

Full Length Research Paper

Determination of calcium, sodium, potassium, phosphorus, urea and creatinine in high prevalence rickets area of Northern Nigeria

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Accepted March 18, 2013

Nutritional rickets remain a problem in developing countries despite a decline in the prevalence of the condition in developed countries. Due to the high Prevalence of rickets among infants and young children in Gonin-Gora, Jankasa and Kaso Northern Nigeria; this study aimed to explore the relationship between some biochemical parameters and the development of rickets in children living in these communities. Serum levels of calcium sodium, potassium, phosphorus, urea and creatinine were estimated as an investigation into the scourge of Rickets. Randox diagnostic kit was used for the determination of serum calcium and urea. Agappe diagnostic kit was used to determine inorganic phosphorus and creatinine while serum sodium and potassium levels were determined using flame photometric method. The results obtained showed lowered levels of serum calcium with mean values of 2.29 ± 0.01 S.E.M., 2.34 ± 0.01 S.E.M and 2.24 ± 0.01 S.E.M for rickets affected children in Gonin Gora, Jankasa and Kaso respectively compared with the 2.25-2.75 mmol/l normal limit. Phosphorous levels were toward the upper limit with mean values of 1.48 ± 0.02 S.E.M and 1.68 ± 0.02 S.E.M for the children in Goningora and Jankasa respectively; compared with the normal limit of 0.8-1.9 mmol/l. Also, the mean serum calcium for rickets affected children from Kaso community (2.19 ± 0.03 S.E.M) was below the normal range value of (2.25-2.75mmol/dL). Rickets among rural children has been reported to be attributed to low serum calcium levels. The low serum levels of calcium and high serum phosphorus levels or the defect in the metabolism of these minerals could be the causes of the disease in these settlements. The comparison of the mean biochemical parameters for Gonin-Gora, Jankasa and Kaso showed significant lowered level of calcium in Kaso compared with the other two communities, which could be the reason why more rickets children were found in Kaso. In conclusion, the concentrations of serum calcium for rickets children were lowered while the concentrations of serum phosphorus were higher which can be attributed to rickets disorder among the children.

Keywords: Rickets, Serum, Biochemical parameters, Northern Nigeria.

INTRODUCTION

Rickets causes bone deformities through the impaired mineralization of actively growing bone. Rickets is ranked

among the five most prevalent diseases of young children in developing countries (Graff et al., 2004), and is

Frequently found in African (Pettifor et al., 1978; Thacher et al., 1997; Thacher, 2003), in Asian (Fischer et al., 1999; Bhattacharyya et al., 1992). Up to 9% of children in central Nigeria have physical findings consistent with rickets (Pfitzner et al., 1998), including bowing of the legs, impaired mobility, pain, and pathologic fractures. Besides the long-term sequel associated with the bone deformities, rickets is also associated with an increase in acute morbidity. In Ethiopia, a case-control study described a 13-fold greater prevalence of rickets among children with pneumonia than in control children (Muhe et al., 1997). Although nutritional rickets is often attributable to vitamin D deficiency (Holick et al., 1999). Recent reports suggest that an insufficient calcium intake is also an important cause of rickets (Oginni et al., 2003; Delucia et al., 2003). Children with calcium-deficiency rickets have higher serum concentrations of 1,25-dihydroxyvitamin D ($1,25(\text{OH})_2\text{D}$) and parathyroid hormone and lower serum concentrations of calcium and 25-hydroxyvitamin D ($25(\text{OH})\text{D}$) than do children without rickets. Calcium supplementation, with or without vitamin D, heals rickets more rapidly in children than does vitamin D alone (Thacher et al., 1999). However, despite uniformly low calcium intakes, calcium intakes are not lower in Nigerian children with rickets than in those without rickets (Thacher et al., 2000). Reduced calcium absorption or relative resistance to $1,25(\text{OH})_2\text{D}$ could account for rickets in these children (Thacher et al., 2000). There are four types of rickets namely; Vitamin D-deficiency rickets or nutritional rickets, Vitamin D – dependent rickets, type 11 or hereditary 1-alpha,25-ihydroxyvitamin D-resistant rickets and Vitamin D-resistant rickets which are of two types (Familial hypophosphatemic rickets or X-linked hypophosphatemic rickets and hereditary hypophosphatemic rickets with hypercalciurea). The miscellaneous group consists of renal rickets, Rickets of prematurity, tumor-induced rickets (Nielsen et al., 2006).

MATERIALS AND METHODS

Materials

Randox diagnostic kit, Randox laboratories Ltd, Ardmore, Diamond Road, Crumlin, Co. Antrim, United Kingdom, BT29 4QY. Agappe diagnostic kit, Agappe Hill: Dist: Ernakulam, Kerala, India_683-562. Flame photometer (model; Corning 410, UK). All reagents were analytical grades and were obtained from British Drug House (BDH) Chemicals Limited, Poole, England.

Methods

Study Protocol

Children with deformities characteristics of rickets were identified, clinical history obtained and examination points documented. 5ml of blood sample were obtained from antecubital vein into capped, clean plastic vials from each of the 30, 40 and 57 rickets (R) and 30, 40 and 57 non rickets (NR) living in Gonin Gora, Jankasa and Kaso communities of Kaduna state respectively. The non-rachitic healthy children from the same communities served as controls. The sera were obtained and analyzed for the content of sodium, potassium, calcium, phosphorus, creatinine and urea. Calcium and urea levels were estimated according to the instructions stipulated in Randox diagnostic kit while Phosphorus and creatinine levels were estimated by following the instruction of Agappe diagnostic kit.

Analysis of Sodium and Potassium

Serum sodium and potassium were determined using flame photometric method. In this method, 0.1ml of serum was added to 9.9ml of deionized distilled water in a universal bottle. The contents were mixed and the reading was taken with flame photometry; for sodium, the galvanometer was set with the working standard and the absorbance was measured at 590nm. And for potassium, the galvanometer was set with potassium working standard and the absorbance was measured at 770nm. (Chuang et al., 2005).

$$\text{Sodium concentration (mmol/l)} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times 0.2$$

$$\text{Potassium concentration (mmol/l)} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times 0.1$$

RESULTS

Determination of mean serum biochemical indices in rickets and non-rachitic children in Gonin-gora community: The mean \pm S.E.M biochemical parameters of rickets and non-rachitic children from Gonin Gora communities are shown in Fig. 1. The values for rickets and non-rachitic were not significantly ($p > 0.05$) different. However higher values were estimated for non-rachitic children compared with rickets children in all

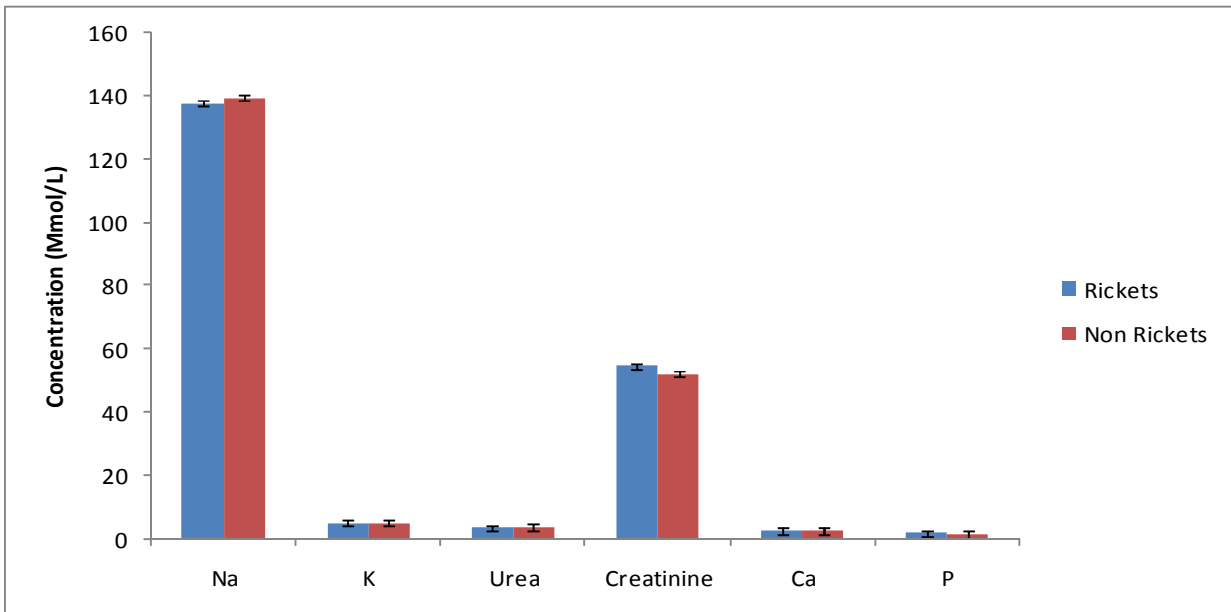


Figure 1. Mean (\pm) S.E.M Serum Biochemical indices for rickets and non-rachitic children in Goni-gora community of Kaduna State.

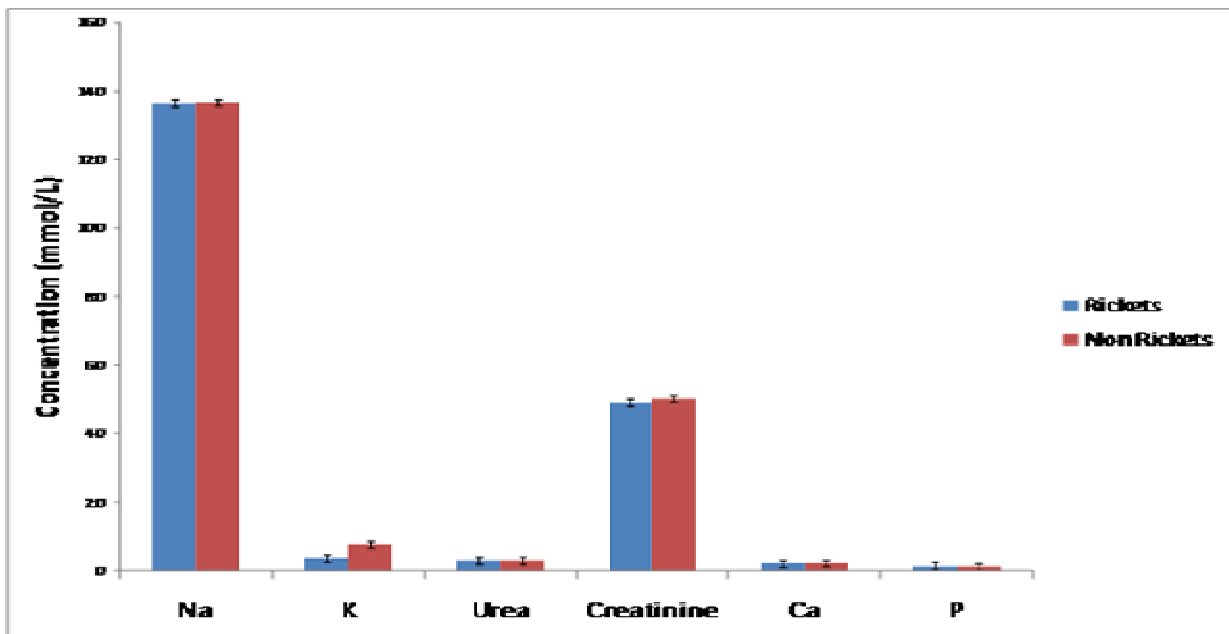


Figure 2. Mean (\pm) S.E.M Serum Biochemical indices for Rickets and Non Rachitic Children in Kaso community of Kaduna State.

parameters expect in creatinine and phosphorus. Mean serum biochemical indices in rickets and non-rachitic children of Kaso community: The results of sodium (Na), potassium (K), urea, creatinine (Cr), calcium (Ca) and

phosphorus (P) levels estimated for rickets and non-rachitic children of Jankasa community are presented in Fig. 2, potassium and calcium levels were significantly lowered in rickets children compared to the non-rachitic

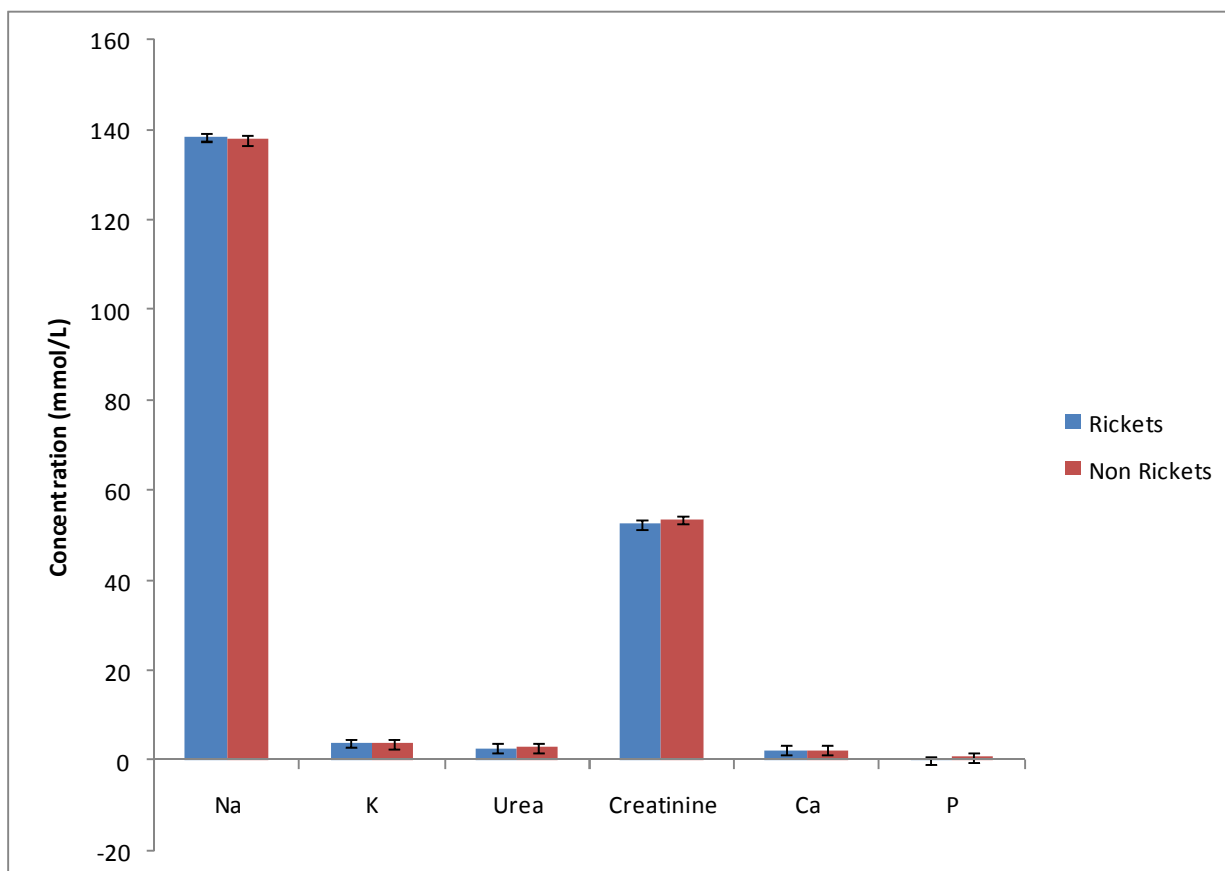


Figure 3. Mean (\pm) S.E.M Serum Biochemical indices for Rickets and Non Rachitic Children in Jankasa community of Kaduna State.

children. The values of calcium in rickets and non-rickets were 2.19 mmol/L S.E.M \pm 0.03 and 2.30mmol/L S.E.M \pm 0.02 and that of potassium in rickets and non-rickets were 3.69 mmol/L S.E.M \pm 0.09 and 7.76 mmol/L S.E.M \pm 4.10. Normal calcium and potassium levels are 2.25-2.75 mmol/L and 3.6-5.2 mmol/L.

Mean serum biochemical indices for rickets and non-rickets children of Jankasa community: The mean (\pm) S.E.M biochemical parameters of rickets and non rachitic children from Jankasa community are shown in Fig. 3. The serum values for rickets and non rachitic are significantly different ($p < 0.05$) for sodium and calcium. The mean biochemical serum values for sodium in rickets and non rachitic children were 138.44 mmol/L S.E.M \pm 0.53 and 137.77 mmol/L S.E.M \pm 0.06 and that of calcium for rickets and non rickets children were 2.35 mmol/L S.E.M \pm 0.02 and 2.32mmol/L S.E.M \pm 0.07 respectively. Normal calcium and sodium levels are 2.25-2.75mmol/L and 136-145mmol/L.

Comparison of mean serum biochemical parameters

for rickets and non-rachitic children of gonin-gora, jankasa and kaso communities: The results of group analysis of values determined for the rickets and non-rachitic children in the three communities are shown in Fig. 4. Calcium and potassium were significantly reduced for rickets affected children.

DISCUSSION

Mean serum biochemical indices for rickets and non-rickets children of Gonin-gora community: The mean serum biochemical indices (sodium, potassium, urea, creatinine, calcium and phosphorus) were within the normal range for each parameter.

However, the serum calcium levels for both rickets and non-rachitic children were at lower limits of the normal range while the serum phosphorus values were at the higher limit of the normal range. Also, the serum values determined for calcium, sodium, potassium and

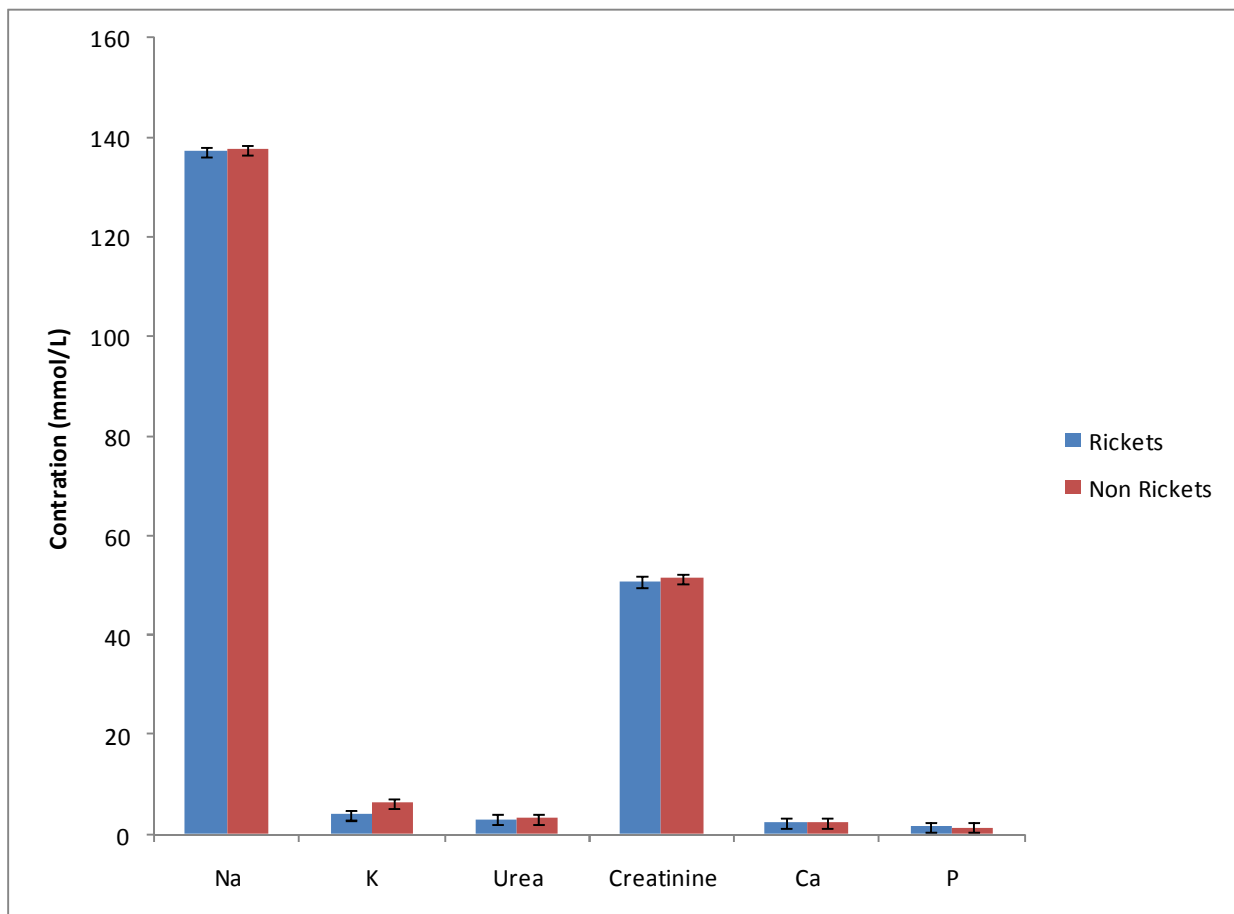


Figure 4. Mean (\pm) S.E.M Serum Biochemical parameters for Rickets and Non Rachitic Children in Gonin-Gora, Jankasa and Kaso communities.

urea were lowered while the serum values for phosphorus and creatinine were higher for rickets children compared to non-rachitic children. Although, nutritional rickets is often attributed to vitamin D deficiency; low calcium intake with high phosphorus is also an important cause of rickets in children (Kooch et al., 1977; Legiuse et al., 1989; Pettifor, 2004). In adequate phosphorus intake will lead to abnormally low serum phosphate levels (hypophosphatemia) which may result in rickets (Higdon, 2006).

Mean serum biochemical indices for rickets and non-rickets children in kaso community. The mean serum biochemical values for sodium, potassium, urea, creatinine, calcium and phosphorus showed that only potassium and calcium serum levels were significantly lowered in rickets children as compared to the non-rachitic children in Kaso community. The calcium level for the rickets children in this community is below the lower limit of the normal range. The serum phosphorus level is

higher than that of the non-rachitic children. These findings also implied nutritional rickets. The fact that the calcium level is below the normal value may explain why this community is mostly affected with the rickets scourge compared with Jankasa and Gonin-Gora. Access to medical facilities may also be low since it is far from Kaduna city compared with the other communities.

Mean serum biochemical indices for rickets and non-rickets children of jankasa: All the parameters determined for the children in Jankasa are within the normal range. However, the results still followed similar pattern. Calcium mean serum value was at the lower limit of the normal range while phosphorus was at the higher limit of the normal range. Higher serum levels were determined for the parameters of non-rachitic children compared with the rickets children except for phosphorus. Thus, implying inadequate intake of dietary calcium. Comparison of mean serum biochemical values for rickets and non-rickets children for the group analysis in Gonin-gora,

jankasa and Kaso communities. The values obtained for the group analysis in rickets and non-rickets children in Gonin-Gora, Jankasa and Kaso communities showed that serum calcium and sodium were significantly lowered in rickets children in all the areas. Calcium and phosphorus serum levels were significantly ($p < 0.05$) lowered for rickets children compared with non-rachitic children when the level were compared for these communities. The reduction was found to be between Kaso compared with the Gonin-Gora community. This again explained the reason for more rickets children identified in Kaso community. The mean serum calcium determined for the three communities were just at the lower level of normal range (A.B.U. Teaching Hospitals Chemical Pathology Department). This further implies the need for more calcium rich food intake in the communities.

The biochemical parameters in the three study settlements (Gonin Gora, Kaso and Jankasa) are low in serum calcium but high in serum phosphorus. The highest mean concentration of serum calcium was found to be $2.35 \text{ mmol/L} \pm 0.02$ (S.E.M) and it was observed in Jankasa. The low serum calcium with high serum phosphorus levels among infants and children has been shown to be attributed to the development of Rickets (Kooch et al., 1977; Legiuse et al., 1989; Pettifor, 2004). Rickets can also be caused by renal disease (renal osteodystrophy) due to disturbances in calcium and phosphorus (Nield, 2006). Further studies are on-going to check the metabolic defect or genetic link of the disorder in these communities.

In conclusion, the results of the determination of serum sodium, potassium, calcium, phosphorus, urea and creatinine in rickets and non-rachitic affected children in Gonin-Gora, Kaso and Jankasa communities might have resulted from the low or inadequate intake of dietary calcium coupled with high phosphorus intake in the communities which is in agreement with the results of Bakare-Odunola et al. (2012) in a different study. Surgical intervention may be necessary to repair severe bony abnormalities.

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