Prevalence of Rickets and Certain Associated Risk Factors Among Children Under Five Years of Age Attending the Outpatient Clinic of Maternity and Children Teaching Hospital in Ramadi City

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Abstract

Objective: this study is an attempt to search for prevalence, risk factors and diagnostic criteria of rickets among children under 5 years of age, attending the outpatient clinic of Maternity and Children Hospital in Ramadi city.

Subject and Methods: Four hundred children under 5 years of age, attending the outpatient clinic of Maternity and Children Hospital in Ramadi city over a period of 2 months(1st of December 2001 to the end of January 2002), were selected randomly and studied for the prevalence of rickets and certain associated risk factors. Diagnosis of rickets was based on clinical, biochemical and radiological findings of active disease. One hundred twenty six children matched for age and sex who had no evidence of rickets, were used as control.

Results: The prevalence of rickets for children attending the outpatient clinic was 10.5% and its 95% confidence interval was 7.8 -13.8%. The majority of cases (97.6%) were within the age range from 3-24 months. The exclusive breast feeding, small houses, apartments and urban areas were found as a significant risk factors for developing rickets ($p< 0.001$, $p=0.04$, $p=0.01$ and $p=0.02$ respectively). Widening of the wrist at all age groups was detected in 69% of rachitic subjects. The mean of serum alkaline phosphatase significantly increased while the mean of serum calcium and phosphorus significantly declined by increasing radiological severity of rickets ($p <0.001$).

Conclusion: vitamin D deficiency rickets still represents an important health problem in our area. It is mostly seen in children under the age of 2 years. The exclusively breast fed infants or those living in apartments or small houses in urban areas are more prone to develop rickets. Widening of the wrist seems to be a good clinical sign for the diagnosis of rickets, and serum alkaline phosphatase appears as the best available indicator for the diagnosis of rickets and its severity.

Key words: Rickets. Under 5 years. Ramadi. Iraq.

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Introduction

Rickets is the term signifying failure in mineralization of growing bone or osteoid tissue[1]. Lack of vitamin D will impair bone formation and growth so that biochemical and radiological abnormalities may precede the clinical signs[2].

At the end of 19th century, rickets was a major scourge of children in developed countries; 80% of infants under the age of 2 years at infant hospital in Boston in 1898 had physical stigmata of rickets[3]. In the first three decades of the last century, the predominant cause of rickets was vitamin D deficiency due either to inadequate direct exposure to ultraviolet rays in sunlight or the inadequate intake of vitamin D, or both[1].

During the last 20-30 years nutritional rickets, due to vitamin D deficiency has almost disappeared from the developed countries but still exist in some countries[4]. Though virtually eliminated from Europe and North America by fortification of foods with vitamin D, nutritional rickets remains prevalent in many parts of the world including Africa, the India subcontinent[5], Asia [6], and the middle East[7].

Rickets has been ranked among the five most prevalent diseases among children in developing countries[8]. Its occurrence is probably highest in many tropical and subtropical countries, despite the abundant sunlight[9]. Social and cultural customs including the adherence to a special often vegetarian diet, avoidance of sunlight by continuous wrapping of children and keeping them indoors, together with increasing urbanization, malnutrition, and extending breast feeding are best recognizable factors in the pathogenesis of rickets in these subtropical and tropical countries[9,10].

In our practice we still see a lot of cases of rickets especially between the age of 6 months and 2 years .Previous studies in Iraq were hospitalized descriptive studies[11,12].

This study is an attempt to search for prevalence, risk factors and diagnostic criteria of rickets among children under 5 years of age, attending the outpatient clinic of Maternity and Children Hospital in Ramadi City.

Subjects and Methods:

Children under 5 years of age attending the outpatient clinic of Maternity and Children Teaching Hospital in Ramadi city, were studied for prevalence of rickets and associated risk factors over a period of 2 months from 1st December 2001 to the end of January 2002.

Four hundred children were studied for the following : age, sex, residency, type of housing, family size, gestational age at birth, type of feeding, vitamin D supplement, age of walking and teething, certain anthropometric measures (weight, length and occipio-frontal circumference) .Careful examination for physical signs of rickets (widening of the wrist , craniotabes , caput quadratum , genu valgum , genu varum , anterior bowing , ricketic rosary , and Harrison sulcus). [1]

Diagnosis of rickets was based on clinical, biochemical and radiological findings of active disease. Radiological examination of the ends of long bones at the wrist joint was done and it was assessed by Radiologist, the positive findings were classified according to the severity of rachitic changes into 3 Grades[14]: Grade I: the first sign is an increased distance between the calcified tissue in the epiphysis and metaphysic.

Grade II: the end of the metaphysic widens and the noncalcified zone assumes a saucer shape, the rachitic cup.
Grade III: generalized cortical bone changes, thinning and lack of definition of cortical bone.

Venous blood samples were collected into disposable plastic tubes, without tourniquet from all children, and examined in the laboratory of the Maternity and Children Hospital in Ramadi city. Serum calcium and serum phosphorus were measured by using specific kits (biomerieux)[15,16], and serum alkaline phosphatase was measured by that of King and Armstrong method[17]. Serum calcium and phosphorus below 8.8mg/dl and 4 mg/dl respectively considered as abnormally low[18], while serum alkaline phosphatase above 27.5 KAU was considered as abnormally high[19].

One hundred twenty six children matched for age and sex who had no evidence of rickets were used as control.

Statistical analyses were done using SPSS version 7.5 computer software (Statistical Pakage for Social Sciences) in association with EPI- info ver6.22. The odds ratio (OR) was used to study the risk of having rickets in the presence of certain risk category to a reference category (the category with the lowest risk). To have an idea about the prevalence of rickets in the target population, the 95% confidence interval of a sample proportion was used.

The statistical significance of association between 2 categorical variables was assessed by Chi-square test, and when the criteria for a valid Chi-square test was not fulfilled (Low expected frequencies), Fisher's exact test was used. The statistical significance of difference in mean of certain continuous dependent variable between 2 groups was assessed by independent samples t-test, while between more than 2 groups ANOVA test was used.

The strength and direction of linear correlation between 2 continuous variables was assessed by Pearson correlation coefficient. P value less than 0.05 was considered statistically significant.

Results

Four hundred children under 5 years of age, attending the outpatient clinic of maternity and Children Hospital in Ramadi city, were studied for prevalence of rickets over a period of 2 months, 42 (10.5%) of them were found to have rickets (23of them were males and 19 were females). There was no significant sex difference among rachitic subjects as male: female ratio was 1.2:2 (p=0.84).

Table 1 shows the prevalence of rickets with its 95% confidence interval at different age groups. Of the 42 rachitic cases, 97.6% were within the age range from 3-24 months, while the remaining 2.4% of cases were in the range from 25-30 months of age. No cases were observed in infants under 3 months of age or children over 30 months of age. Widening of the wrist was found in 69% of our cases at all age groups and all cases who had craniotabes were under 6 months of age, while the frequencies of other physical signs were variable, figure 1.

The risk of preterm infants to have rickets was 1.5 times more than full term, but the calculated OR was not significant statistically (p=0.38), table 2. However, 77% of all studied preterm infants were on fortified formula or mixed feeding, also 54% and 66% of whom had received more than three eggs per week and regular vitamin D supplementation respectively.

Regarding housing, apartments and small houses showed 4.3 and 2.8 times risk for developing rickets (p=0.01 and p=0.04 respectively) than large houses. On the other hand children in urban area had 2.4 times risk than those in rural area (p=0.02).

Children with irregular or no vitamin D supplementation had 4.6 times more risk to have the disease than those with regular supplementation (p=0.03). however, the educational state of the parents and the family size showed no significant risk, table 3.

The exclusive breast feeding was found as a significant risk factor for developing rickets among both age groups; under 6 months and 6-24 months (OR 230, p<0.001 and OR 18, p=0.001 respectively). Of the latter age group, breast fed children receiving 3 eggs or less per week had 15 times risk to have rickets than those receiving more than 3 eggs per week (p=0.004). In both age groups, the fortified formula and mixed feeding showed no significant risk, table 4.

There were no significant differences in weight, length and occipito-frontal circumference among rachitic subjects as compared to control ones, table 5.

The mean age of teething, and walking was significantly delayed among rachitic subjects as compared to control ones (p=0.002 and p<0.001 respectively), table 6. The linear correlation of age of teething with that of walking was strong among rachitic subjects, but no such correlation was found among control subjects (r=0.46, p=0.21 and r=0.002, p=0.91 respectively), figure 2 &3.

The mean of serum alkaline phosphatase value was significantly elevated while the mean of serum calcium and phosphorus significantly declined by increasing radiological-severity of rickets (p<0.001), table7. The linear correlation of serum calcium and phosphorus value in relation to serum alkaline phosphatase value was significantly strong among rachitic subjects, while it was weak among control ones (r=0.83, p<0.001, and r=0.18, p=0.04 respectively), figure 4 & 5.

Discussion

Nutritional rickets due to vitamin D deficiency continues to be a worldwide problem [(9)]. In the present study, the prevalence of rickets in children under 5 years of age attending the outpatient clinic was found to be 10.5% and its 95% confidence interval (7.8-13.8%) gives an idea about the prevalence of rickets in the larger population. It appears that this disease still represents an important health problem in our area compared with industrialized countries where it is rare[(1)], while its prevalence is less than that found in certain developing countries (15-50%) [(20,21,22)]. Various reasons have been advanced to explain its occurrence in these countries despite abundant sunlight, including inadequate dietary vitamin D, reduced vitamin D production in darkly pigmented skin and inadequate sunlight exposure because of air pollution, infants remaining indoors, or infants being excessively covered when outside[(5)].

The vast majority of cases were within the age-range from 3-24 months, and this is consistent with other studies [(11,23,24)]. Therefore, vitamin D deficiency rickets is mostly seen in children under the age of 2 years, and this may be due to inadequate vitamin D nutrition in infancy resulting from very low vitamin content of maternal milk, early vitamin depletion in infant born of vitamin D depleted mothers and the absence of regular exposure to sun in many infants[(25)].

The prematurity was found to have no significant risk for developing rickets in our study, while it is well known that rickets is more common in premature infants due to rapid growth [(1,26)].

This may be explained by finding that 77% of all studied preterm infants were on fortified formula or mixed feeding, also 54% and 66% of whom had received more than 3 eggs per week and regular vitamin D supplementation respectively; therefore these factors together may be regarded as preventive measures.

This study, showed that children who are living in apartment, or small houses and in urban areas had significant risk to have rickets as compared to those who are living in large houses and rural areas, while the educational state of parents showed no significant risk. It is suggested that inadequate sunlight exposure in apartments, small houses and urban areas is probably responsible for increasing the risk for developing the disease. Further, generally those living in urban areas with small houses or apartments have less economic resources to get food rich in vitamin D, due to the effect of economic sanction on Iraq. On the other hand, living in large houses and rural areas provided adequate sunlight exposure and hence no significant risk for developing rickets among children of less educated parents like farmers who have good income and can offer their children diet rich in vitamin D.

Widening of the wrist was found in 69% of cases at all age groups and all cases who had craniotabes were under 6months of age, this is similar to other studies[27,28]. Hence, widening of the wrist at all age groups and craniotabes in those under 6 months of age are good clinical signs for the diagnosis of rickets. Further, our cases had significantly delayed age of walking and teething with strong linear correlation, and this can be explained by the lack of muscle tone observed in children with rickets in addition to poor bone and teeth mineralization[1].

The majority of cases (70%) were breast fed. Similar such observation were reported by Erfan et al [23], and Lubani et al[29].

Further, kreiter et al[30], recommended to supplement all dark skinned breast fed infants and children with 400 IU of vitamin D per day, starting at least by 2 months of age. The total vitamin D concentration in human milk is 15-50 IU/L[31,32], which is too low to provide the recommended daily requirement[33]. Maternal vitamin D status is the major factor regulating the vitamin D content of human milk[34]. However, even vitamin D supplementation of the mother may not raise the infant's 25-hydroxyvitamin D level sufficiently to prevent rickets[35,36,37].

This study showed that the formula fed infants and those who received more than 3 eggs per week in addition to breast feeding had no significant risk to have rickets, since most commercially prepared milk for infant formulas are fortified with vitamin D10µg/l of milk; on the other hand, eggs are good natural source for vitamin D, as each 1 g of egg yolk contains 3-10µg of vitamin D[1].

In the present study, increased serum alkaline phosphatase was found to be a constant finding in vitamin D deficiency rickets. This is consistent with other studies[11,23,30,38]. Furthermore, the present results suggest that serum alkaline phosphatase can be considered as a good biochemical indicator for assessing the severity of rickets. The significantly strong linear correlation of serum calcium and phosphorus value in relation to serum alkaline phosphatase, explained the biochemical abnormalities with subsequent radiological and clinical changes that occur in rachitic subject.

We conclude from this study that vitamin D deficiency rickets still prevalent in Ramadi city although it has abundant sunlight, particularly in those under 2 years of age. Exclusively breast fed infants, and those who are living in apartments or small houses in urban areas are more prone to develop rickets. This reflects the need for oral supplementation with vitamin D in infancy and public awareness about the importance of sunlight exposure and introduction of vitamin D rich diet particularly regular egg supplementation. Widening of the wrist seems to be a good clinical sign for the diagnosis of rickets , while serum alkaline phosphatase appears to be the best available indicator for the diagnosis of rickets and its severity.

Table 1: The prevalence of rickets with its 95% confidence interval by age

N	Prevalence of rickets		95% Confidence interval Age in months
	%	for revalence	
<6 (n=109)	13	11.9	6.5-19.5
6-12 (n=115)	16	13.9	8.2-21.6
13-18(n=55)	9	16.4	7.8-28.8
19-24(n=36)	3	8.3	1.7-22.5
25-30(n=24)	1	4.2	0.1-21.1
30+(n=61)	0	0.0	*** ***
Overall (n=400)	42	10.5	7.8-13.8

Table 2: The difference in the relative frequency of preterm gestational age between rachitic and non-rachitic subjects

Gestational age	All subjects	rachitic	non-rachitic
Full term	387	40	347
Preterm	13	2	11
Total	400	42	458

OR = 1.5 P = 0.38*[NS]*

Table 3: The differences in the distribution of rachitic and control subject by different variables (risk factors)

Characteristics	Rachitic Subjects		Control Subjects		OR	P
	No.	%	No.	%		
1. Type of Housing						
Large house	12	28.6	68	54	Ref*	***
Small house	27	64.3	54	42.8	2.8	0.04
Apartment	3	7.1	4	3.2	4.3	0.01
2. Residency						
Rural	17	40.5	78	62	Ref	***
Urban	25	59.5	48	38	2.4	0.02
3. Vitamin D supplementation						
Regular	2	4.8	23	18.2	Ref	***
Irregular or not at all	40	95.2	103	81.8	4.6	0.03
4. Educational state of father						
Illiterate	6	14.3	20	15.8	Ref	***
Primary	9	21.4	36	28.6	0.8	0.73 [NS]
Secondary	12	28.6	34	27	1.2	0.81 [NS]
University	15	35.7	36	28.6	1.4	0.58 [NS]
5. Educational state of mother						
Uneducated	12	28.6	57	45.3	Ref	***
Primary	11	26.1	24	19	2.2	0.1 [NS]
Secondary	13	31	35	27.8	1.8	0.2 [NS]
University	6	14.3	10	7.9	2.9	0.07 [NS]
6. Household size						
<6	17	40.5	65	51.6	Ref	***
6+	25	59.5	61	48.4	1.6	0.21 [NS]
Total	42	0.0	126	0.0		

*Ref : Reference

Table 4 : The risk of having rickets for each type of feeding compared to the lowest risk category (stratified by age group)

	Rachitic Subjects		**Control Subjects**		**OR**	**P**
	No.	**%**	**No.**	**%**		
1. <6 months age						
Breast feeding	10	76.9	1	2.5	230	<0.001
Formula feeding	1	7.7	23	59	Ref	***
Mixed	2	15.4	15	38.5	3.1	0.34 [NS]
2. 6-24 months age *Breast feeding*						
No eggs	6	31.6	2	8.3	18	0.001
≤3 eggs/week	10	52.6	4	16.7	15	0.004
>3 eggs/week	3	15.8	18	75	Ref	***
Formula feeding						
≤3 eggs/week	2	66.7	12	48	2.2	0.55 [NS]
>3 eggs/week	1	33.3	13	52	Ref	***
Mixed feeding						
No eggs	1	33.3	9	32.1	1.3	0.83 [NS]
≤3 eggs/week	1	33.3	12	42.9	1.7	0.63 [NS]
>3 eggs/week	1	33.4	7	25	Ref	***

*four rachitic and 10 control subjects not included in this table as they were on diet only.

Table 5: Case-Control Difference in Mean of Certain Anthropometric Measures.

	Healthy Controls	Rachitic Cases	P (t-test)
Body weight (Kg)			0.99[NS]
Minimum	4.000	3.600	
Maximum	15.000	13.500	
Mean	8.2	8.2	
*SD	2.5	2.7	
**SE	0.2	0.4	
***N	126	42	
Body length (cm)			0.28[NS]
Minimum	53.0	51.0	
Maximum	88.0	78.0	
Mean	67.6	66.0	
*SD	8.6	8.1	
**SE	0.8	1.2	
***N	126	42	
Occipito-frontal circumference (cm)			0.59[NS]
Minimum	36.0	37.0	
Maximum	51.0	51.0	
Mean	44.1	43.7	
*SD	4.3	4.0	
**SE	0.4	0.6	
***N	126	42	

*SD: Standard Deviation **SE: Standard Error ***N: Number

Table 6: The difference in age of teething and starting walking between rachitic cases and healthy controls

	Healthy Controls	Rachitic Cases	P (t-test)
Age of teething in months			0.002
Minimum	5.0	6.0	
Maximum	12.0	12.0	
Mean	7.1	9.6	
*SD	1.3	2.1	
**SE	0.2	0.5	
***N	59	19	
Age of starting walking in months			<0.001
Minimum	11	12	
Maximum	19	23	
Mean	13.7	16.4	
*SD	1.8	3.5	
**SE	0.3	1.2	
***N	40	9	

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Table 7: The difference in mean of certain biochemical indicators between healthy controls and three grades of radiological severity of rickets

	Radiological Severity of Rickets				P trend
	Healthy Controls	Grade-I	Grade-II	Grade-III	(ANOVA)
1.Serum Alkeline Phosphatase (KAU)					<0.001
Minimum	5	28	35	62	
Maximum	27	33	55	67	
Mean	14.4	30.3	42.1	64.5	
*SD	4.8	1.6	5.7	3.5	
**SE	0.4	0.5	1.0	2.5	
***N	126	9	31	2	
2.Serum Calcium (mg/dl)					<0.001
Minimum	8.0	8.4	7.2	7.3	
Maximum	11.9	10.0	9.5	7.8	
Mean	9.5	9.3	8.5	7.6	
*SD	0.8	0.5	0.5	0.4	
**SE	0.1	0.2	0.1	0.3	
***N	126	9	31	2	
3.Serum Phosphorous (mg/dl)					<0.001
Minimum	3.7	3.5	2.0	2.1	
Maximum	6.6	4.5	4.0	2.4	
Mean	5.1	4.0	3.1	2.3	
*SD	0.6	0.3	0.5	0.2	
**SE	0.1	0.1	0.1	0.1	
***N	126	9	31	2	

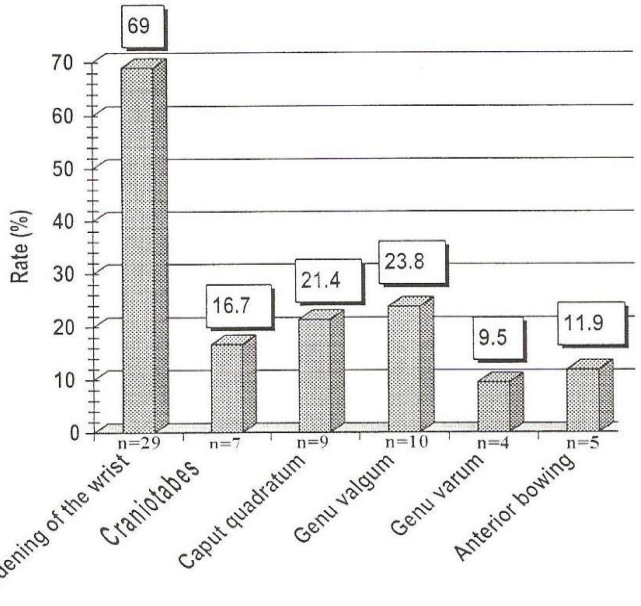

Figure 1: Bar chart showing the relative frequency of different clinical presentatio of rachitic subjects (n=42).

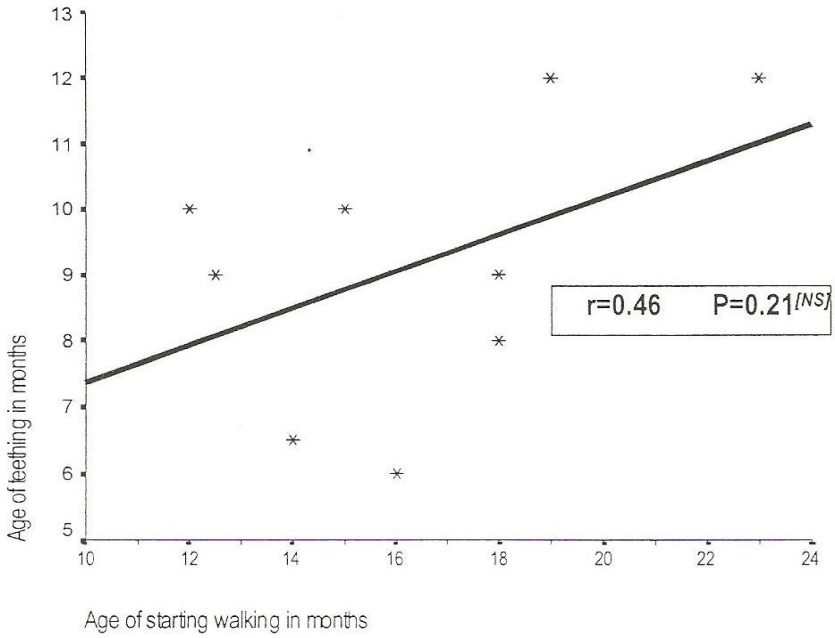

Figure 2: Scatter diagram showing the linear correlation of age of teething with that of walking in months among cases with rickets.

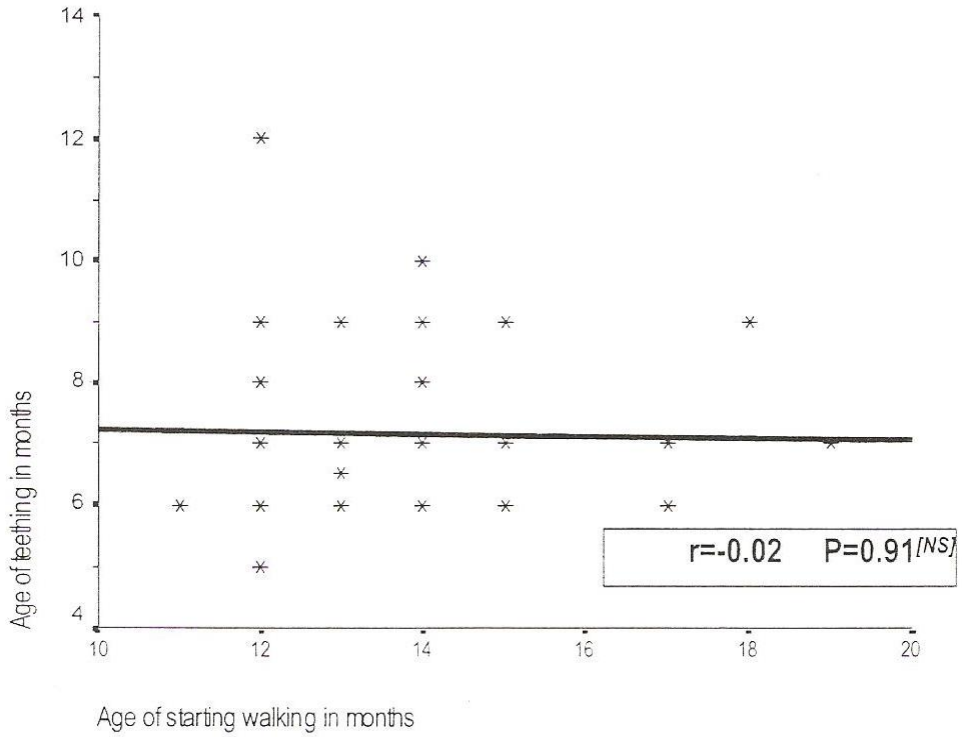

Figure 3: Scatter diagram showing the linear correlation of age of teething with that of walking in months among healthy controls.

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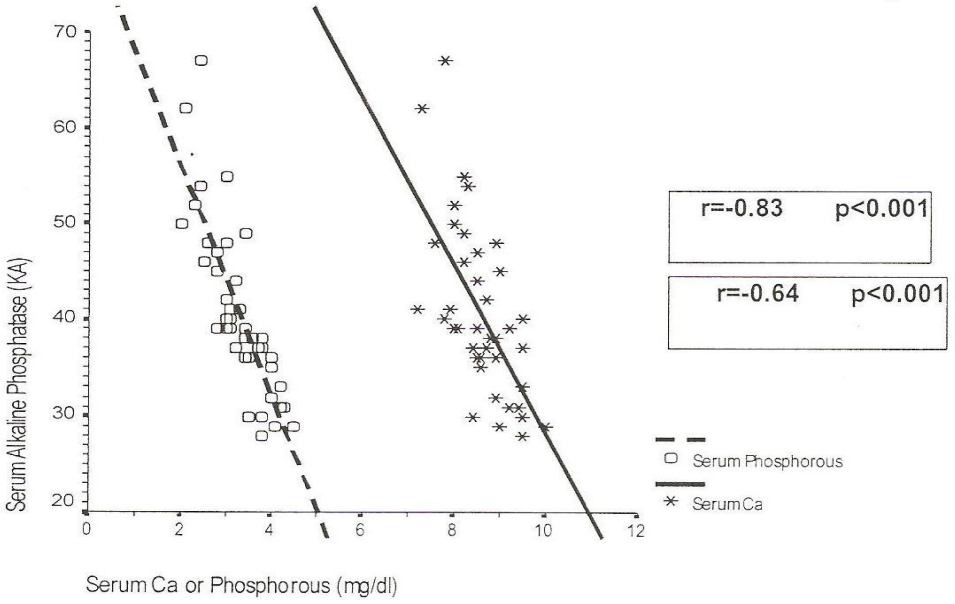

Figure 4: Scatter diagram showing the linear correlation of serum Calcium and phosphorous with serum alkaline phosphatase among cases with rickets.

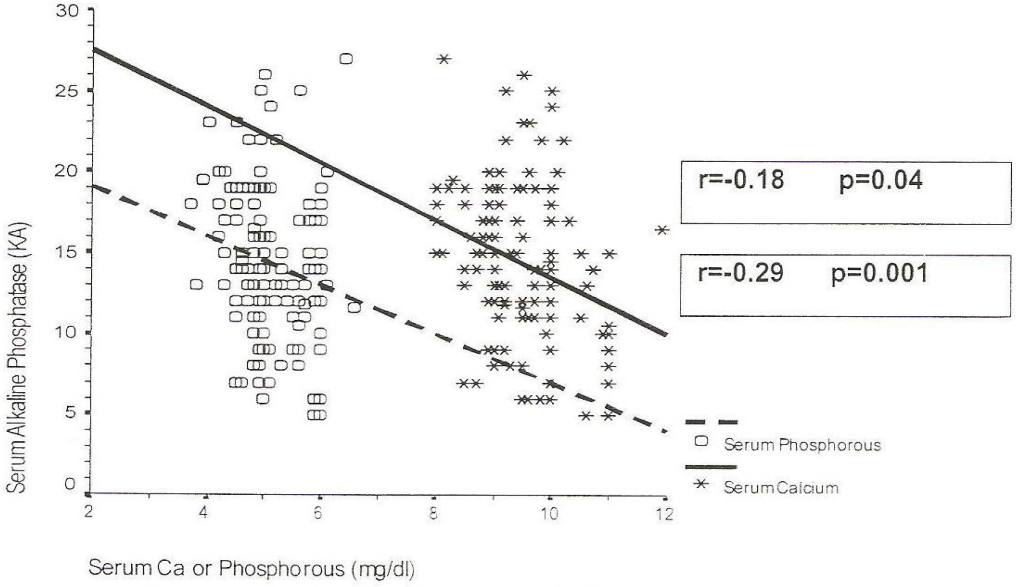

Figure 5: Scatter diagram showing the linear correlation of serum Calcium and phosphorous with serum alkaline phosphatase among healthy control .

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