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Levels of Serum Alkaline Phosphatase among Infants (2–27 months) in the British Zone of Germany*

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The occurrence of rickets in the British Zone of Germany has increased since the end of the last World War, and it was thought useful to carry out an investigation of the serum alkaline phosphatase levels among infants. The ages of the children of whom the following figures are published varied from 2 to 27 months, and all, except one, were living in institutions at the time of the investigation, viz. fifty-two in the Kinderhospital, Celle; forty-four in an U.N.R.R.A. nursery at Auemuehle, near Celle, and eight in a Celle nursery for orphans.

EXPERIMENTAL

Procedure. Blood was drawn by a German physician from either the anterior fontanelle, or the jugular vein. About 5 ml. were collected and allowed to clot. The samples were stored overnight in a refrigerator. In a number of cases, blood was taken from the same infants after intervals of several months. Here, in each case, only one (random) determination has been included.

It must be pointed out that the sampling, although random in the group, will be weighted in favour of 'ill' babies, as 50% were patients in the Kinderhospital. As far as could be ascertained, none of the infants suffered from any disease, except bone diseases, likely to give high values of serum alkaline phosphatase. Klasmer (1944) found discoloration of serum in some infants, suggesting transient hepatic damage, which might be expected in dystrophic rather than in healthy children. We found many cloudy serums which did not appear to be due to fat. The remainder, i.e. the 'well' babies, were largely the children of displaced persons.

Measurement of alkaline phosphatase. The method adopted was that of King (1946), with slight modifications for reading the blue colour in a Coleman colorimeter. Disodium phenyl phosphate was hydrolysed under controlled conditions, and the

* This investigation was carried out between September 1946 and May 1947.

liberated phenol estimated by photo-electric colorimetry. The King-Armstrong unit (K.-A. unit) is the amount of enzyme capable of producing 1 mg. of free phenol under the standard conditions.

Dietary. Present rations in the British Zone of Germany have the following characteristics as judged by the Tripartite Nutrition Committee's recommendations of December 1946:

(a) The diets of children 0-6 years of age are not deficient in calories and calcium.

(b) The diets of lactating women, provided that they take the infant's ration in addition to their own, are not deficient in calories and calcium.

(c) The diets of normal consumers are deficient in calories and calcium.

These are general assumptions based on ration scales from May 1946 to May 1947 as a whole. Figures could not be obtained for deficiencies in phosphorus or vitamin D, although the intake of the latter may be low owing to the small ration of fat.

RESULTS

The results are given in Table 1. During the tabulation of the results it was noticed that, in addition to the values which might be considered normal in character, there existed a small residuum of 'abnormal' values. Nearly 4% (four out of 109) of the babies showed grossly abnormal values, i.e. over 30 K.-A. units/100 ml. serum. The high figures occurred among the 'ill' babies. The values in K.-A. units were 35 (eczema), 39 (spasmophilia), 40 (pneumonia and bronchitis), 75 (rickets). These results have been placed in a separate category and have not been taken into account in the calculation of means and deviations.

Table 1. *Serum alkaline phosphatase of infants in the British Zone of Germany*

	No.	Serum phosphatase (K.-A. units)		Infants with a serum phosphatase titre of more than 30 K.-A. units*	
		Mean value	Standard deviation	No.	% of total
All infants, aged 2-27 months	109	12.4	5.4	4	4
Infants with rickets	11	12.8	5.2	1	9
Infants without rickets	98	12.5	5.4	3	3
Healthy infants	57	13.4	4.8	0	0
Ill infants	52	12.0	5.8	4	8
Males	57	13.1	5.6	1	2
Females	52	12.4	5.0	3	6
Infants receiving vit. D suppl.	70	12.6	4.8	4	6
Infants not receiving vit. D suppl.	38	13.1	6.2	0	0
Infants less than 12 months old, breast fed	27	12.1	5.1	1	4
Infants less than 12 months old, bottle fed	37	13.4	6.1	0	0

*Not included in the means.

Stearns & Warweg (1933) showed that plasma phosphatase, which was low in value at birth, rose abruptly to a maximum during the 1st month, maintaining the peak only for a short time, and then fell rather rapidly during the 2nd and 3rd months,

gradually declining through the remainder of the year, although the level remained higher than that found in the older age groups.

Barnes & Munk (1940), however, did not find a peak rise during the 1st month; their figures showed the highest values during the 4th and 5th months. Their observations were based on 630 determinations carried out during the 1st year of life on infants receiving adequate amounts of milk, vitamin D and accessory foods.

I examined one infant on three separate occasions at the ages of 7, 10 and 13½ months. His serum alkaline phosphatase was 21, 17 and 13½ K.-A. units respectively. A scatter-diagram was also constructed of age against K.-A. units, but is not included in this report as it did not give a very clear-cut result. However, it tended to show that the highest values obtained occurred between the ages of 8 and 15 months, and so did not agree with the results of either Stearns & Warweg (1933) or Barnes & Munk (1940).

The mean alkaline phosphatase in K.-A. units at the Kinderhospital, Auemuehle, and Celle was 11.6 (52 cases), 13.4 (44 cases) and 14.9 (8 cases) respectively.

The means for the following groups were also calculated and are given in the table:

(a) Infants with and without clinical signs of rickets.

(b) Infants healthy and not healthy.

(c) Males and females.

(d) Infants obtaining vitamin D supplement, and those not receiving any supplement.

(e) Infants (less than 12 months in age) breast fed for more than 6 weeks and those in the same age category, bottle fed (or breast fed for less than 6 weeks).

The mean for all the infants was 12.4 K.-A. units. This is very much higher than in adults, for whom I found mean values of between 3 and 5, but seems to be in agreement with findings of other workers.

There were no statistically significant differences between the mean values for the different groups of infants set out above.

SUMMARY

1. The serum alkaline phosphatase (K.-A. units) was determined for over 100 infants aged 2-27 months during the period September 1946 to May 1947, in the British Zone of Germany.

2. Mean values and standard deviations have been calculated for all the infants and for various groups.

3. The mean value for serum alkaline phosphatase, for all the infants (12.4 K.-A. units) was very much higher than the mean values of between 3 and 5, found for adults, but no statistically significant differences were observed between the means for the various groups of infants.

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The Estimation of the Metabolic Rate in the Starvation State

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In the classical studies of undernutrition in man, reviewed by Lusk (1921), the basal metabolism was found to be reduced whether it was expressed in terms of heat production/sq.m. of body surface or of heat production/kg. body-weight. The percentage fall in basal metabolism was, however, greater when it was calculated with reference to the surface area than when calculated in terms of heat production/kg. body-weight. This discrepancy was not discussed by Lusk who was concerned mainly with drawing attention to the fact that energy production in the starvation state is reduced below normal.

EXPERIMENTAL

Selection of subjects

Studies of energy metabolism in severely undernourished persons in Holland in 1945 and in Germany in 1946 revealed great discrepancies between the levels of basal metabolism when these were expressed in terms of heat production/sq.m. of body surface and of heat production/kg. body-weight. It appeared that the discrepancies increased with increased weight loss. We were unable at the end of our first study in 1945 to decide which method of expressing the basal metabolism was the better index of the rate of tissue oxidation. In Germany we were able to study a group of young adults who, with one exception, were between the ages of 21 and 31 years. During a preliminary period of observation lasting 4 weeks, forty men between 20 and 40 years of age were studied while living on a diet containing not more than 1750 Cal./day and identical with that consumed during the preceding 3 months. By gradual elimination of subjects who had some clinical evidence of organic disease or a recent history of tuberculosis,