THE SERUM PROTEINS OF PEDI SCHOOLCHILDREN*

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Numerous studies of the serum-protein patterns of the Bantu have been reported over the past 20 years. Notable are the papers by Arens and Brock,[1] Powell,[17] and Carr and Gelfand.[5] Interracial studies have been conducted by Bronte-Stewart *et al.*[4] and Joubert *et al.*,[13] and in newborn infants by Bersohn and Wayburne.[2] These authors have shown that the majority of apparently healthy Bantu have a protein pattern which is distinctive. The total-protein and the gammaglobulin levels are higher, and the albumin level lower, than the usually accepted norm for healthy Whites. When Bantu receive a diet which is adequate in terms of daily protein requirements, the serum total-protein and the serum-albumin levels approximate more closely the levels for Whites. The gammaglobulin level, however, remains a point of difference.

The studies cited above have been confined to adults and the newborn. Only recently have studies of Bantu schoolchildren been reported. In his thesis[22] Walker lists mean figures from a small series of teenage children. Figures for younger girls and boys are not presented. He has commented[23] on the general trend, over the last 15 years, for the Bantu serum-protein pattern to approximate that of the Whites. Du Plessis *et al.*[6,8] have published serum-protein figures from schoolchildren of the 4 main racial groups examined in the course of nutrition status surveys conducted in Pretoria between 1962 and 1965. Their data from urban children are of considerable value. It is clear that similar data should be available from groups of rural schoolchildren.

During August and September 1965, anthropometrical and clinical examinations were conducted on 301 Pedi schoolchildren living in the Kgolokoe's location area of the Bantu Reserve of Sekhukhuniland in the north-eastern Transvaal. The geographical and cultural backgrounds of the children have already been described, as has the statistical method in which a representative sample was selected from the more than 6,000 children attending schools in the area.[14]

METHODS

On the day when each child underwent anthropometrical and physical examination a specimen of venous blood was

*Date received: 3 September 1968.

drawn from the median cubital vein. A sample of this blood was allowed to clot. The serum was then separated and placed in the deep-freeze section of a refrigerator until protein determinations could be performed. The method used was a modification suggested by Du Plessis[7] of the method of Woolfson *et al.*[26] based on the method of Weichselbaum.[24]

Total Protein Method

To 1·9 ml. of distilled water was added 0·1 ml. of serum. An aliquot of 1 ml. was transferred to a second test-tube, and to this 3·0 ml. of 0·2N NaOH solution and 1 ml. Weichselbaum reagent were added. A blank was prepared by taking 1 ml. distilled water, 3·0 ml. 0·2N NaOH solution and 1 ml. Weichselbaum reagent. These mixtures were allowed to stand for 30 minutes at room temperature. Colour intensities of the test against the blank at 540 mμ were then read, using a Gallenkamp colorimeter.

Albumin Method

To 1·9 ml. 26·86% sodium sulphate solution in a centrifuge tube were added 0·1 ml. of serum and 1 ml. of ether. The mixture was shaken for 60 seconds and then centrifuged for a few minutes. An aliquot of 1 ml. was transferred from the bottom aqueous layer to a test-tube. To this aliquot were added 3·0 ml. 0·2N NaOH solution and 1 ml. Weichselbaum reagent. A blank was prepared with 1 ml. 26·86% sodium sulphate solution, 3·0 ml. 0·2N NaOH solution and 1 ml. Weichselbaum reagent. After both had stood for 30 minutes, the test was read against the blank at 540 mμ. Concentrations of total protein and albumin were read from a standard curve.

The accuracy of the method was tested on a number of occasions by means of control determinations, using a commercial preparation (Versatol)[21] with known protein concentrations. The greatest error demonstrated in these test determinations was 7%.

RESULTS

The results are tabulated in Tables I and II. Total serum proteins were determined on sera from 143 girls and 154 boys. Mean total-protein levels were very similar in all age-groups, with a slight increase in the older children. The mean value for boys was 7·09 G/100 ml. and for girls 7·01 G/100 ml.—an over-all mean total-protein level of 7·05 G/100 ml. Total-protein levels of less than 6 G/100 ml. were found in 7·2% of the boys and 7·7% of the girls, placing them in the 'deficient' category according to the classification of the Interdepartmental Committee on Nutrition for National Defense (ICNND)[31,32] (Fig. 1).

TABLE I. MEAN SERUM-PROTEIN VALUES IN BOYS (G/100 ML.)

Age (years)	*Total protein*	*Albumin*	*Globulin*
7	6·95	3·81	3·15
	(0·78)*	(0·32)	(0·74)
8	6·99	3·60	3·40
	(0·89)	(0·55)	(0·36)
9	7·12	3·70	3·39
	(0·70)	(0·60)	(0·82)
10	6·99	3·66	3·33
	(0·63)	(0·62)	(0·92)
11	7·05	3·80	3·25
	(0·55)	(0·58)	(0·70)
12	7·16	3·78	3·38
	(0·69)	(0·53)	(0·78)
13	7·27	3·80	3·47
	(0·79)	(0·59)	(0·88)
14	7·12	4·01	3·01
	(0·76)	(0·47)	(0·82)
15	7·16	3·97	3·25
	(0·71)	(0·51)	(0·52)

*Figures in parenthesis indicate standard deviation.

TABLE II. MEAN SERUM-PROTEIN VALUES IN GIRLS (G/100 ML.)

Age (years)	*Total protein*	*Albumin*	*Globulin*
7	6·98	3·79	3·19
	(0·74)*	(0·55)	(0·63)
8	7·02	3·84	3·14
	(0·58)	(0·52)	(0·63)
9	7·04	3·80	3·25
	(0·53)	(0·66)	(0·71)
10	6·81	3·66	3·14
	(0·69)	(0·47)	(0·60)
11	6·77	3·94	2·86
	(0·22)	(0·56)	(0·68)
12	7·10	3·91	3·14
	(0·65)	(0·45)	(0·84)
13	7·06	3·93	3·17
	(0·77)	(0·47)	(0·79)
14	7·19	4·02	3·18
	(0·74)	(0·56)	(0·87)
15	7·09	3·93	3·15
	(0·68)	(0·41)	(0·69)

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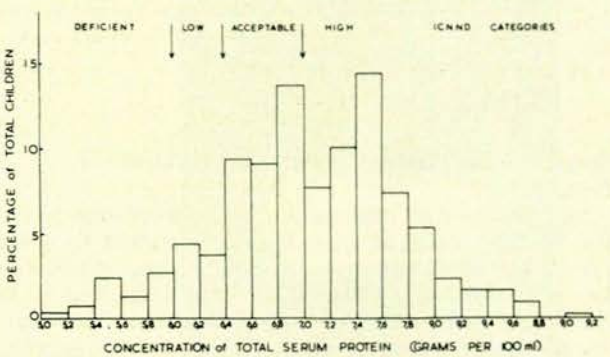
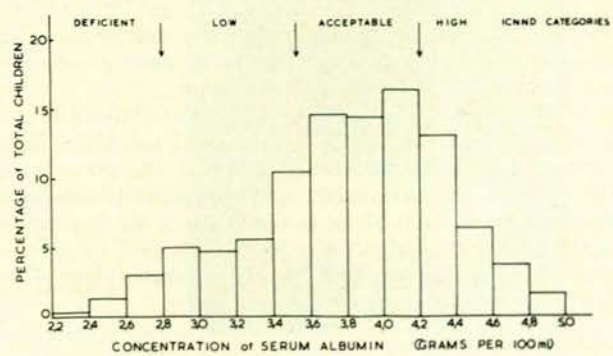


Fig. 1. See text.

Serum-albumin levels were determined on sera from 145 girls and 156 boys. A trend towards higher values in older children was again observed. The mean value for boys was 3·79 G/100 ml. and for girls 3·87 G/100 ml.—both values within the 'adequate' range according to ICNND classification. The over-all mean was 3·83 G/100 ml.



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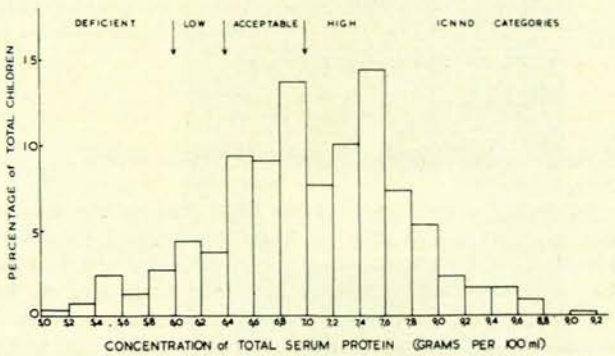

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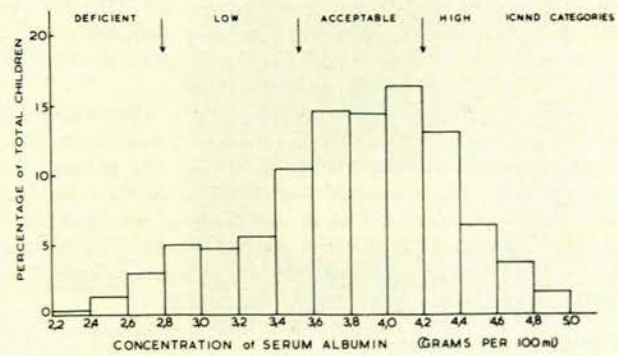

Fig. 2. See text.

In the case of 5·1% of boys and 2·1% of girls, values were in the 'deficient' range and 22·4% of boys and 24·1% of girls had values in the 'low' range of the ICNND classification (Fig. 2).

Serum-globulin levels for each child were obtained by subtracting the serum-albumin level from the total serum-protein level. The mean level for boys was 3·29 G/100 ml. and for girls 3·14 G/100 ml. The over-all mean figure was 3·22 G/100 ml. (Fig. 3).

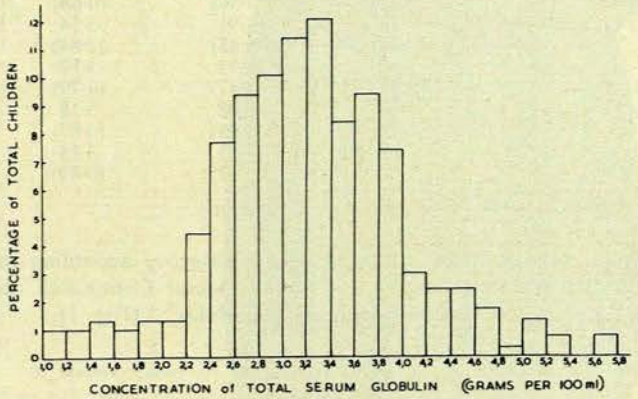

Fig. 3. See text.

DISCUSSION

Serum-Protein Patterns in Relation to Nutritional Environment

In frank protein malnutrition, the total-protein level is low and the serum-albumin level is depressed to a very low figure. This is well shown in the syndrome of kwashiorkor. The effect of a balanced diet may be gauged by the rise in the serum-albumin level, and clinical recovery is associated with a serum-protein figure which lies within the normal range. Subsequent severe protein deprivation may lead to clinical relapse, when the serum-albumin level will again be very low. This association is well known and accepted in clinical paediatrics.

Brock[3] has reasoned that a low serum-albumin level may be accepted as evidence of dietary protein deficiency when a diet of good protein content produces a rise in that serum-albumin level. Schendel *et al.*[19] have used the serum-albumin concentration as a biochemical index of the protein sufficiency of the diet, and have defined 3 ranges of levels. They regard the marginal range 2·78 - 3·52 G/100 ml. as evidence of dietary protein deficiency in the absence of other pathology. The serum-protein ranges of the ICNND[31,32] categories are very similar.

When comparing serum-protein results, allowance must be made for differences due to laboratory technique. Mean total-protein values for all age-groups in the present Pedi survey lie in the 'acceptable' or 'high' ICNND categories. Mean albumin levels all lie in the range of the 'acceptable' category. Mean total-globulin levels, obtained by subtraction, lie within an accepted Caucasian normal range,[35] but tend towards the upper limit of normality.

Pedi Albumin Pattern

Of more significance than the mean total-protein and mean albumin levels in this survey, is the number of children with serum-albumin levels in the 'low' or 'deficient' category. Values below 3·52 G/100 ml. were found in 27% of children. If the serum-albumin level is taken as a biochemical index of the protein sufficiency of the diet, it would appear that at least one-fifth of the children attending schools in Sekhukhuniland suffer from protein deficiency. As the serum-albumin level falls only when protein deficiency is well advanced,[3] the percentage whose diet is suboptimal in terms of protein content is probably much higher. This finding correlates well with the finding that 33·2% of the children had height measurements, and 39·5% had weight measurements, which lay below the Boston 3rd percentile.[15] This association between hypoalbuminaemia and low weight has been noted by Wittmann and Hansen.[25]

It is also shown in this survey that the serum-albumin levels confirm the somatometric findings in demonstrating the inadequacy of the children's diet.

An increase in the protein content of the diet of the Pedi children should produce a general rise in the mean albumin levels and a reduction in the number of children whose serum-albumin level lies below the lower limit of the 'acceptable' category. A corresponding decrease in the number of children with height and weight measurements below the Boston 3rd percentiles should also occur.

Bronte-Stewart *et al.*[4] showed that once a certain level of dietary protein intake is reached, further increases in the serum-albumin level do not occur. If this 'luxus' consumption level is maintained throughout the growing period, and the diet is adequate in other respects, it can be anticipated that the mean height and weight findings of the children will approximate the Boston 50th percentile.

Pedi Globulin Pattern

Studies in a number of places have demonstrated differences between Bantu and White serum-protein patterns.[4,9,10,13] A feature of the Bantu pattern is the high total-globulin level usually found. Electrophoresis shows that this is due to an increase in the gammaglobulin fraction. This increase is presumed to be due to the high incidence of infective disease in Bantu communities. However, an increased globulin fraction is found among American negroes,[16,18] and among West Africans who have lived in England for many years,[20] as well as among healthy well-nourished Bantu in Southern Africa.[4] Bersohn and Wayburne[2] have found that the serum-protein patterns of Bantu and White newborn infants differ only in the slightly higher gammaglobulin levels found in the Bantu. These findings have led to speculation whether the Bantu pattern might be genetically determined.

Pedi mean globulin figures approach the upper limit of the normal Caucasian range. The mean value is, however, lower than that found in Pretoria,[6,8] and in other reported African studies. Sekhukhuniland enjoys a healthy climate and is free of tropical disease. Clinical examination shows that the incidence of infection among schoolchildren is low. The lower globulin levels may reflect a lower incidence of infection among the children than prevails elsewhere.

SUMMARY

Serum-protein levels were determined on sera from 301 Pedi schoolchildren living in a rural Bantu Reserve. Mean levels for

total protein, albumin and globulin are presented. Twenty-seven percent of the children had serum-albumin levels below 3·52 G/100 ml. The findings are discussed in relation to dietary protein content and the incidence of infection.

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