

Levels of Calcium, Phosphorus, Alkaline Phosphatase, Bilirubin and Glucose in Newborn Infants and their Mothers

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Summary

Abdurrahman MB, Raza MK, Ajayi VA, Zakolshi W and Ame J. Levels of Calcium, Phosphorus, Alkaline Phosphatase, Bilirubin and Glucose in Newborn Infants and their Mothers. *Nigerian Journal of Paediatrics* 1981; 8:52. Calcium, phosphorus, alkaline phosphatase and bilirubin levels were measured in cord blood from full-term neonates and in venous blood from their respective mothers. Capillary blood glucose was measured in the neonates. The mean values in the neonates were calcium 2.56 mmol/l (10.24 mg/dl), phosphorus 1.64 mmol/l (5.13 mg/dl), alkaline phosphatase 127iu/l, and glucose 33.4 mg/dl; the median for phosphorus was 1.68 mmol/l (5.16 mg/dl). Levels of calcium and phosphorus were significantly higher in the neonates than in the mothers, but there was no difference in the mean level of alkaline phosphatase. There was significant correlation between cord serum levels of calcium, phosphorus and alkaline phosphatase and the respective maternal serum levels. There was no correlation between cord serum calcium and phosphorus. The levels of blood glucose in the babies were low, with a range of 20-50 mg/dl and a mean of 33.4 mg/dl. 29 out of 86 babies had blood glucose less than 30 mg/dl, but none of these babies was symptomatic.

Introduction

BIOCHEMICAL disorders commonly seen in a newborn nursery include hypocalcaemia,^{1 2} hypoglycaemia^{3 4} and hyperbilirubinaemia.^{5 6}

These disorders can give rise to immediate and long term complications, the most serious of which is brain damage.^{7 8} Knowledge of the normal range of values of these biochemicals is therefore a prerequisite in the prevention and proper management of their disorders.

The purpose of the present study was to determine the normal serum levels of calcium, phosphorus, alkaline phosphatase, bilirubin and glucose in full-term babies, and to define the relationships, if any, between the serum levels of these substances in the babies and their mothers.

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Materials and Methods

Healthy, full-term, normally delivered babies with normal birthweights and their respective mothers were selected for the study. An additional criterion was that the mothers had no problems during pregnancy, and showed no overt signs of malnutrition. Cord and maternal blood were collected at the time of delivery, and serum was extracted from each blood sample by centrifugation. If estimation could not be done on the sera on the day they were collected, the samples were stored in a deep freeze and the estimation done within a week.

Blood for glucose was separately obtained from the babies by heel-pricks, and the glucose level measured by 'Dextrostix'* and 'Eyetone'* Dextrose meter. Accuracy of the Dextrose meter was assessed earlier by comparing the values of glucose obtained by the standard glucose oxidase method⁹ with those obtained with the Dextrose meter. Using blood of varying glucose concentrations, a linear relationship with a correlation coefficient of 0.95 was obtained.

Serum calcium was determined by the cresolphthalein complexone method of Baginski, *et al.*¹⁰ Serum phosphorus was determined colorimetrically.¹¹ Alkaline phosphatase was measured by the method of Kind and King,¹² and serum bilirubin by the photoelectric method of Malloy and Evelyn.¹³

Results

There were 125 babies (68 males and 57 females), with mean birthweight of 3.2 kg, and 123 mothers, with a mean age of 23.2 years and mean parity of 2.9. Blood was not collected from two mothers and these were therefore not included in the analysis. Blood glucose was determined in only 86 babies.

The distribution of blood glucose levels in the 86 babies is shown in Figure 1. The blood glucose levels in the babies were generally low, ranging between 20 and 50 mg/dl (mean = 33.4 mg/dl). Twenty-nine (34%) babies had blood glucose less than 30 mg/dl. The mean glucose level of 35.9 mg/dl in female babies was significantly higher than that of 31.6 mg/dl in male babies ($t = 2.329$; $P < 0.05$). The mean cord calcium concentration of 2.56 mmol/l (10.24 mg/dl) was significantly higher than that of 2.39 mmol/l (9.56 mg/dl) in the mother ($P < 0.001$) (Table I). Sixty-three (50%) of the 125 babies had serum calcium level of between 2.5 and 2.9 mmol/l (Fig. 2). Although the mean cord serum calcium was high, 12 babies had levels less than 2 mmol/l, but none of them had signs of hypocalcaemia. The mean serum phosphorus level in the newborn babies was 1.64 mmol/l compared with 1.24 mmol/l in their mothers. The difference is statistically significant ($P < 0.001$). The medium cord serum phosphorus was 1.68 mmol/l. The distribution of the serum levels in the 125 babies is presented in Fig. 3. There was a wide scatter in the serum levels of alkaline phosphatase in both the babies (Fig. 4) and their mothers, but there was no difference in the mean values. The mean concentration of alkaline phosphatase in cord and maternal sera was higher than the local normal range of 35-70 iu/l in non-pregnant adults.

There was no significant sex difference in the mean levels of cord serum calcium, phosphorus and alkaline phosphatase.

In our laboratory, the normal serum bilirubin in adults is 3.4-20 $\mu\text{mol/l}$, while 50 $\mu\text{mol/l}$ is arbitrarily used as the upper limit of normal total serum bilirubin in the newborn. Nineteen mothers had total serum bilirubin level greater than 20 $\mu\text{mol/l}$, and 7 babies had levels greater than 50 (Fig. 5). Four out of the 7 babies had unconjugated bilirubin greater than 50 $\mu\text{mol/l}$. The median cord serum unconjugated bilirubin was 20.5 $\mu\text{mol/l}$. None of the babies or mothers developed jaundice during their stay in the hospital.

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TABLE I

Biochemical Values in Newborn babies and their mothers

Substance	Source	Range	Mean	SD	Confidence Interval	P
Calcium (mmol/l)	Cord (n=125)	1.5-4.0	2.56	0.50	1.58-3.54	<0.001
	Mothers (n=123)	1.4-3.7	2.36	0.47		
Phosphorus (mmol/l)	Cord (n=125)	1.0-3.0	1.64	0.42	0.82-2.46	<0.001
	Mothers (n=123)	0.7-2.1	1.24	0.29		
Alkaline Phosphatase (iu/l)	Cord (n=125)	25-420	127	86	42-296	<0.5
	Mothers (n=123)	25-333	126	71		
Glucose (mg/dl)	Baby (n=86)	20-50	33.4	9.0	15.8-51	

n = number of subjects

SD = Standard deviation

p = level of statistical significance between mean cord and maternal levels.

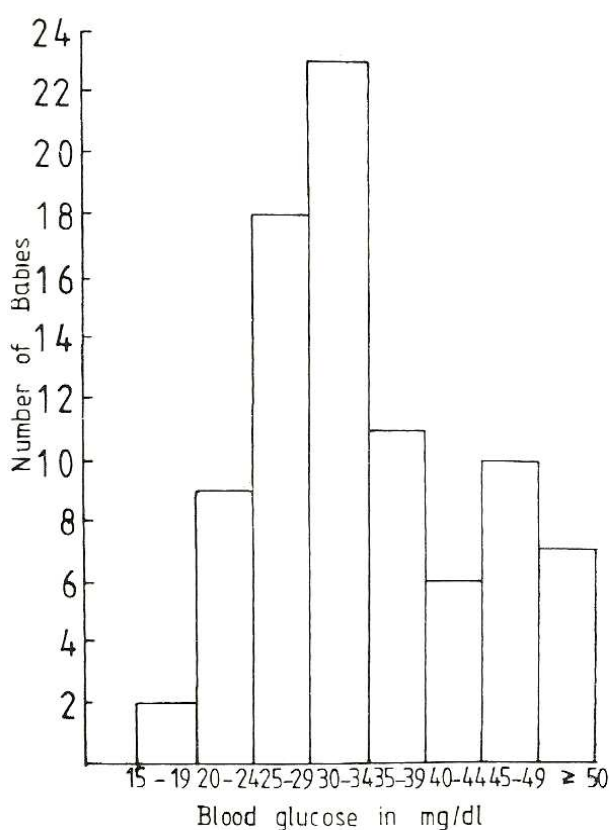


Fig. 1 Distribution of blood glucose in 86 newborn babies

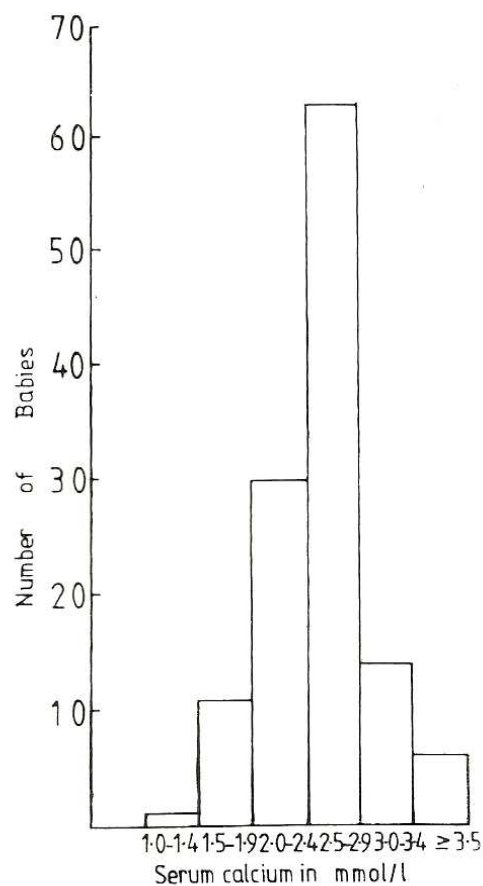


Fig. 2 Distribution of cord serum calcium in 125 newborn infants

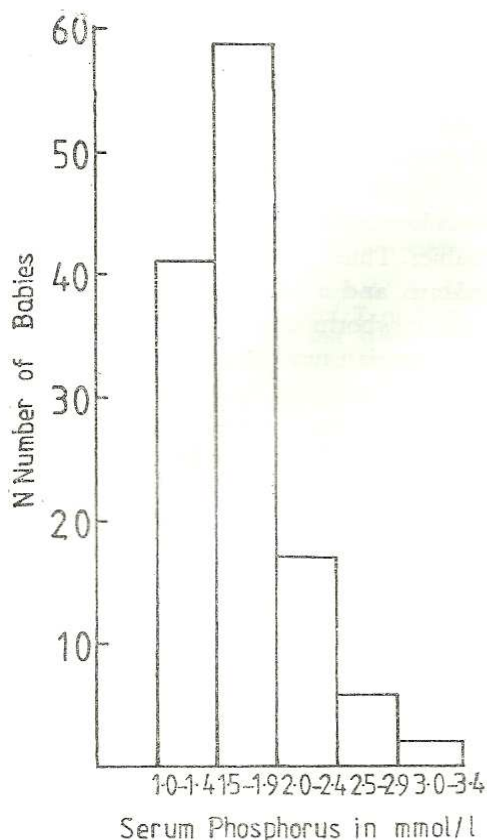


Fig. 3 Distribution of cord serum phosphorus in 125 newborn babies.

The distribution of glucose, calcium and alkaline phosphatase fell into the so-called 'normal' (or Gaussian) pattern (Figs. 1,2,4), whereas the distributions of phosphorus and bilirubin were skewed to the left (Figs. 3,5). There was a significant correlation between cord serum levels of calcium, phosphorus and alkaline phosphatase and the respective maternal serum values (Table II). There was no correlation between cord serum calcium and phosphorus levels ($r = 0.94, P > 0.1$).

Discussion

The mean serum calcium level of 2.56 mmol/l (10.24 mg/dl) in babies in the present study is on the high side of the normal range of 9-11 mg/dl in healthy adult Nigerians.¹⁴ This relative

TABLE II

<i>Relationship between maternal and cord biochemical values</i>			
<i>Substances</i>	<i>Coefficient of correlation</i>	<i>t</i>	<i>p</i>
Calcium	0.499	6.332	< 0.001
Phosphorus	0.277	3.168	< 0.01
Alkaline Phosphatase	0.375	4.447	< 0.001

hypercalcaemia in the newborn has also been reported by Todd, Chuinard and Wood¹⁵ and by David and Anast.¹⁶ The high serum calcium in the neonates is unlikely to be due to hyperactivity of foetal parathyroid glands because of the low or undetectable immunoreactive parathyroid hormone in cord sera,¹⁶ but is likely to be due to a high foetal-to-maternal calcium gradient by means of a specific calcium transport system.¹⁷

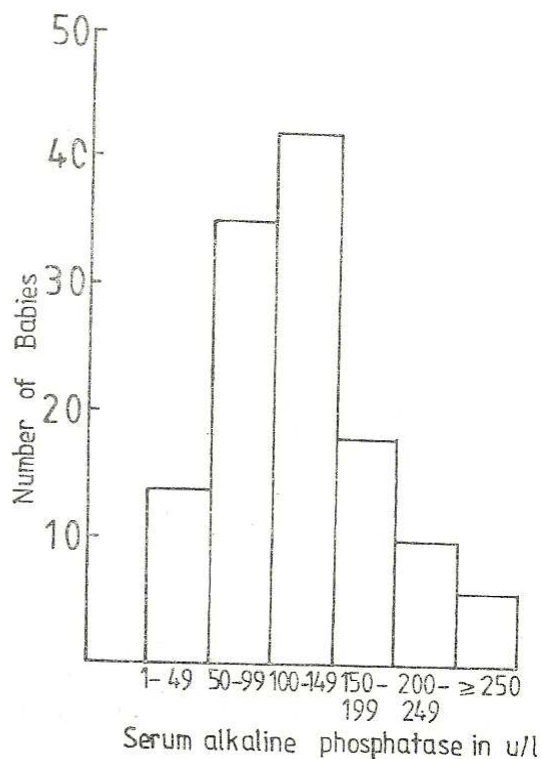


Fig. 4 Distribution of cord serum alkaline phosphatase in 125 babies.

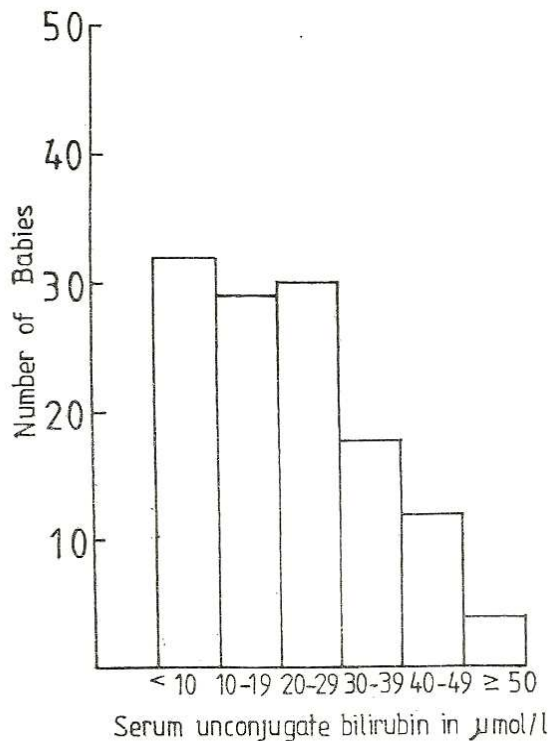


Fig. 5 Distribution of unconjugated bilirubin in cord serum from 125 babies.

The mean cord serum phosphorus of 1.64 mmol/l (5.13 mg/dl) is higher than the normal adult level of 2-4 mg/dl.¹⁴ The high cord serum phosphorus and the lack of correlation between serum calcium and phosphorus found in this study are similar to the findings of Todd, Chui-nard and Wood¹⁵ and of David and Anast.¹⁶ Without isoenzyme studies, it was not possible to determine how much of the alkaline phosphatase in the cord serum was of placental origin.

If blood glucose of less than 30 mg/dl is used to define hypoglycaemia,³ one third of the babies in the present study would be considered to have asymptomatic hypoglycaemia. Using the same criterion, 20 (16.6%) out of 120 term babies reported by Effiong and Ojo¹⁸ would also be

considered hypoglycaemic. It seems unlikely that such a high percentage of full-term and adequate for gestational age babies could have abnormal blood glucose levels. Rather, it seems more likely that the normal blood glucose level in Nigerian babies is lower than the level reported in caucasian babies. Thus, whereas the values of calcium, phosphorus and alkaline phosphatase found in Nigerian newborns are similar to those reported in the caucasian newborns, the blood glucose in the Nigerian neonate seems lower than in the caucasian neonate.

The present study has also revealed significant differences between newborns and adults in respect of the biochemical contents of their sera. Therefore, adult biochemical values should not be used as the criteria for diagnosing biochemical disturbances in the newborn, in order to avoid unnecessary or delayed intervention.

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