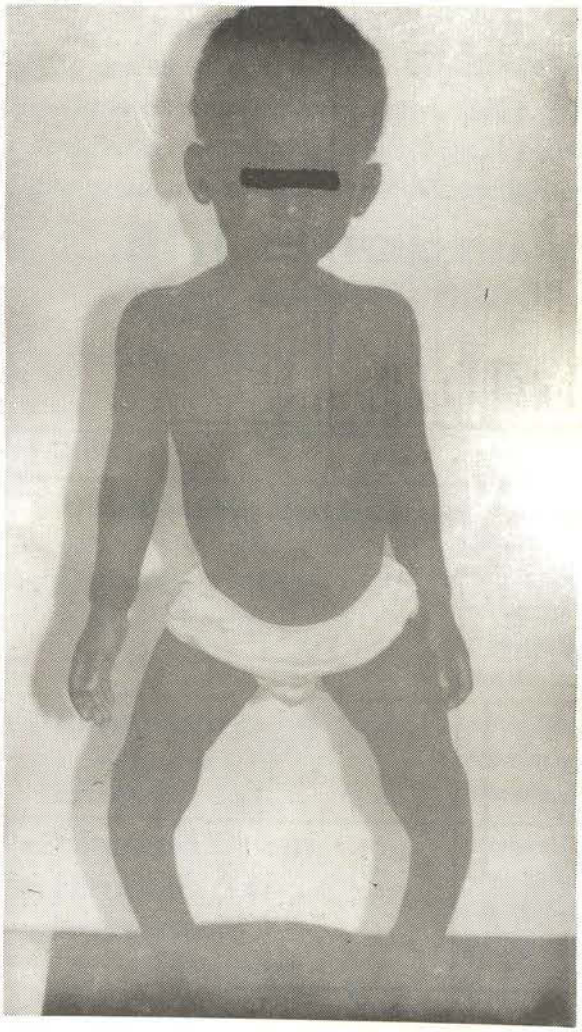
Figure 3: Gross Bowing of the Legs and Prominence of the wrists in one of our Patients



diagnostic. See figures 4, 5 and 6. Figure 7 is that of one of the patients taken four weeks after starting treatment to assess healing.

DISCUSSION

Nutritional rickets is the commonest of the varieties of this bone disease. Its diagnosis, clinical, radiologic or biochemical laboratory findings, has remained essentially unchanged over the decades[1,4,8-11]. Assessment of blood levels of Vitamin D metabolites may be helpful parameters in the confirmation of refractory forms of rickets; but their prohibitive costs prevent their routine use; especially in third world countries. The refractory types of rickets are uncommon[13-15].

Florid nutritional rickets when diagnosed, requires adequate vitamin D in the dosage of 600,000 international units (iu) given intramuscularly[6,10]. Hypervitaminosis is unlikely and problems of non-compliance arising from multiple injections are avoided[8,11]. Dietary corrections are also advised to ensure provision of adequate food sources of calcium and phosphates.

Figure 4: Diagnostic X-rays of the Wrists and Ankes. *(See the cupping and fraying at the distal ends of the bones in the lower arms and legs.)*

Figure 5. Cupping and Fraying of Wrist Bones

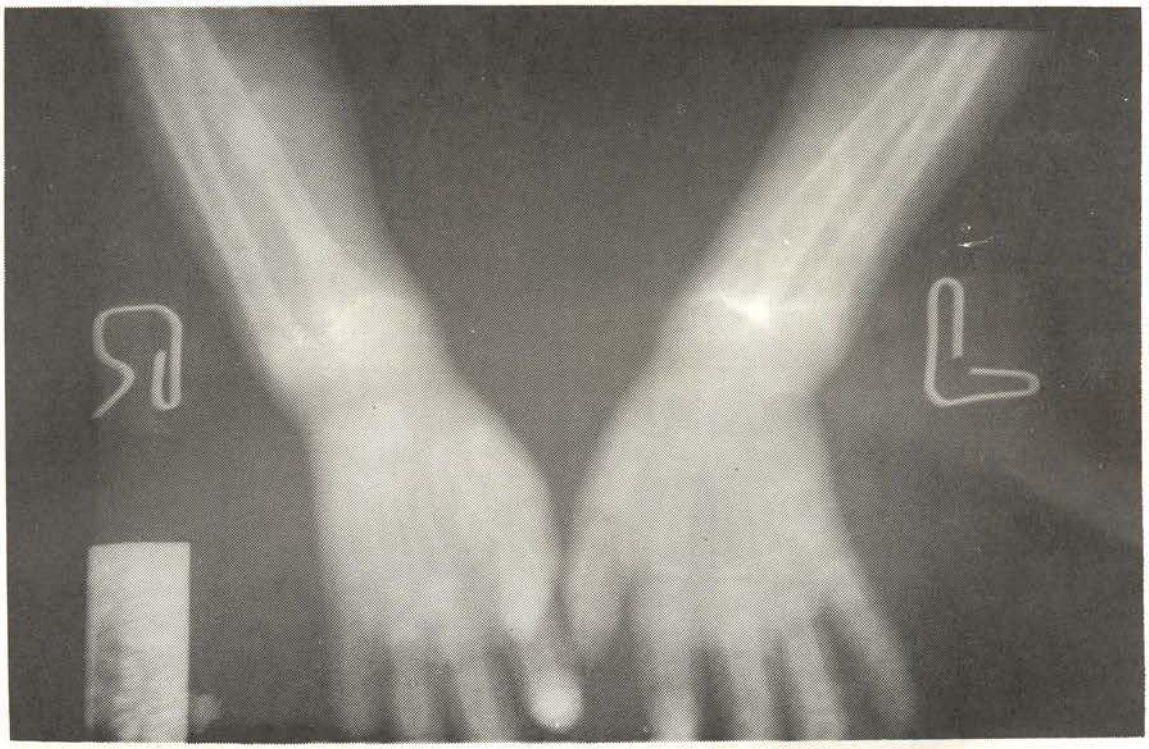


Figure 6: **Serum Levels of Calcium, Inorganic phosphate, Alkaline phosphatase and (Ca x Pi) plotted against Ages in Months**

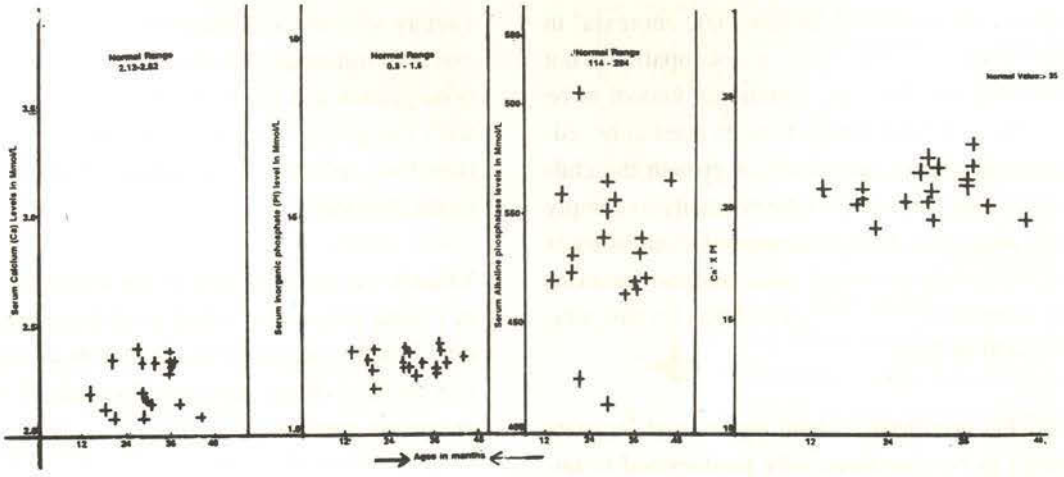
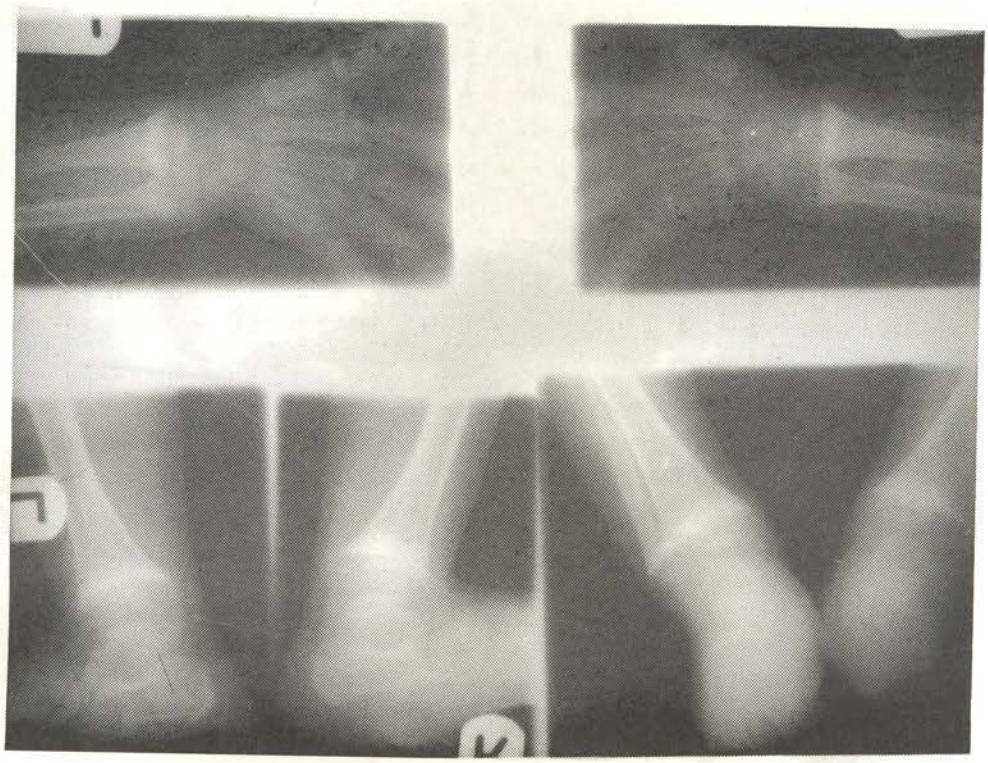


Figure 7: Changes in Recovery, Four Weeks After Starting Therapy



Early clinical as well as radiologic responses are noticeable and impressive within weeks of starting treatment[10,11]. See figure 4. The disorder is prevalent between the ages of 1-3 years. All our cases were in this age group. These ages fall on the plateau of the growth curve. This is when the growth rate is at its lowest; the period of "psychologic anorexia" in child development[9]. The child's preoccupation is not toward eating and they are commonly known to be "Picky" eaters at meal times. Parents need to be educated to understand this phase of growth the children are passing through and the necessity to comply with the advice to daily recommended allowances (DRA) for certain essential minerals and vitamins such as vitamin D[4,9-11,18,21]. The DRA for this vitamin D is 400 iu daily.

Arabs of the Northern African region and Negroes are known to be constitutionally predisposed to nutritional rickets[4,7,8,11]. All our eighteen (18) cases are dark-skinned Ghanaian children; among them are two siblings and a pair of identical female twins and our cases involved children of all socio-economic strata.

Dietary sources in developing countries are poor in essential minerals and vitamin D needed for skeletal bone growth and teeth formation. This fact, coupled with the growth patterns seen in early childhood therefore reduces their supply of these essential items drastically.

Vitamin supplementation is not routinely practised in Ghana and a number of over-the-counter (OTC) multivitamin preparations obtainable in our pharmacies do not contain adequate amounts of vitamin D or contain none at all[22].

Of the five (5) cases who were diagnosed on the ward, only two (2) were admitted because of malnutrition. One of these two, also tested positive to human immune deficiency virus antibodies (HIV) together with his mother. The others were on admission for non-nutritional disease disorders. Two had carpopedal spasms on the ward. They both responded to a bolus of Vitamin D given in a single injection and dietary counselling.

ACKNOWLEDGEMENTS

We wish to thank Prof. Jonathan N. Addy for his support and guidance. The secretarial staff in the Department of Child Health, University of Ghana Medical School and Ms. Gifty Laryea are also mentioned for typing the manuscript. Mr. N.O. Quao and his staff at Medical Illustration Unit are also appreciated for assisting us produce figures in this paper.

REFERENCES

1. Dunne K.B. and Clarren S.K. The origin of prenatal & postnatal deformities. *Ped. Clin. of N. Amer.* 1986; **33:** 1277-1297.
2. Okonofua F. *et al.* Rickets in Nigerian Children: a consequence of calcium malnutrition. Metabolism: *Clinical & Experimental.* 1991; **40:** 209-213.
3. Davidovits M. *et al.* Calcium - deficiency rickets in a four year-old boy with allergy. *Journal of Paediatrics.* 1993; **122:** 249-251
4. Feldman E.W. *et al.* Nutritional rickets. (Reviews) *American Family Physician.* 1990; **42:** 1311-1318.
5. Alfin-Slater R.B. and Jolliffe D.B. Nutritional requirements With Special reference to infancy. *Ped. Clin. of N. Amer* 1977; **24:** 3-16
6. Harrison H.E. Disturbances of calcium and phosphate metabolism. In Paediatrics. Barnett H.L. and Eihorn A.H. (Ed) 14th ed. 1968; Meredith Corp. N.Y. 369-391.
7. Stephens A.J.H. Vitamin D and rickets. In Paediatrics in the Tropics: Current review. Hendrickse, R.G. (Ed). Reprint. 1984; Oxford Med. Pub. Oxford. 132-135.
8. Davidson Stanley Sir. Nutritional disorders. The Principles and practice of medicine. 9th ed. 1971; E & S Livingstone Ltd. Edin. & Lond. 250-258.
9. Watson E.H. and Lowery, G.H. Growth and Development of Children. 5th ed. 1967 Year book. Med. Pub. Inc. Chicago.
10. Barness L.A. Nutritional disorders. In Nelson Textbook of Paediatrics. Vaughen V.C. and Mckay R.J. (Ed) 10th ed. 1975; W.B. Saunders Co. Phil-Lond-Toronto, 183-206.
11. Caffey J. and Silverman F.N. Bone in Avitaminosis. Paediatric X-ray Diagnosis. 5th ed. Tear book Med. Inc. Chicago, 1970; 973-993.
12. Kooh S.W. *et al.* Ultraviolet irradiation for hepatic rickets Arch. Dis. Child. 1989, **64:** 617-619.
13. Bergstrom W.H. and Gardner L.I. Metabolic disorders with bone lesions. In Nelson Textbook of Paediatrics. Vaughan V.C. and Mckay R.J. (Ed) 10th ed. 1975; W.B. Saunders Co. Phil-Lond-Toronto, 1503-1513.
14. Kaplan F.S. *et al.* Osteopetrorickets. The Paradox of plenty. Pathophysiology and treatment. *Clinical orthopaedic & related research.* 1993; **294:** 64-76.
15. Konishi. K. *et al.* Hypophosphatemic osteomalacia in von Recklinghausen neurofibromatosis. *Amer. Journal of the Medical Sciences.* 1991; **301:** 322-328.

16. Dagnelie P.C. *et al.* High prevalence of rickets in infants on macrobiotic diets. *Amer. Journal of Clinical Nutrition.* 1990; **51:** 202-208.

17. Borgstedt A.D., Bryson M.F., Young L.W., Forbes G.B. Long term administration of antiepileptics and development of rickets. *Yearbook of Ped.* 1974; 366-368.

18. Gellis S.S. Vitamin D deficiency rickets in two Bread-fed infants who were not receiving vitamin D supplements. *Year book of Ped.* 1979; 306-307.

19. Castile R.G., Marks L.J., Stickler G.B. Vitamin D deficiency rickets; Two cases with faulty feeding practices. *Year book of Ped.* 1977; 60-61.

20. Pitt M.J. Rickets and Osteomalacia are still around. (Review) *Radiological Clin. of N. Amer.* 1991; **29:** 97-118.

21. Specker B.L. *et al.* Prospective study of Vitamin D supplementation and rickets in China. *Journal of Ped.* 1992; **120:** 733-739.

22. Gyesie, A. Medical Index of pharmaceutical specialities in Ghana. 1991; **1:** 65-70