pant and vest) or no clothes had less likelihood of developing rickets than those fully dressed. This is because those dressed with minimal clothes were able to expose a bigger percentages of the body surface area, hence giving a way to the production of vitamin D in the skin. Odds ratio indicated that those fully dressed were 2.1 times likely to develop rickets as compare to those dressed with minimal clothes who were 0.4 times. Heavy dressing that covers much or all body is associated with high prevalence of low vitamin D (Siddiqui and Kamfar, 2007).

According to the study which was done in Gaza city (Mushtaha,2006) rickets among children increased with the decreased exposure to sunlight. As per this study, most of the children with rickets were sun bathed for a long period, however, they had rickets as sun bathing of children at that stage was viewed as being curative rather than preventive. Moreover, sun bathing is also a preventive measure. The statistical differences shown between the groups can be attributed to the health talks given to the mothers when they present themselves to the clinic.

It is known that sunlight exposure is the main source of vitamin D, for people with light skin pigmentation when fully undressed and exposed for 10 to 15 minutes is termed adequate to yield enough vitamin D3 within 24 hours. However, those with darker pigmentation require 5 to 10 times more exposure to generate similar amount of vitamin D3 (Kimlin and Schallhorn, 2004). Therefore, it is paramount to educate the mothers and the community on the essence of sun basking and on the best practices to ensure synthesis of vitamin D in the skin.

5.3.2 Health seeking practice

According to this study, there was no association between co-morbidity status and occurrence of rickets. This differs with previous studies conducted at Kiambu county, Kenya and in Ethiopia which showed that presence of rickets was associated with childhood illness (Theuri,2017, Wondale *et al*,2005). This study showed that there was adherence to immunization, this is a good health seeking behaviour which protect children from diseases. Among those who were not fully immunized were children who had not attained the age of full immunization. The study also differs with a study in Bangladesh hospital which found that children with severe pneumonia were affected with rickets (Haider, Nagi and Khan,2010). According to focus group discussion

with the mothers, this could be attributed to good health practices like hospital deliveries, adherence to routine immunization and monthly growth monitoring for the children under-five years, good practices of exclusive breastfeeding and good care of the mothers and caregivers on the health of their children. In addition to health talks given by health workers at the MCH clinics and good relationships between health workers and the mothers which enable them to open and seek more information on the health care of the children.

5.4 Family planning practices

This study shows that large number of the mothers who used family planning methods used Depo-Provera 47(26.4%). This indicated a similar trend as that of KDHS (2014) which shows that Depo-Provera was the mostly used family planning method in Kenya (26%) and also widely used in Embu County (31%). The study showed a relationship between Depo-Provera and occurrence of rickets. A greater number of children who developed rickets were from the mothers 30(63.8%) who had used Depo-Provera for more than one year. Odds ratio test results indicated that children of mothers who use Depo-Provera for more than one year during their preconception period are 15.5 times likely to develop rickets. This implies that the longer the period a mother uses Depo-Provera the higher the likelihood of their children to develop rickets and this can be attributed to compromised bone mineral density. Previous study estimated that women who use Depo-Provera for longer than one year, could take as long as 92 months (i.e. over 7 years) for them to regain their original BMD (Clark *et al.*, 2006). This implies that if a woman conceives after using Depo-Provera for more than one year there is higher chances for the child to develop rickets in the early stages of life.

These study findings give weight to the observation of mothers attending ante-natal, postnatal and family planning clinic in Ishiara hospital; that children of mothers who use Depo-Provera at their preconceptional period are most like to have rickets. Most studies are done to show the effect of Depo-Provera on bone mineral density and very scanty information exist to compare rickets and Depo-Provera.

In summary, the study has contributed to new knowledge on risk factors contributing to rickets. It shows that usage of Depo-Provera for more than one year during preconception period by mothers is a contributing factor to rickets.

5.5 Limitation of the study

The study was limited to the under-five year old children who their mothers availed them to the hospital during the period of study.

The study was limited to those who were willing to be participants in the study.

The study was limited by the nurses strike which began with the study time and affected the flow of patient in the hospitals.

5.6 Conclusions

1. The study concludes that large family size (more than four members) and occupation of the mother (farming and self-employment) are contributing factors to rickets.
2. The study confirms that rickets among children under-five years old is associated with failure to exclusively breastfeed for first six months of life, early introduction of complementary foods, low consumption of foods that are rich in vitamin D, high consumption of vegetables rich in oxalates (spinach) and protein energy malnutrition.

3. Inadequate exposure to sunlight (specifically in the area of study) due to either not being exposed to sunlight at all or exposed while covered and/or for a short time is a risk factor to rickets.
4. The study concludes that use of Depo-Provera for more than one year during preconception period is a risk factor to rickets.

5.7 Recommendations

The is need to strengthen the current programmes that are targeting infants and young children (Maternal and Infants Young Child Nutrition) to include infant care towards reduction of rickets.

There is need to ensure that mothers know the importance of exposure to sunlight, best exposure practices and vitamin D and that they apply the knowledge as preventive measures to rickets.

The government and collaborating agencies need to promote the consumption of vitamin D rich foods and establish supplementation programme with vitamin D.

There is need to educate mothers on the effects of long term use of various types of family planning especially Depo-Provera.

The county government of Embu and other collaborating agencies should design interventions to curb the upsurge of rickets in Embu county.

Further investigation is needed to determine if Depo-Provera is a cause to rickets among under-five years old children.

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APPENDIXES

APPENDIX 1: CONSENT FORM

REQUEST FOR CONSENT TO PARTICIPATE

Name of the client……

Age ……..

Address ……..

I would like to ask you to allow the study team to ask you questions regarding feeding practice of the child and the family planning used by the mother. The aim of the study is to contribute towards management and reduction of rickets in children under-five year. The results of the study will can be used to help the mothers in planning diets that minimises rickets in their children and help health sectors to plan family planning strategies that reduces possibilities of rickets as side effects in the children.

In this study, you will be expected to provide truthful information regarding your household characteristics to the enumerator assigned to you. Once you consent to participate in the study, the enumerator will ask you questions and the responses you will give will be captured in this questionnaire. With your cooperation, the interview will last for approximately 45 minutes after which the enumerator will let you free to leave.

The data collected shall be only seen by members affiliated with the study, and will not be link to any identifying information such as name, address or other personal details that you will supply. The data shall be averaged over many participants and therefore your individual data shall not be identifiable.

This study poses no known risk (s) to your family. You may decide to stop participating in the study at any time however we encourage you to remain in the study. You have a right to demand that any data provided until that point be withdrawn/destroyed.

If you have any questions with regards to this information sheet, you should ask the enumerator before the study begins.

Name of respondent……signature/thumbprint……

Name of interviewer……..... signature……..

CONSENT FORM

Researcher name…….contact……..

Title of project:

FACTORS CONTRIBUTING TO RICKETS AMONG CHILDREN UNDER-FIVE YEARS

CASE STUDY OF ISHIARA AND EMBU HOSPITALS, EMBU COUNTY

Kindly tick where appropriate

1) I confirm that I have read (or been read to) and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had the question answered satisfactorily.

2) I understand that my participation is voluntary and am free to withdraw at any time without giving any reason, without my legal rights being affected.

3) I understand that relevant sections of information and data collected during the study may be looked at by other members of this research team. I give information for these individuals to have access to these records.

4) I agree to take part in the study without any demands and of my own free will.

Name of the respondent…….

Date……

Signature…….or

Thumb print…

APPENDIX 2: QUESTIONNAIRE:

FACTORS CONTRIBUTING TO RICKETS AMONG CHILDREN UNDER-FIVE YEARS:

CASE STUDY OF ISHIARA AND EMBU HOSPITALS, EMBU COUNTY

Personal identification

Sub-County…….. Code …….. Questionnaire no……

Name of interviewer…… Date of interview……/……../2017

Respondent's name ……

Gender ( ) 1= Male, 2= Female

SECTION A: Demographic and Socio-economic characteristics

1. Household profile

S/no	Name	Relationship to the HH	Age	Marital status	Religion	Level of education	Main occupation
1							
2							
3							
4							
5							
6							
7							
8							
9							

RHHH	Marital Status	Religion	Education	Occupation
1= HHH 2=Spouse 3=son 4=Daughter 5= Grandson 6=Grand daughter 7=Relative 8=Parent 9=Employee	1= married 2=Separated 3=Widowed 4=Single 5=Divorced 6=not applicable <15 years	1= Christian 2=Muslim 3=Traditionist 4= Others (specify	1= in primary 2=Primary drop-out 3=Completed primary 4=Secondary drop-out 5=In secondary 6=Completed secondary 7=Tertiary level 8=University 9=Adult education 10=Other (specify	1=salaried employee 2=farmer 3=Self employment 4=Casual labourer 5=Student 6=Unemployed 7=Others (specify)

Socio-economic characteristics

2. What was is your total household income per month? .....

3. Please describe the home where you live

1= Self- Owned 2= Hosted by parent or relative for free 3= Pay rent 4= others specify ……..

SECTION B: DIETARY PRACTICES AND BREASTFEEDING

BREASTFEEDING HISTORY

4. Where was the child born?

1= Hospital 2= At home 3= Others Specify_____

5. How soon after delivery was breastfeeding initiated?

1 = First 30 minutes 2= First 1 hour 3= 1 hour to 24 hours 4= after 24hours

6. Are you still breastfeeding this child?

1= Yes 2= No if yes move to number 8.

7. How old was the child when you stopped breastfeeding him or her? _____

8. Why did you stop breastfeeding him or her?

1= Baby is not getting enough 2= Cultural beliefs 3= the baby has grown up 4= had to go back to work 5= others specify_____

I. EXCLUSIVE BREASTFEEDING/ INITIATION OF COMPLEMENTARY FEEDING

9. Did you give the child any food or drink besides breastmilk in the first 6 months?

1= Yes 2= No if no moved to number 11.

10. What foods or drinks did you give your child?

1= Water 2=Herbs 3= Porridge 4= Milk 5= Solid food 6= water and salt

11. How old was the child when you gave him/her any other food or drink apart from breast milk? (Prelacteal feed including herbs)_____

12. Which combination of grains do you add to make your child's porridge?

Composition	1= yes , 2= no	Addition e.g. milk, sugar, oil/fat, citric acids
Maize and legumes		
Sorghum and legumes		
Millet legumes		
Sorghum and millets		
Maize, sorghum and millets		
Maize sorghum millets and omena		
Maize sorghum millet legumes		
No combination		
Others specify		

CULTURAL PRACTICES

12. Are there special foods recommended and forbidden to infants in the community?

Food recommended	Reason	Food not recommended	Reason

13. How often do you feed the child on the following foods in a week: (7-day food frequency)

Types of food	Once a week	2X a week	3X a week	4X a week	5X a week	6X a week	Daily	Never
Fruits and vegetables								
Spinach								
Amaranth (terere)								
Pumpkins leaves								
Sukuma wiki (kales)								
Tomatoes								
Oranges								
Kunde								
Ripe bananas								
Legumes								
Beans								
Peas								
Cowpeas								
Soy beans								
Green grams								
Njahi								
Animal products								
Eggs								
Liver								
Meat								

Yoghurt								
Poultry								
Fish and fish oil								
Cereals								
Millet								
Sorghum								
Maize								
Rice								
Wheat								

SECTION C: NON DIETARY PRACTICES

Sun exposure practices

14. Do you take your child out to bask in the sun?

1= yes 2= no

15. At what time of the day do you take your child out of the house to bask in the sun?

1= 7am to 10 am 2= 11am to 3pm 3= 4pm to 6pm 4= others specify_____

16. How do you dress your child when basking?

1=undressed fully 2= dressed with pant only 3= dressed with pant and vest 4= fully dressed 5= others specify_____

17. Do you cover your child after undressing when basking?

1= yes 2= no

18. If yes what do you cover the child with? .....

19. Where do you position the child while basking in the sun?

1= open sky 2= under umbrella 3=under shade 4= others specify……

20. How long does your child stay in direct sun?_____

21. Who takes care of the baby?

1=mother 2= other siblings 3=house help 4= relatives 5= others specify

22. Do you use napkins to wrap the baby? 1= yes 2= no

If yes how often? .....

23. Do you use baby carrier to carry the baby? 1= yes 2= no

FAMILY PLANNING

24. Were you using any family planning before conception of the index child?

1=yes 2= no

25. If yes, what type of family planning were using?

1= Depo-Provera 2=implants 3= oral pills 4= intra-uterine devices (IUDs) 5= others specify…….

26. For how long have you used?

1= 3months 2= 6months 3= 1year 4=2years 5= more than 2years

27. Where do you access your family planning?

1=Private hospitals 2= public hospitals 3=others specify…….

Which other types of family planning have you used before and for how long?_____

_____

_____

_____

ANTHROPOMETRIC MEASUREMENT

28. Taking measurement.

Age of the index child…… Date of birth ……..male……..female……

Measure	Measurement 1	Measurement 2	Average
Weight			
Height /length			
MUAC			

MORBIDITY STATUS

29. Has the child been sick for the past 2 weeks?

1= yes 2= no

30. If yes what did you do to the child? 1= took child to the hospital 2= bought drugs for the child 3= nothing 4= others specify……

31. What was the child suffering from?

1=Cough and flue 2=diarrhea 3= respiratory infections 4= others specify…….

32. Has the child been fully immunized? Check from child card/booklet

1= yes 2= no

33. Does this child have rickets? 1. Yes 2. No

34. Did any of the elder child have rickets? 1. Yes 2. No

35. If yes which type of family planning were you using before conception of the elder child with rickets? 1= Depo-Provera 2=implants 3= oral pills 4= intra-uterine devices (IUDs) 5= others……..

36. For how long did you use that type of family planning? 1= 3months 2= 6months 3= 1year 4=2years 5= more than 2years

24 hour recall

Meal	**Name of food**	**Ingredients**	**Amount of ingredients used**	**Total amount of dish**	**Total amt. served to children**	**Amt. ate by child**	**Amount ate**

APPENDIX 3: KEY INFORMANT INTERVIEW GUIDE

Topic: FACTORS CONTRIBUTING TO RICKETS AMONG CHILDREN UNDER-FIVE YEARS

Key informant: Clinical Officer, Nutritionist, Occupational therapist.

Name …….

Professional……

Facility name……..

In the course of your work how often do you encounter children suffering from rickets?

……

……

……

……

……

Which is the mostly affected age and gender?

……

……

What in your opinion is the cause of the rise in the cases of rickets?

……

……

APPENDIX 4: FOCUS GROUP DISCUSSION GUIDE

TOPIC: FACTORS CONTRIBUTING TO RICKETS AMONG CHILDREN UNDER-FIVE YEARS

Duration 45 minutes

Introduction

Discussion

What is the main source of livelihood in the community?

What types of food are mainly produced by people in this are?

What is rickets?

What do you think are the contributing factors to rickets?

How do you feed your children?

How do you dress your children?

What are the effect of using napkins and baby carrier?

What do you know about family planning?

What are effects of Depo-Provera?

Conclusion

Team members

Principle investigator, note taker.