

Determinants of Nutritional Rickets among Children Aged below 5 years in Naivasha District Hospital, Kenya

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Abstract

Rickets, a common deficiency disease affecting children below five years of age, is rare in most developing countries but is observed in severely malnourished children. According to literature, Vitamin D, Calcium and Phosphorus deficiencies are the main causes of rickets. The purpose of this study was to investigate the determinants of the development of nutritional rickets among children below 5 years undergoing treatment at the Naivasha District Hospital (NDH). Out of the target population of one hundred and eighty four children (184), seventy four (74) mother-child pairs were purposively selected for this study. The children in this study had been diagnosed with rickets and were undergoing treatment and occupational therapy at NDH. A structured questionnaire was administered to the caretakers of the children. Two (2) key informants from the Municipal council were interviewed and provided information regarding water quality. A pilot test was conducted before data collection. Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20 (2011). A p value of >0.05 was considered significant. Results showed that poor feeding practices were evident where children were deprived of animal source proteins represented by forty six percent (46%) in infants and forty percent (40%) among those diagnosed post-infancy. Majority (41%) of the children had inadequate daily sunlight exposure of less than 30 min a day. Fifty nine percent (59%) of them were fully clothed during sunlight exposure. Sixty seven percent (67%) of the households used fluoride contaminated borehole water for cooking activities. This finding was significant ($p=0.05$). Insufficient sunlight exposure due to inappropriate dressing and use of fluoride contaminated water were the main determinants of rickets among these children. It is hoped that results from this study can be used to develop interventions which can alleviate the prevalence of rickets among children in Naivasha.

Keywords: *Rickets, Vitamin D, Calcium, Sunlight*

Introduction

Nutritional rickets is a disease of growing bone that afflicts children and adolescents during times of rapid growth. Vitamin D deficiency and/or nutritional rickets remain prevalent in developing regions of the world and rank among the five most common diseases in children (Lerch, 2007; Wagner, 2008). Vitamin D is essential in promoting absorption of Calcium and Phosphorus which build strong bones and teeth (Schwarz, 2011). Low plasma levels of Vitamin D causes the body to produce parathyroid hormone which causes Calcium and phosphate to be released from the bones leading to their weakness, hence the development of rickets. This consequently weakens the bone structure leading to skeletal deformities such as bowlegs, knock-knees, non-closure of the fontanel, enlarged wrist bone, non-development of teeth even at 6 months and failure to thrive (Wagner, 2008).

The development of rickets is common in areas which have low socio-economic conditions, insufficient breastfeeding, inadequate complementary feeding practices and lack of exposure to sunlight (Thacher, 1999). Researchers have found that insufficient dietary intake of Vitamin D, calcium and phosphorus leads to the development of rickets in sun-rich countries (Pettifor, 2004; Bener et al., 2003). In many developing countries, the staple diet of children who have been weaned is low in Calcium. In Nigeria for example, dairy products are rarely incorporated in children's diet (Bishop, 1999) and fluoride-calcium interaction has been shown to cause rickets (Norman, 2001). Further, uptake of Calcium as Calcium phosphate by bones is hindered by high fluoride content in food and water. The Rift Valley region in Kenya has very high fluoride concentration in water (rivers -2-21ppm; boreholes >7.5ppm), soil (2300ppm) and food sources (>6ppm) (National Institute of Health, 2009). The contents are far above the levels recommended by the World Health Organization and Kenya's Ministry of Water and Irrigation of 1.5 ppm (parts per million) (Rombo, 2009).

Naivasha, one of the constituencies in the Rift Valley, has reported an increase in cases of rickets among children. Hospital records indicate an alarming increase of up to 84 new cases among children aged between 6-12 months, within a 6 month period (Gitonga, 2013). This paper presents findings of a

research study carried out on children aged below 5 years who were diagnosed with rickets and were undergoing treatment and occupational therapy at Naivasha District Hospital (NDH). The purpose of this paper was to find out the determinants of nutritional rickets among the children attending NDH.

Materials and Methods

The descriptive cross-sectional research design was employed in this study. Data was collected from mothers or care givers of children aged below five years undergoing treatment at (NDH) between December 2012 and January 2013.

This research was carried out in Naivasha one of the six constituencies in Nakuru county. It covers an area of 2,300 Km² and experiences seasonal rainfall ranging between 156-1134 mm. This climate supports agricultural activities in particular subsistence farming and floriculture due to the rich volcanic soils. Poverty incidence is high with the urban poor consisting of 41% while the rural poor 45% (Kenya National Bureau of Statistics, 2012). This research was carried out in Naivasha District Hospital which is the main health facility that serves residents of Naivasha and is the only hospital in Kenya which provides the treatment and occupational therapy for children affected by rickets.

According to KNBS (2009) census Naivasha constituency has a population of 224,141 people. The target population for this study was derived from the hospital records as the estimated number of children who had been diagnosed with rickets and were undergoing treatment and occupational therapy at the NDH in the year 2012. According to these records, 184 new cases of rickets had been recorded this is approximately 15 new cases every month (Muiruri, 2012).

The study sample was drawn from the target population (184) who were mothers and caregivers of children who had been diagnosed with rickets. A total of seventy four (74) children were selected from the target population using the purposive sampling technique. Solvin's formula (2001) was used to calculate this sample size. On a specific clinic day medical personnel assisted the researcher identify the mother or caregiver who had turned up for the child's weekly therapy. Such a mother was found suitable to form the study sample and was interviewed. Thereafter, the next mother or caregiver was identified and if found suitable was selected for the study. On average, the researcher sampled and interviewed about ten mothers every day. This continued until the total number of seventy four (74) mother-child pairs was reached.

The researcher administered a structured questionnaire to the mothers or caretakers of the children attending NDH for weekly occupational therapy and filled in their responses. The questionnaire consisted of the following sections; socio-demographic characteristics of the mothers, child data, infant and child feeding practices, sources of water for cooking and household consumption. A separate section on water quality was filled by Naivasha municipal authority officials with knowledge about water treatment in the area during a scheduled interview. A pilot test was carried out on 5 mothers at the start of data collection to ensure there was no ambiguity in the questions and that the data collected was relevant to the study. Although the questionnaire was written in English the questions were verbally translated to Kiswahili when necessary. Data was coded and converted into numerical codes and analyzed using the Statistical Package for the Social Sciences (SPSS) version 20 (2001). Pearson's chi-square test was used to test relationships between variables. A p value of (>0.05) was considered significant.

Approval to carry out this study was granted by the Naivasha District Hospital Superintendent and the University of Eldoret. Further, consent to participate in the study was sought from the participants. Anonymity of the respondents was maintained by giving them code numbers.

Results

Demographic and Socio-Economic Characteristics of the Respondents

Data was obtained from 74 respondents most (31%) of whom were aged between 23 and 28 years and only 9% had attained the age of 40 years and above. Majority (76%) of the respondents, were married and 11% of them were single. Only 4% of the respondents were widows or widowers. The male headed single household was the most dominant in Naivasha. Seventy percent (70%) of the households were male headed while 24% were female headed.

Of the respondents interviewed, 39% were self-employed whereas 16% formed the lowest segment of the permanently employed. The percentage of respondents who had attained primary and secondary school education was almost equal at 44% and 43% respectively. The rest of the mothers had no formal schooling. This survey also found that 71% of the respondents had less than 5 people per household whereas 29% had between 5 and 10 people per household.

Child Information

More than half (63%) of the children had been diagnosed with rickets at the age of 1-11 months and only 33% were diagnosed at the age of 12-23 months. Seventy percent (70%) of the affected children were female while 30% were of male gender.

Feeding Habits of the Children

Results from this study showed that sixty five percent (65%) of the children were breastfed several times a day whereas the rest were breastfed minimally. Ninety five percent (95%) of the infants were on complementary feeding at the time of the diagnosis while only 5% were not (Figure 1).

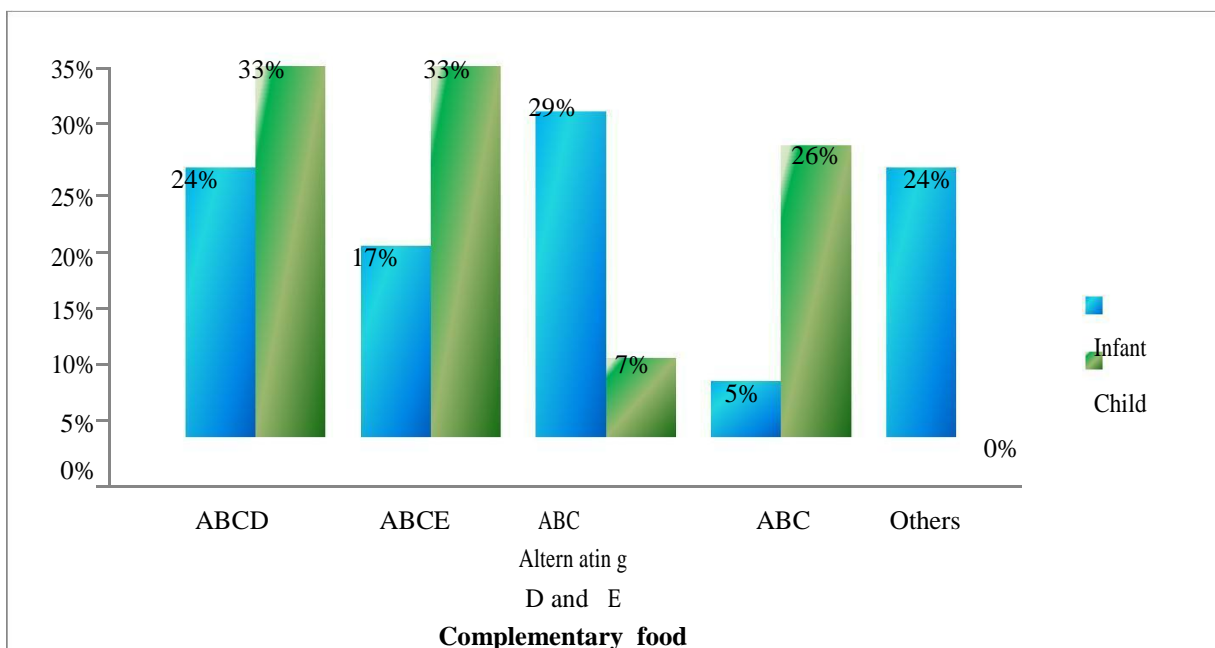


Figure 1. Infant and Child Complementary Food Combination before Diagnosis
 A-Cereal based food, B-Vegetables, C-Fruits, D-Plant Proteins and E-Animal Proteins

Infancy: The highest number of respondents (29%) fed their infants on ABC alternating D and E food combination. Seventeen percent (17%) did give food combination ABCE.

Post-Infancy: Figure 1. indicates that more children (33%) were either fed on food ABCD or ABCE. The least (7%) number of the children were fed on food ABC alternating D and E. The complementary food combination of ABCD and ABCE were the highest which indicates that most children who were diagnosed post infancy were fed on balanced diets. A total of 40% (combinations ABCE and ABCD/E) were fed on animal proteins which have Calcium, Phosphorus and Vitamin D nutrients greater than the plant proteins.

Length of Time the Index Child was Breastfed

All the forty three (43) children who were infants at the time of rickets diagnosis were still breastfeeding while 27 children who were diagnosed post infancy had been breast fed before diagnosis. Majority (63%) of mothers breastfed their children for a period of over 8 months in their infancy before they were diagnosed post infancy.

Duration of Daily Sunlight Exposure of Infants and Children

Thirty seven percent (37%) of the children had average sunlight exposure of 26-35 min which conforms with the recommended daily exposure of 30 minutes. However, forty one (41%) percent of the children were under exposed to adequate sunlight thus hindering the synthesis of vitamin D by the skin.

Child's Mode of Clothing during Sunlight Exposure

Fifty nine percent (59%) of the respondents' children were fully clothed when taken out for sunlight exposure which according to the respondents was to prevent the child from catching cold related illnesses. Only 6% of the respondents' children were well clothed for sunlight exposure.

Source of Water for Household Use

The study findings showed that only 14% of the households used harvested rain water which was not contaminated with fluoride. However, sixty seven percent (67%) of households used fluoride contaminated bore hole or well water for cooking activities and another 19% used untreated municipal water for the same. Both these water sources had greater quantities of fluoride compared to the recommended safe levels of 1.5 parts per million. Pearson's chi-square indicated a significant ($p > 0.713$) relationship between water sources and the development of rickets in children. From these results it is evident that fluoride contaminated water was one of the determinants for the development of nutritional rickets among children under the age of 5 years (Figure 2).

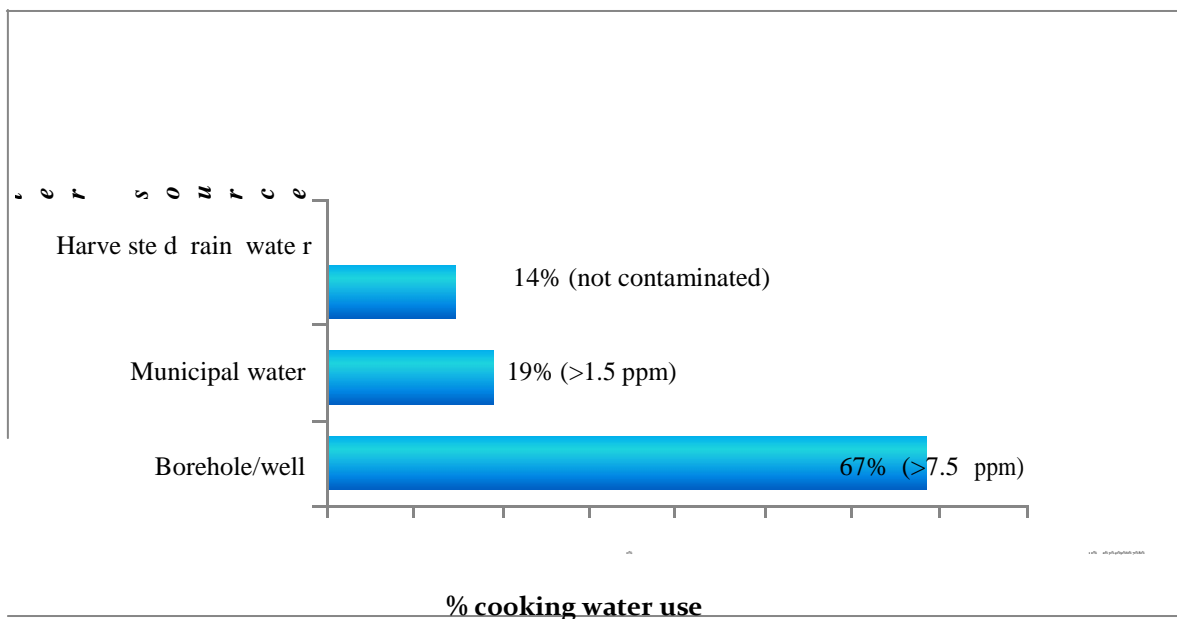


Figure 2. Source of Water for Household Use and Cooking

Discussion

The development of bone related illnesses especially in children that manifests itself as rickets is strongly related to deficiencies of essential micronutrients Calcium, Phosphorus and Vitamin D. The risk factors assessed that contribute to the development of rickets such as poor dietary intake, poor sun exposure and fluorosis are discussed.

Thirty one percent (31%) of the respondents who were mothers and caregivers of the children were aged between 23 and 28 years. This indicates that most of the mothers were relatively young and may be first time mothers thus lack adequate information and experience on raising children in their first years of life. The median age at first birth among women aged 25-49 years in the Rift Valley region is 19.6 years where women with some secondary education begin child bearing three years later (KDHS, 2008).

According to KDHS (2008), 58% of the respondents were married or living with a partner, and only 31% had never been married. Results from this study found out that majority (76%) of the respondents, were married. Seventy percent (70%) of the respondents came from male headed households, which further confirms the norm that males are always the head of most families and not females. Further, it has been assumed that rickets commonly affect children from single mother households or female headed households leading to lack of sufficient care by the caregivers who were left to take care of the children as the single mothers go to work. Results from this study confirmed that the

increase in the prevalence of rickets in Naivasha is attributed to the fact that mothers who work in flower farms and other low wage earning sectors were unable to hire nannies to take care of their children. Instead they took the children to day care centers which are crowded with poor lighting and ventilation leading to an increase in rickets (Kageni 2009; Gitonga, 2013).

Limited income may affect the types of food available to the household. However, findings from the present study are contrary to this since majority (75%) of the mothers were in some form of employment. It is evident that mothers lack adequate time to give full attention to their children in terms of dietary practices and sunlight exposure. Theuri (2012) reported that low socio-economic conditions lead to low education status and empowerment. Consequently, the purchasing power of foods rich in Calcium and Vitamin D that prevent rickets may be affected. Similarly, a study conducted in Turkey found that nutritional rickets was a disease of the underprivileged being strongly correlated to negative social backgrounds (Alsaied *et al.*, 2009).

Mother's education persists as a strong predictor of child's nutritional status (Abuya, 2012; Theuri, 2012). The fact that almost half of the respondents (44%) in the present study had primary education may be an indicator of lack of knowledge on proper dietary habits particularly serving nutritious foods to their children thus, this finding concurs with the Kenyan survey (KDHS, 2008) which indicated that most women in Kenya have not attained high levels of education.

Most research studies carried out in developing countries indicate that malnutrition is common in households with large families. On the contrary, the results from this study showed that the development of rickets in children may not be due to large household sizes where food availability may be affected. This is because 71% of the children affected by rickets came from households with less than 5 persons.

Sixty three percent (63%) of the children were diagnosed with rickets at infancy indicating that infancy period is a crucial period where susceptibility to the development of rickets due to inadequate nutritional practices is high. This is a crucial age for bone development since it is the most rapid period for bone growth (Boyers, 2012). Therefore, dietary practices deficient in Calcium, Phosphorus and Vitamin D and taking or using water highly contaminated with fluoride puts the children at risk.

Female children comprised 70% of the total sample studied. From the results, the female child therefore, seems more susceptible to the development of rickets than male children thus need for more attention to this group. The consequences of untreated rickets to the female child are pelvis deformities which later lead to difficulties in vaginal delivery (medicinenet.com, 2002). This therefore calls for urgent treatment and preventive measures.

Results from this study show that breast milk formed a major part of the infant's diet where 65% of the children were breastfed several times daily. This decreases access to Vitamin D rich sources of food assuming that this was the norm after 6 months of age with minimal sun exposure and complementary feeds deficient in Calcium, Phosphorus and Vitamin D. Breast milk does not contain adequate quantities of Vitamin D thus depriving the infants especially those who were exclusively breastfed of the vitamin (Greenbaum, 2011). Theuri (2012), reported that children who were not breast feeding were 0.3 times more likely to develop rickets than those who were breast feeding. Further, in Kenya, Vitamin D supplementation is not included in the infant and young child feeding requirements and is only given as treatment where deficiency is noted. This underscores the need for supplementation of Vitamin D to the under fives.

Ninety five percent (95%) of children diagnosed with rickets at infancy were on complementary feeding at the time of diagnosis. This finding corresponds with KDHS (2008) which showed that 60% of infants in the country are on complementary feeding by the age 4-5 months and by the age of 6-9 months, 83% are given complementary feeds. This is a huge indicator showing that the choice of food for this kind of feeding may to a great extent have contributed to the development of rickets. Poor choice of food and inadequate weaning practices may be linked to complementary feeding being a contributing factor (Majeed, 2007). The likelihood of developing rickets is higher among children who started complementary feeding before six months of age ($p < 0.01$) (Theuri 2012).

Food combinations greatly reflect the nutritional status of children. The Infant and Young Child Feeding standards recommend infants of 6-8 months receive food from the three food groups other than breast milk twice in a day and at least three times for those 9-23 months of age. For the children who were diagnosed at infancy and were already on complementary feeding, 29% were fed on balanced diets where animal and plant protein sources were being alternated. Only 17% of the children were fed on balanced diets comprising animal source proteins alone. Animal source proteins are richer in nutrients necessary for bone health than plant proteins. The results indicate that insufficient animal source foods may contribute to the development of rickets but cannot be concluded as a predominant risk factor. The

children diagnosed post-infancy had been fed on balanced diets either comprising animal source or plant source proteins. Both food combinations were represented by 33% each. According to the present study, food combinations for this group, especially lack of animal source proteins, therefore, seem to have a minimal link to the development of rickets.

All children who were diagnosed with rickets at infancy were breastfeeding and all children diagnosed post-infancy had been breastfed. From the results of this study, lack of breast feeding was not a cause of rickets thus making breastfeeding a likely cause in the event that it formed a major part of diet and there was inadequate sunlight exposure. This is because of its low quantities of vitamin D. Sixty three percent (63%) of the children were breastfed for a period of over 8 months thus indicating that development of rickets may be due to continuous breast feeding especially exclusive breastfeeding. Girls are breast fed longer than boys in Kenya and women with no education tend to breastfeed slightly longer (21 months) than those who have at least some secondary education (KDHS, 2008). These statistics support why more girls (70%) as seen in this study were affected by rickets. Prolonged breastfeeding beyond 6 months is advised among infants who are being weaned so that breast milk just forms a part of their diets but in situations where it is the main part of the daily diet, it may be a major factor in the development of rickets due to its deficiency in Vitamin D which is needed for Calcium absorption.

The recommended sunlight exposure for infants and children is for a period of approximately 30 minutes every day. Only 37% of the children had sunlight exposure in line with the approximated duration. This indicates that inadequate sunlight exposure which is the best source of Vitamin D by the skin may be one of the major factors leading to the development of rickets. All respondents were of African race thus had darker skin pigmentation which requires longer sun exposure as compared to races of fairer skin pigmentation (Royal Children's Hospital, 2009). In order to ensure maximum absorption of Ultra Violet B rays which assists Vitamin D synthesis, children require adequate duration of sunlight exposure coupled with appropriate clothing where the face, arms, legs and back are exposed. In this study, only 6% of the children were half clothed during sunlight exposure and 59 % fully clothed thus inadequate exposure. This may be attributed to poor maternal education which affects the extent of sunlight exposure in terms of fully wrapping children with clothes (Majeed, 2007). This therefore, indicates that lack of proper clothing that exposes the relevant parts during sunlight exposure is among the predominant causes for the development of rickets.

Majority (80%) of the respondents used water from boreholes for both household activities and for cooking. Borehole water in the area has been confirmed to be highly contaminated with fluoride levels of at least 7.5ppm and up to 50ppm (Rombo, 2009). This puts the respondents and their families at great risk for the development of bone related diseases since the safe levels of fluoride contamination are below 1.5ppm. The municipal officials confirmed that municipal water is not treated for fluoride contamination thus has high fluoride content greater than the recommended 1.5 ppm. However, they were not aware of the level of contamination of the water supplied. This water source cannot be treated for contamination at household level thus leads to ingestion of contaminated food by 19% of households who use it. This is particularly crucial to children who still have fragile growing bone. Harvested rain water was used by only 14% of the respondents for cooking which is possibly free from contamination but may be contaminated in the process of collection especially if rain water hits roof tops containing local dust and soil that are also thought to have high fluoride levels. Dust contains 2300ppm of fluoride contamination while the soil surrounding Lake Elementaita contains 1000ppm (Kenya Bureau of Standards, 2010). These percentages, thus, indicate that prolonged use of fluoride contaminated water for cooking as a predominant factor in the development of rickets

Conclusion

The following conclusions can be drawn from the study findings:

1. Water sources used by all households were contaminated with high levels of fluoride making it the most predominant factor leading to the development of rickets in Naivasha. Continued use could bring about fluorosis which inhibits the absorption of calcium as calcium phosphate by bones .
2. Inadequate sunlight exposure through decreased time under the sun while fully clothed was found to be a predominant risk factor as it hindered production of Vitamin D under the skin.
3. Length of breast feeding and poor combination of complementary foods was also another risk factor for the development of nutritional rickets.
4. Presence of cheap day care centers which have very poor hygiene standards have contributed to the development of rickets in Naivasha.

Recommendations

From the results of this study the following recommendations can be made:

1. The government should put systems in place for adequate treatment of fluoride in all water sources in Naivasha Constituency.
2. The Naivasha District Hospital should increase the number of nutritionists so as to promote health and nutrition of mothers, infants and young children.
3. The Ministry of Health should include Vitamin D supplementation for pregnant mothers and children.
4. Medical personnel should offer nutrition education programs specifically on the prevention of rickets to sensitize mothers on the need to incorporate Calcium, Phosphorus and Vitamin D rich foods.
5. There is an urgent need for a multi-sectoral approach to the issue of day care centers so as to set standards that safeguard the welfare of children in Naivasha.

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