

eral investigators feel that on the basis of the *in vitro* hemolysis of erythrocytes by peroxide, a tocopherol blood level below 0.5 mg/100 ml is indicative of a deficiency(1,2). Whereas Harris *et al*(3) found 7% of their samples to be below 0.5 mg/100 ml, we found none in this range. Only 6.1% of our group were below 0.7 mg/100 ml.

A correlation between tocopherol and carotenoids in serum was also noted by Leitner *et al*(7) in their survey of British men and women. Such a relationship may be expected in a population consuming reasonable quantities of vegetables consistently, since both α -tocopherol and carotenoids occur in green and yellow vegetables.

Summary. Serum tocopherol levels in 61 female and 71 male normal adult employees of the National Institutes of Health averaged 1.06 mg/100 ml. No samples were below

0.50 mg/100 ml, and 93.9% were above 0.70 mg/100 ml. A significant correlation was found between serum tocopherol and carotenoids for both males and females.

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Serum Vitamin E Levels in the Rural Population of East Pakistan.* (29516)

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Nutritional surveys in developing countries generally have not included serum vitamin E among the routine biochemical analyses. In a limited sample of Jordanian children with kwashiorkor low serum tocopherol levels were recently encountered(1). When it became apparent during the course of a recent survey in East Pakistan(2) that the rural diets in many areas were very low in fat, a special study was undertaken on serum levels of vit. E. Concomitantly, vit. A and carotene analyses were also made.

Procedure. Blood samples were taken at random during the day by venipuncture, using oxalated vacuum syringes, from villagers in 4 rural districts of East Pakistan (Khulna, Pabna, Kustia, and Sylhet). The samples were put into vials with rubber stop-

pers and packed in ice in an insulated chest which was shipped to the laboratory in Dacca. Not more than 24 hours elapsed between time of collection and arrival in the laboratory, by which time the ice was melted. The serum was separated and frozen until analyzed within 2 to 3 days. Studies of possible changes in the vit. E content of sera permitted to stand at room temperature (26-28°C) for periods up to 24 hours showed that no significant loss of tocopherol occurred.

Vitamin E was determined by the ferric chloride-bipyridyl reaction as described in the preceding paper(3). Vit. A was determined on an extract from 2 ml of serum prepared as above. The reaction with 1 ml of antimony trichloride in chloroform was measured in 10 × 75 mm cuvettes at 620 mμ in the Coleman Junior Spectrophotometer. A correction was made for carotenoids,

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TABLE I. Distribution of Serum Tocopherol Values in Villagers of East Pakistan.

Range (mg/100 ml)	Males adult (79)*	Females adult (23)	Females pregnant & lactating (19)	Children male & female (31)	Total sample (152)
	%				
.1- .19				6.5	1.3
.2- .29		4.4	15.8	9.8	4.6
.3- .39	6.3	4.4	5.3	3.2	5.3
.4- .49	13.9		5.3	9.8	9.9
.5- .59	13.9	26.0	21.0	6.5	15.1
.6- .69	16.4	21.8	21.0	19.4	18.4
.7- .79	12.6	4.4	5.3	9.8	9.9
.8- .89	11.4	21.8		9.8	11.2
.9- .99	6.3	4.4	10.5	6.5	6.6
1.0-1.09	7.6		10.5	3.2	5.9
>1.1	11.4	13.1	5.3	16.1	11.8
Group avg	.76 $\pm$.31†	.73 $\pm$.27	.66 $\pm$.34	.70 $\pm$.34	

* Number in parentheses is No. of subjects.

† Standard deviation.

previously determined at 450 m μ .

Results. Subjects were divided into 4 categories: (1) adult males (15-60 years), (2) adult females (16-58 years), (3) pregnant and lactating females (18-42 years), and (4) boys and girls (6-14 years).

The results in Table I show that 21.1% of the total sample had serum tocopherol values below 0.5 mg/100 ml. More pregnant and lactating women and children (26.4 and 29.3%, respectively) fell in this low range than did men and non-pregnant or lactating women. Whereas 2 recent surveys of blood tocopherol values of normal men and women in the United States(3,4) reported 86 and 79%, respectively, of samples above 0.8 mg/100 ml, in this East Pakistan population only 37% of the men and women were in this

range considered "normal" for Western countries. Of particular interest is the significant number of individuals with very low values, below 0.4 mg/100 ml, 11.2% of the total.

In Table II are the serum vit. A and carotenoid values on most of these subjects, grouped according to the classification used in the nutrition surveys of the Interdepartmental Committee on Nutrition for National Defense(5). The low carotenoid values are evidence that intake of green and yellow vegetables and fruits is meager in at least 50% of the sample (below 60 μ g/100 ml). With respect to vit. A, 36.4% of the total sample were in the low and deficient range (<20 μ g/100 ml). The percentage of children and pregnant and lactating women with

TABLE II. Distribution of Serum Vitamin A and Carotenoid Levels in Villagers of East Pakistan.

Range (μ g/100 ml)	Males adult (79)*	Females adult (20)	Females pregnant & lactating (14)	Children male & female (24)	Total (137)
	%				
Vitamin A					
<10	2.6	4.7	7.1	0	2.9
11-20	26.6	28.5	57.1	46.0	33.5
21-35	57.4	43.0	35.7	54.0	52.2
>36	13.3	23.8	0	0	11.1
Carotenoids					
<40	22.7	33.3	14.3	16.6	22.4
41- 60	32.9	23.8	50.0	20.8	31.1
61- 80	24.0	9.5	14.3	45.8	24.6
81-100	11.3	19.0	7.1	4.1	10.8
>100	8.8	14.2	14.3	12.5	10.8

* Number in parentheses is No. of subjects.

low values was, as with vit. E, greater than for the other 2 groups. Scatter diagrams of all combinations of vit. E, vit. A and carotene failed to suggest any correlation among these blood constituents. Detailed data for vit. A and carotenoids on 2,000 serum samples from a broader 2-year nutrition survey(6) will be presented in another report.

Discussion. A summary of surveys of blood vit. E values in Western countries compiled by Harris *et al*(4) yielded an average of 1.01 mg/100 ml plasma (or serum). The averages for 2 urban U.S. populations of adults reported recently were $1.05 \pm .26$ and $1.05 \pm .32$ mg/100 ml(3,4). In the men and non-pregnant or lactating women of rural East Pakistan, an average of $0.76 \pm .30$ mg/100 ml was found. Guzman *et al*(7) reported an average value of $0.65 \pm .26$ mg/100 ml for school children in 5 Central American countries, while in adults in these countries the values varied from approximately 0.46-1.08 mg/100 ml during the year.

It is generally accepted that the vit. E requirement is related to the amount of polyunsaturated fatty acids in the diet(8,9), or more precisely to the content of these acids in the tissues, so that serum levels by themselves have no definitive meaning. In a preliminary report(2), the dietary fat in East Pakistan was found to be only 10% of calories. Work is in progress to characterize the fatty acid composition of the dietary fat and also of the serum and erythrocytes in order

to evaluate the significance of the low serum tocopherol levels.

Summary. Serum tocopherol values were determined on 79 adult males, 23 adult females, 19 pregnant or lactating females and 31 children. Of the total, 21% had values below 0.5 mg/100 ml. Children and pregnant or lactating females had 29% and 26%, respectively, in this low range. Serum vit. A and carotenoid levels were also determined and significant numbers of low values were found.

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Effect of Skin Temperature on Infectibility of *Plasmodium gallinaceum* Sporozoites in the Chick.* (29517)

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Recently, I(1,2) have shown that the exo-erythrocytic stage of *Plasmodium gallinaceum* infection is apparently not established in the albino mouse when the sporozoites of the organism are introduced by the mosquito, and that the inhibitory action seems to be ex-

erted almost immediately in the skin at the time of the introduction of the organisms. Presently, I am reporting an attempt to determine whether the skin temperature difference between the chick, a susceptible species, and the mouse might account for the non-susceptibility of the latter.

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