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Rickets in Tehran

Study of 200 cases

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Salimpour, R. (1975). *Archives of Disease in Childhood*, **50**, 63. **Rickets in Tehran: study of 200 cases.** Radiologically diagnosed rickets was found to be common in children of the poorer classes in Tehran. It was frequently associated with gastroenteritis or bronchopneumonia and a large proportion of the children were severely underweight for their age. In children below the age of 1 year malnutrition tended to mask the signs of rickets. Convulsions were much less frequent in the malnourished children; the concentration of calcium in the serum was higher and that of alkaline phosphatase was lower than in those who were well nourished. Biochemistry is of little value in the diagnosis of rickets in the presence of malnutrition.

In spite of the large amount of sunshine, rickets is a common disease in children in Tehran. A small pilot study was made in March 1966 in the Shahrazad Children's Hospital, a charity hospital admitting children mainly from the lowest income group. In 82 consecutive *x*-rays of the wrist in children under 5 years old admitted to this hospital, 12 showed evidence of rickets, an incidence of 15%.

Because of this relatively high incidence, a more systematic study was made in the following 7 years. This paper summarizes the findings in 200 children in whom rickets was diagnosed radiologically. All children in the series had *x*-rays of the wrist and chest, with further radiological investigations whenever indicated. Evidence of rickets was found in the ulna in all 200 cases, and in the radius in 188. In many patients radiological changes in the ribs gave the first clue to the diagnosis of rickets.

Biochemical measurements were made in a number of cases, but no attempt was made to diagnose rickets on biochemical grounds alone, without radiological changes, in view of the difficulty of interpreting alterations in serum calcium, inorganic phosphate, or alkaline phosphatase in the presence of malnutrition, subclinical scurvy, or acute infectious diseases (Park, 1954).

Chemical methods

Venous blood was centrifuged soon after withdrawal. Serum inorganic phosphorus was measured by the method of Fiske and Subbarow (1925); serum calcium was measured by a modification of the method of Bett and Fraser (1959), using the Oxford reagent. Alkaline phosphatase was estimated by a modification of the method of Bessey, Lowry, and Brock (1946) (Andersch and Szczpinski, 1947).

Clinical findings

The sex distribution was 127 males to 73 females. The age range is shown in Table I, 60% being between 4 and 12 months of age. Distribution of admissions according to time of year is shown in the Fig., the majority of patients being admitted in the spring and early summer.

TABLE I

Age of admission in 200 cases of rickets in Iran

Age	No. of cases
0– 2 m	1
3– 5 "	20
6– 8 "	63
9–11 "	21
12–17 "	41
18–23 "	12
2– 3 yr	21
3– 4 "	12
4– 6 "	7
Adolescents (13 and 14 yr)	2
Total	200

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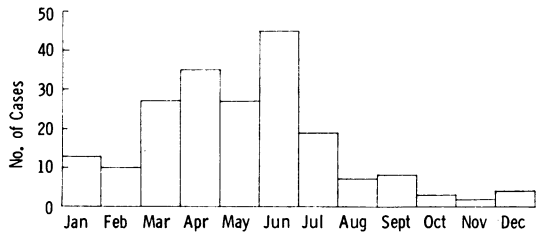

FIG.—*Month of admission of 200 cases of radiologically proven rickets in Tehran.*

The presenting symptoms and signs were classified in three groups. Respiratory symptoms and signs were the commonest complaint (36%), and convulsions the next most common (25%). 54 children were admitted for complaints which could not be attributed directly to rickets, most commonly diarrhoea. In 113 children measurements of body weight were available. In 88 of these (78%) the weight was at or below the Harvard 3rd centile (Nelson, 1959). In only 4 cases was it above the 50th centile. Thus, the majority of the children were undernourished or malnourished.

In nearly 75% of the children rickets was found to be associated with some infective condition, most commonly bronchopneumonia or gastroenteritis. Enlargement of the liver and/or spleen, for which no obvious cause was found, was observed in about 10% of cases, and 5% had finger clubbing. Many children were anaemic, some severely so. Haemoglobin concentration ranged from 2·7 to 15·0 g/dl.

Biochemical measurements were made on only a proportion of the children. The results are shown separately in Table IIA and B for two different age ranges. They are also related in Table II to the severity of malnutrition which, following the classification of Gomez *et al.* (1956), is graded according to the deficit in weight for age by comparison with the Boston standards (Nelson, 1959). Table IIA shows that in the age group 0–12 months the well-nourished children were more prone to convulsions. As the children became more malnourished the frequency of convulsions fell. The serum calcium concentration tended to rise, while the levels of inorganic phosphorus and alkaline phosphatase fell. In order to test the significance of the association between nutritional state and convulsions, it was necessary because of the small numbers to amalgamate groups 0 and I and groups I and II. Fisher's exact test for 2×2 contingency tables shows $P = 0{\cdot}044$ (2-tailed test), which is significant. The differences in serum calcium between the groups are not significant. The differences in alkaline phosphatase between the well-nourished children (group 0) and the more severely malnourished ones (groups II and III) are significant ($0{\cdot}05 < P < 0{\cdot}01$). The serum inorganic phosphate concentration is also significantly higher in group 0 than in groups II and III ($0{\cdot}01 < P < 0{\cdot}001$).

All the children between 13 and 36 months old (Table II) were malnourished, the majority severely. In this age group there was no relation between the biochemical findings and the nutritional state. Serum calcium levels were in general higher than in the younger children, and convulsions were less common.

All the children were treated with vitamin D. At the beginning of the study it was given orally in a dose of 5 000 IU daily, but as the response was poor the treatment was altered to a single intramuscular dose of 600 000 IU. A control *x*-ray of the wrist was taken after 2–3 weeks. In some cases, mainly in the severely malnourished group, further

TABLE II

Biochemical findings in children with rickets, classified according to grade of malnutrition

	A. Age 0–12 m				B. Age 13–36 m		
Grade of malnutrition	0	I	II	III	I	II	III
No. of children	5	7	11	8	6	7	13
No. with convulsions (%)	3 (60)	3 (43)	2 (17)	0	2 (33)	0	1 (8)
Serum calcium (mg/100 ml) (mean ± SD)	7·27 ±2·8	6·87 ±1·22	8·16 ±1·50	8·26 ±1·48	9·78 ±0·78	9·19 ±0·62	8·67 ±1·82
Serum Po_4 (mg/100 ml) (mean ± SD)	5·94 ±2·17	3·81 ±0·79	2·52 ±0·81	2·57 ±0·99	3·54 ±1·39	3·46 ±0·87	2·56 ±0·71
Alkaline phosphatase (BLB units/ml) (mean ± SD)	16·7 ±3·0	12·4 ±3·8	7·3* ±5·9	8·0 ±5·2	10·2 ±8·0	5·7 ±2·2	12·1† ±5·8

*Omitting 1 value of 34 units.
†Omitting 1 value of 79 units.

intramuscular doses of vitamin D were given, but no more than three doses were ever required. When repeated dosage was necessary, control measurements were made of serum calcium and phosphorus concentration. 8 children in the series died.

Appropriate treatment was given for concomitant diseases. The children were discharged to their homes after follow-up *x*-ray of the wrist showed healing of the rickets, but 8 children were discharged before complete recovery because their parents refused further treatment.

Discussion

In Tehran there is plenty of sunshine throughout the year, and therefore the high incidence of rickets is unexpected. However, there is less sun in the winter months, from October to January, when it is also very cold. Most of the children in this study belonged to families of the lower socioeconomic classes, who live in high-walled, sunless houses. In several such families there was more than one rachitic child. Children are kept indoors for most of the first year of life, and when they go out in the winter they are well wrapped up. The seasonal pattern of admissions, with the highest incidence in spring and early summer, is similar to the seasonal variation in serum 25-hydroxycholecalciferol described by Gupta, Round, and Stamp (1974). This suggests that lack of sunlight, in the absence of an adequate dietary intake of vitamin D, is the main causal factor. Most of the children were breast-fed for the first year, and breast milk is a poor source of vitamin D. Other factors may contribute as well; bread, which in Iran contains large amounts of phytic acid, is introduced into the infant's diet at an early stage. Diarrhoea, which is extremely common in young children in Tehran, may also interfere with the absorption of calcium.

The incidence of rickets in patients admitted to this hospital was 15%, based on radiological criteria. The true incidence would probably have been higher if biochemical and radiological changes had not been masked by malnutrition and/or acute infections. We have observed normal serum calcium, phosphorus, and alkaline phosphatase concentrations in many rachitic children with malnutrition, especially in advanced cases. Budiansky (1949) and Reddy and Srikantia (1967) have also described normal alkaline phosphatase levels in malnourished children with rickets. Serum biochemistry, therefore, cannot serve as a diagnostic tool in such cases.

Malnutrition may also mask the changes in bones. It is well known that rickets does not occur in florid coeliac disease, in spite of the malabsorption of calcium. In kwashiorkor rickets may appear for the first time during recovery, when vitamin D becomes a limiting factor in growth.

The degree of anaemia is striking in the children of this series. The anaemia coupled with hepatosplenomegaly, which responds to vitamin D, needs further investigation. Finger clubbing has not previously been mentioned as a clinical feature of rickets. The present study suggests that this may be a fairly common sign in advanced rickets.

The large number of rachitic children suffering from bronchopneumonia (43%) was an unexpected finding. However, the work of Muftu, Cikrik, and Tinaztepe (1972) in Turkey has shown the role of vitamin D deficiency in causing lung lesions in rats—mainly emphysema, atelectasis, alveolar haemorrhage, and hyperaemia. The large size of the fontanelle in many of the children, combined with irritability and convulsions sometimes led to the mistaken diagnosis of meningitis at the time of admission.

These results suggest that rickets in Iranian children may be classified into three groups.

(1) Classical rickets, in which the children are of average nutrition or even apparently fat, with slight rachitic rosaries, large abdomen, and biochemical and early radiological evidence of rickets; these children respond well to vitamin D. Presentation is usually with convulsions.

(2) Thin, malnourished children with obvious rachitic rosaries, deformed chest, bone deformities, hepatosplenomegaly, anaemia, clubbing, and pulmonary infection. These children present mostly as failure to thrive or as cases of chest infection. They may have normal serum concentrations of calcium, phosphorus, and alkaline phosphatase. For treatment they may need 2–3 doses of vitamin D, 600 000 IU, intramuscularly.

(3) Intermediate cases.

Of practical importance is the fact that when children are severely malnourished the radiological and biochemical changes of rickets may not appear until treatment has been instituted with a high protein, high energy diet, and growth is restored. In such cases the presence of vitamin D deficiency may not be appreciated at first, and the diagnosis may be delayed.

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