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Full Length Research Paper

Nutritional assessment of the diets in rickets prevalent communities in Kaduna State of Nigeria

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Absorption (SHIMADZU MODEL 650) was used to determine the levels of calcium and phosphorus in the food samples. Wet digestion method was adopted for the food samples preparation. The results obtained showed that calcium levels in all foods were low with mean values of 0.056±0.02, 0.069±0.04 and 0.127±0.06 mg\kg (S.E.M) in Gonin Gora, Jankasa and Kaso respectively. Phosphorous levels were high with mean values of 0.538±0.09 and 0.431±0.01 mg\kg (S.E.M) in Gonin Gora and Kaso respectively; compared with the allowable limit of 0.412 mg/kg. However, phosphorus concentration was low (0.261 mg/kg) in Jankasa. The low levels of calcium in foods or the low calcium intake with high phosphorus intake could be a contributing factor to the cause of the disorder in these settlements especially during the period of the children growth.

Key words: Nigeria, Kaduna state, rickets, food, calcium, phosphorus.

INTRODUCTION

Rickets is a bone disease of children, resulting in progressive softening and weakening of the bone structure as a result of loss of calcium and phosphate from the bone, which eventually causes destruction of the supportive gland matrix (Blok et al., 1998; Rowe, 2001; Rajakumar, 2003). Nutritional rickets can be caused by inadequate intake of nutrients (vitamin D in particular), calcium, or phosphorus, or inadequate sunlight exposure. It is common in dark-skinned children who have limited sun exposure and in infants who are breastfed exclusively. Vitamin D-dependent rickets - type I, results from abnormalities in the gene coding for 25(OH) D_3-1-alpha-hydroxylase, and type II results from defective vitamin D receptors. The vitamin D-resistant types are familial hypophosphatemic rickets and hereditary hypophosphatemic rickets with hypercalciuria. Other causes of rickets include renal disease, medications, and malabsorption syndromes. Rickets prevalence is reported to be on the increase in several countries (Finberg, 1979; Pettifor et al., 1981; Igbal et al., 1994; Muhe et al., 1997; Dux et al., 2001; Rowe, 2001; Delucia et al., 2003). There have also been increasing reports of nutritional rickets in healthy children without vitamin D deficiency (Muhe et al., 1997; Delucia et al., 2003).

In developing countries where calcium intakes are characteristically low and the population relies heavily on cereal-based staples, with few or no dairy products, dietary calcium deficiency appears to be the major cause of rickets among children outside the infant age group (Thacher et al., 2006).

Gonin Gora, Jankasa, and Kaso, are communities with high prevalence rate of rickets; there is hardly a family without a child afflicted with the disease. This work assessed the nutritional status of these communities in order to determine the adequacy of their diet.

MATERIALS AND METHODS

Measurements were made with a Buck model 210 variant giant pulse correction (UGP) system, and Atomic Absorption Spectrophotometer (AAS) equipped with calcium or phosphate

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hollow cathode lamp. Lamp current of 10 mA, wavelength 420.0 nm, band pass 0.5 nm with air/acetylene flame and stiochiometric fuel flow at 0.9 to 1.21 min^{-1} was used.

Description of sampling areas

The study areas/sampling points are areas most affected by the rickets disorder. These areas include: Jankasa, Kaso, and Gonin Gora, all in the southern part of Kaduna Metropolis. Jankasa and Kaso are rural land locked villages approximately 25 km along Kaduna- Kachia road while Gonin- Gora is a few kilometers from the metropolis along Kaduna-Abuja road. The inhabitants of these villages are 'Gbaygi, Kadara, Hausa and Fulani by tribe.

Sample collection and preservation

The water sample collection and preservation method as described by Department of Water Affairs and Forestry (DWAF), Hydrological Research Institute, Pretoria, South Africa (Analytical Methods Manual) and the vegetable/foods samples collection and preservation methods as described by Bakare-Odunola (2006) were adopted in this study. The treatment of both water and vegetables/foods samples, which were kindly provided by the occupants of the communities were done following the procedures described by Laboratory Procedure for Fertilizer and Water Analysis, Ahmadu Bello University, Nigeria, Training Workshop (Bakare-Odunola, 2006). The address and place of collection, date of collection, name of sample and time of collection were recorded at the collection sites. Samples were all collected in the Months of October and November 2006.

Official methods were used for the identification of calcium and phosphorus (British Pharmacopoeia, 2002)

Preparation of calibration curves for calcium and phosphorus

Calcium and phosphorus sample solutions were prepared by dissolving 5 g each of dried ground calcium/phosphorus in a digestion tube using 20 ml of digestion acid mixture (nitric acid, sulphuric acid and perchloric acid). The resulting solution was then heated at low temperature to avoid fuming and loss of volatile minerals. When the initial reaction subsided, the temperature of the digestion block was slowly increased to 200°C. This digestion was continued at this temperature with occasional shaking until there were no visible particles and the colour of the digestion acid was cleared. The temperature was allowed to rise from heating source to 240°C and evaporation of the digestion acid ensued. This was confirmed by the formation of white fumes within the digestion tube. The tube was removed from the heating source and the content was filtered through acid washed filter paper in a 100 ml volumetric flask using deionized water.

Working standard solutions of concentrations 0.001, 0.002, 0.005, 1.000, 2.000, 3.000, 4.000, and 5.000 mg/l each were prepared by dilution using deionized water. 5 ml of standard was drawn into a 25 ml volumetric flask. 10 ml of lanthanum was added to calcium standards while molybdate vandate was used as a complexing agent for phosphorus standards. The resulting solution was shaken and made up to the volume with deionized water. The solution of the mixture was aspirated into the flame and the absorbance was recorded.

Sample preparation for calcium and phosphorus

Each of the samples was weighed in duplicate (5 g) and added into series of weighed beakers labeled accordingly and treated as described under calibration curve.

5 ml of the digested sample was also treated as described for calibration curve of calcium and phosphorus. The concentration of calcium and phosphorus was determined from the respective calibration curve. The stability of the instrument was checked at intervals by introducing the lowest or the highest working standard solution and blank.

RESULTS

The results obtained for calcium concentrations are shown in Tables 1, 2 and 3, for Gonin Gora, Jankasa and Kaso communities respectively. Calcium concentration in all foods in the study areas were found to range from 0.00 to 1.30 mg\kg. The highest concentration of 1.300 mg\kg was determined in soya beans for Kaso area and calcium was not detected in kunu sample from Gonin Gora (Tables 1 and 3) respectively. Despite the different nature of the samples, the calcium concentrations have similar patterns. In Gonin Gora, the concentration was found to be high, compared to that of other study areas.

The result obtained for phosphorus concentrations are shown in Tables 4, 5 and 6 for Gonin Gora, Jankasa and Kaso respectively. The concentrations were found to range from 0.007 to 5.43 mg\kg. The lowest concentration (0.007 mg\kg), found in orange and the highest concentration (5.42 mg\kg), found in fish, were recorded in Gonin Gora. Jankasa and Kaso samples showed high concentration of phosphorus (Tables 5 and 6, respectively). Phosphorus levels were higher in all the study areas compared with calcium level. It was significantly low ($p < 0.05$) for Kaso.

DISCUSSION

The prevalence of rickets disease is lower in Gonin Gora compared with Jankasa and Kaso. Gonin Gora has a higher level of calcium in most of their food due to closeness of the village to Kaduna town which improved the standard of the diet in the community

The mean value of calcium level in Kaso was 0.127±0.066 mg\kg (S. E M.) which is higher than that of Gonin Gora and Jankasa since soya beans with high calcium concentration (1.30 mg/kg) formed part of their stable food which affecs the mean value of calcium levels. Despite the high mean value of calcium levels, the area was mostly affected with the disease than other communities. Nearly all families had a victim of rickets. It is possible that they do not take much of the soya bean meal or they have metabolic defect. The low calcium intake among infants and children has been attributed to the development of rickets (Kooh et al., 1977; Legius et al., 1989). Rickets among rural children has been reported to be attributed to low dietary calcium intake (Pettifor et al., 1978)

The health condition of Jankasa with the mean calcium value of 0.069± 0.045 mg\kg is better than Kaso but most

Table 1. Calcium levels (mg/kg) for different food samples from Gonin Gora settlement of Kaduna State.

S/N	Sample	Concentration of calcium
1	Tuwo	0.069
2	Gari	0.034
3	Kuka	0.156
4	Okro	0.044
5	Karkashi	0.045
6	Honey	0.001
7	Fish	0.223
8	Beef meat	0.000
9	Yoghurt	0.003
10	Nono	0.348
11	Orange	0.001
12	Yakuwa	0.048
13	Water	0.006
14	Yam	0.005
15	Kunu	0.000
16	Fura	0.032
17	Spinach	0.024
18	Cabbage	0.015
19	Potatoes	0.012

Mean = 0.056 ± 0.021 mg\kg.

Table 2. Calcium levels (mg/kg) for the different food samples from Jankasa settlement of Kaduna State.

S/N	Sample	Concentration of calcium
1	White kaura	0.018
2	Yellow kaura	0.008
3	Red kaura	0.012
4	Millet	0.021
5	Maize meal	0.042
6	Acha	0.008
7	Water	0.012
8	Beans	0.051
9	Patte	0.045
10	Nono	0.871
11	Groundnut	0.030
12	Fura	0.053
13	Maize	0.007
14	Yam	0.004
15	Sweet potatoes	0.021
16	Kuli kuli	0.016
17	Bread	0.002
18	Onion	0.032
19	Lettuce	0.054

Mean = 0.069± 0.045 mg\kg.

Table 3. Calcium levels (mg/kg) for different food samples from Kaso settlement in Kaduna State.

S/N	Sample	Concentration of calcium
1	White kaura	0.003
2	Red kaura	0.002
3	White beans	0.058
4	Black beans	0.047
5	Yam	0.013
6	Water	0.013
7	Gurjiya	0.021
8	Sweet potatoes	0.009
9	Maize meal	0.068
10	Tomatoes	0.006
11	Dadawa	0.022
12	Patte	0.189
13	Rice	0.010
14	Soya beans	1.300
15	Kindirmo	0.623
16	Gauta	0.015
17	Sesame seed	0.010
18	Millet	0.002
19	Bread	0.002
20	Eggs	0.014

Mean = 0.127± 0.066 mg\kg.

Table 4. Phosphorus levels (mg/kg) for different food samples from Gonin-Gora settlement of Kaduna State.

S/N	Sample	Concentration of phosphorus
1	Maize meal	0.310
2	Gari	0.034
3	Kuka	0.184
4	Okro	1.064
5	Karkashi	0.451
6	Honey	0.036
7	Fish	5.426
8	Beef meat	1.097
9	Yoghurt	0.036
10	Orange	0.007
11	Nono	0.068
12	Orange	0.080
13	Yakuwa	0.067
14	Water	0.053
15	Yam	0.080
16	Kunu	0.098
17	Fura	0.881
18	Spinach	0.056
19	Cabbage	0.193

Mean = 0.538± 0.283 mg/kg.

Table 5. Phosphorus levels (mg/kg) for different food samples from Jankasa Settlement of Kaduna State.

S/N	Sample	Concentration of phosphorus
1	White kaura	0.172
2	Yellow kaura	0.550
3	Red kaura	0.398
4	Millet	0.423
5	Tuwo	0.300
6	Acha	0.400
7	Water	0.016
8	Beans	0.333
9	Patte	0.037
10	Nono	0.026
11	Groundnut	0.262
12	Fura	0.110
13	Maize	0.360
14	Yam	0.000
15	Sweet potatoes	0.062
16	Kuli kuli	0.348
17	Bread	0.077
18	Onion	0.489
19	Lettuce	0.873

Mean = 0.262± 0.054 mg\kg.

Table 6. Phosphorus levels (mg/kg) for different food samples in Kaso settlement Kaduna state.

S/N	Sample	Concentration of phosphorus
1	White kaura	0.360
2	Red kaura	0.470
3	White beans	0.260
4	Black beans	0.228
5	Yam	0.073
6	Water	0.009
7	Gurjiya	0.234
8	Sweet potatoes	0.065
9	Tuwo	0.320
10	Tomatoes	0.765
11	Dadawa	1.264
12	Patte	0.390
13	Rice	0.173
14	Soya beans	0.338
15	Kindirmo	0.982
16	Gauta	0.376
17	Sesame seed	0.338
18	Millet	0.430
19	Bread	0.088
20	Eggs	0.400
21	Eguisi	1.484

Mean = 0.431± 0.084 mg\kg.

of the houses also have at least a victim of the rickets disease.

The levels of phosphorus in the foods were found to be generally higher than the levels of calcium for the communities. The functional consequences of this high intake of phosphorus in the presence of low calcium remain a topic of controversy (Sax, 2001). Wyshak (2000) reported that high phosphorus intake contributed to hypocalcaemia and fractures in children. The high phosphorus intake in the presence of low calcium could also be responsible for the problem (Thacher et al., 2000).

Rickets therefore remained common in many parts of the world and calcium deficiency, not vitamin D deficiency, was the important cause of the disease (Thacher et al., 2006; Graff et al., 2004).

Conclusion

In conclusion, most staple food in the three communities (Gonin Gora, Kaso and Jankasa) are low in calcium but high in phosphorus. The low levels of calcium in the foods and/or the low calcium intake with high phosphorus intake could be the major cause of the disease in these communities, especially during the period of child growth.

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