staff attending the child make it almost certain that the mother was the source of infection.

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THE MEAT RATION AND BLOOD LEVELS INVESTIGATION OF INDIAN SOLDIERS IN PERSIA AND IRAQ, 1944

BY

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The striking contrast between the vegetarians and the meat-eaters of the Indian soldier population at Shaiba (Iraq) in the incidence, severity, and type of anaemia suffered (Taylor and Chhuttani, 1945) promoted an investigation into the blood levels of the apparently healthy men on full duty.

The garrison had about 17,000 meat-eaters and 1,188 vegetarians. Two units (S and B), each with a strength of over 500 men and well over 50 vegetarians, were chosen because among the vegetarians in unit S the incidence of nutritional macrocytic anaemia was high whereas unit B was the only major unit without a single case of anaemia for at least a year previous to the time of the investigation. The material was not selected, any two meat-eating and vegetarian soldiers being sent each day by unit authorities from among those who were doing full duties.

Blood was taken in oxalated flasks from the vein first thing in the morning, before breakfast, and sternal puncture was performed at the same time. In addition to a full clinical examination, including search for signs of malnutrition, stools were examined for helminthic and protozoal infection in all cases. The haematological investigations were carried out in the field laboratory attached to the hospital by the workers who had done the anaemia cases; they were not aware of the clinical features or the dietetic habits. Cytological nomenclature and the haematological technique of the earlier investigation were adhered to (after Napier and Das Gupta, 1942). The erythrocyte sedimentation rate was estimated by Wintrobe's tubes before spinning them for corpuscular volume estimation.

Forty meat-eaters and forty-two vegetarians from unit S were examined during August–November, 1944. The inquiry had to be suspended when twelve unit B men from each batch had been examined; the data yielded by this unit are thus referred to for one significant feature only. Men from unit S had been in Shaiba for one and a half years and the majority were from United Provinces of India.

The meat-eaters and the vegetarians were served from the same kitchens. The vegetarians had never taken meat

or eggs in their whole life. We often visited unit S camp to acquaint ourselves with the living, eating, and working conditions of the two dietetic groups; these were found to be alike in all respects except that the vegetarians on account of their social customs did not consume the weekly ration of 20 oz. (570 g.) of fresh mutton. The unit was carrying out pioneer duties of a heavy nature entailing a 44-hour week.

The daily rations were: 18 oz. (510 g.) of atta (wheat flour) or rice, 2½ oz. (70 g.) of dal (pulses), 3¼ oz. (92 g.) of ghee (clarified butter or vegetable oil), ¾ oz. (19 g.) of condiments, 2 oz. (57 g.) of onions, 2 oz. of potatoes, 4 oz. (114 g.) of fresh vegetables, 2 oz. of unsweetened tinned milk, and 6 oz. (170 g.) of fresh mutton with bone for five days in the week. Leafy vegetables were issued for only a few months of the year. In lieu of fresh meat vegetarians were allowed 4½ oz. (128 g.) of tinned milk three days a week and ¾ oz. (21 g.) of ghee and 3 oz. (85 g.) of atta or rice for two days a week, but none of the vegetarians of unit S had received these. No one had supplemented his rations from canteen or elsewhere. The meat ration of 6 oz. of fresh mutton with bone for five days a week amounted to 4 oz. without bone; this was checked in local carcasses. The total daily intake was over 3,000 calories and over 80 g. of vegetable protein.

Haematological and Clinical Features Peripheral Blood

The various averages obtained are shown in Table I. The average means of red cells and haemoglobin were significantly higher among meat-eaters than among vegetarians (5,550,000 and 4,670,000; 15.44 and 14.32 g.).

TABLE I.—*Haematological Averages of Meat-eaters and Vegetarians*

	Meat-eaters (40)			Vegetarians (42)		
	Range	Mean	S.D.	Range	Mean	S.D.
Red cells (millions/c.mm.)	4.46–6.85	5.55	0.58	1.9–6.6	4.67	0.9
Haemoglobin (g./100 ml.)	11.1–19.6	15.44	1.4	7–17	14.32	1.71
M.C.H.C. %	21.7–35.5	28.25	2.32	23.6–33.7	28.54	1.71
M.C.V. (c.µ)	80–114	96.33	8	80–153	109.48	13.4
E.S.R. (Wintrobe)	1–20	4.43	4.24	1–37	10.64	9.15
Total W.B.C.*	3,000–9,000	6,022	1,843	3,000–9,000	5,600	1,524.2
Neutrophils %	30–72	60.4	10.38	39–74	58.25	9.38
Lymphocytes %	20–62	31.7	10.52	15–55	35.68	10.34
Mononuclears %	1–8	4.64	1.76	1–9	3.86	2.35
Eosinophils %	0–8	2.64	1.76	0–12	2.04	2.59
Basophils %	0–4	0.54	0.91	0–1	0.25	0.44

* For the leucocyte count only 33 meat-eaters and 28 vegetarians were observed.

The range and the distribution around the average mean (the standard deviation), especially of red cell counts, were quite abnormal among vegetarians. Whereas there was only one instance among meat-eaters of a red cell count below 4,500,000, there were seventeen among vegetarians. Eight of the latter had red cell counts of 4,000,000 and below, two showing marked anaemia with red counts of under 2 and under 3 millions per c.mm.; all the eight had an M.C.V. above 110 c.µ. Though the average haemoglobin value for meat-eaters was significantly higher than for vegetarians, the difference was not so marked as with the red cell counts. (The explanation of this selective effect on red cell levels in vegetarians lies in the macrocytic type of blood picture exhibited. In haemopoietic-principle (or principles) deficiency anaemia the red cells suffer more than haemoglobin, but in iron-deficiency anaemia it is the haemoglobin which drops relatively more than red cells.) There were five vegetarians and one meat-eater with a haemoglobin value of less than 13 g. Average mean corpuscular haemoglobin concentration (M.C.H.C.) values were low in both groups, being less than one-third in 29%, but there was no significant difference between the two

groups. The M.C.V. in the vegetarians was significantly higher than in the meat-eaters—109.48 c. μ (S.D. 13.4) and 96.33 c. μ (S.D. 8). Twenty vegetarians and one meat-eater had an M.C.V. higher than 110 c. μ , and all except four vegetarians had red cell counts lower than 4,500,000.

The erythrocyte sedimentation rate was found to be significantly higher among the vegetarians. Average means were 10.64 mm. (S.D. 9.15) and 4.43 mm. (S.D. 4.24). Correction for anaemia (Hynes and Whitby, 1938) made no appreciable difference, the corrected average for vegetarians being 9.4 mm. In unit B also the E.S.R. in vegetarians was very significantly higher than in meat-eaters—14.83 mm. (S.D. 9.31) and 4.14 mm. (S.D. 2.54)—in spite of the small total number examined and lack of significant difference between the Hb and red cell levels of the groups. Leucocytes of the two groups of unit S showed no significant differences (Table I).

To sum up, the vegetarians showed a widespread low-grade macrocytic anaemia. In comparison with meat-eaters they had significantly lower haemoglobin and red cell levels, but the M.C.V. and E.S.R. were significantly higher.

Sternal Marrow

The averages, the standard deviations, and the range for each type of cell have been recorded for vegetarians and meat-eaters separately (see Table II). The main point

TABLE II.—Sternal-marrow Differential Nucleated Cell Count

	Vegetarians (41)			Meat-eaters (40)		
	Range	Mean	S.D.	Range	Mean	S.D.
Nucleated red cells:						
Megaloblasts	0-18.5	2.76	2.91	0-2	0.69	0.59
Erythroblasts	2.25-20	10.01	4.64	0.5-8.25	2.13	1.44
Macroblasts	1.75-24.5	12.51	4.52	3-18.5	8.78	3.4
Normoblasts	0-15.5	6.04	3.92	3-27.75	14.52	6.01
White cell series:						
Myeloblasts	0.25-5.25	2.18	1.26	0.1-5.25	2.22	2.99
A. Granular series:						
Premyelocytes	0-6.5	1.6	1.4	0-5.75	1.51	1.32
Neutrophil myelocytes ..	3.25-17	9.81	3.53	2.5-5.25	9.85	4.14
" metamyelocytes ..	7.75-22	14.02	3.57	4.75-19.75	13.38	3.56
" band form	1.25-10.75	5.43	2.32	1.75-11	5.61	2.29
" segmented	8.25-48.75	14.44	7.14	2.8-39	15.62	7.89
Eosinophil myelocyte ..	0-7.5	2.31	4.11	0.5-5.75	1.75	1.26
" metamyelocyte ..	0-3.5	0.93	0.77	0-2.25	0.72	0.6
" band form	0-1.75	0.25	0.46	0-1.5	0.2	0.33
" segmented	0-10.25	2.26	2.05	0.25-7.25	1.73	1.37
Basophils	0-2.25	0.56	0.6	0-2	0.6	0.56
B. Non-granular series:						
Lymphocytes	4.5-23.5	13.61	4.65	7.5-33	18	7.46
Plasma cells	0-2.25	0.72	0.61	0-2.5	1.15	0.65
Large mononuclears ..	0-2.25	0.4	0.56	0-2.25	0.52	0.6

of interest was the difference between the two groups in respect of the nucleated red cell elements. The percentage of megaloblasts, erythroblasts, and macroblasts in the vegetarians was significantly higher than in the meat-eaters. In contrast the percentage of normoblasts was significantly lower among vegetarians than among meat-eaters. Even excluding the marrow counts of the two markedly anaemic vegetarians (see above) the significant differences held true. There were six vegetarians with megaloblasts above 4% ; but only one of the meat-eaters reached 2%. Again, 27 vegetarians and one meat-eater showed a proportion of erythroblasts higher than 8%. Readings of more than 4% of megaloblasts and 8% of erythroblasts in sternal marrow are well outside the usually accepted normal limits.

It was found that in the meat-eaters no significant correlation existed between the red cell count, Hb, M.C.V., and the nucleated red cell elements of the sternal marrow. But in the vegetarians the haemoglobin and the red cell counts bore a significant negative correlation to the percentage of megaloblasts. The correlation between red cell counts and macroblasts, also normoblasts, was positive but significant at 5% value. The M.C.V. showed a positive correlation to the percentage of megaloblasts, significant at 5% value.

Clinical

There was no clear clinical difference between the two groups. No one had an enlarged spleen. The vegetarians could often be distinguished by a tired look. The average means of weight and height showed no appreciable difference. The history of past illnesses was carefully gone into in each case (Table III). Authentic records of previous treat-

TABLE III.—Complicating Factors

Disease	No. of Cases	
	Vegetarians	Meat-eaters
*Bacillary dysentery	3	1
Hookworm	4	6
*Infective hepatitis	Nil	1
*Malaria	2	Nil
Roundworm	Nil	1
Syphilis (under treatment) ..	1	3
Tapeworm	Nil	1

* During the previous year.

ment in hospital overseas were available, and the men were under the regular supervision of the unit medical officer. Only five meat-eaters and six vegetarians gave a history of a relevant illness during the previous year. Three of these six vegetarians (two had had bacillary dysentery and one malaria during the previous year) and another harbouring hookworms showed red cell counts below 4,000,000 per c.mm. and macrocytosis (M.C.V. above 110 c. μ). Four vegetarians and six meat-eaters showed hookworm infestation. This was light, was equally distributed between the two groups, and bore no relation to the blood levels (Table III). Thus out of ten vegetarians with a possible anaemia-precipitating factor four showed macrocytic anaemia. None of the thirteen meat-eaters exhibiting similar precipitating factors (Table III) was suffering from appreciable anaemia, the lowest red cell count and Hb reading being 4,750,000 and 13.18 g. ; there was no macrocytosis.

Signs suggestive of early hypovitaminosis A and B₂ (riboflavin and nicotinic acid) were seen in a number of cases in both groups (Table IV); the incidence did not vary

TABLE IV.—Findings in Mouth, Eyes, Nails, and Skin

	Meat-eaters (40)	Vegetarians (42)
Angular stomatitis	32	15
Cheilosis	22	24
Seborrhoea of nose	9	4
Geographical tongue	1	—
Glossitis	1	1
Bitot's spots (xerophthalmia) ..	5	3
Phrynodermia	—	2
Koilonychia	1	3
Flat nails	1	4

significantly between the meat-eaters and the vegetarians. Koilonychia and flattened nails were seen. These findings in skin, mouth, eyes, and nails were not confined to this one unit but were to be seen well distributed among the local Indian soldier population.

Discussion

The vegetarians on the whole showed significant incipient macrocytic anaemia which on quite a few occasions was marked and clinically overt even though the men were performing full duties. Their sternal-marrow picture was also significantly different from that of the meat-eaters and confirmed the findings in the peripheral blood. The megaloblasts were seen to be increased with the fall in the red cell count and rise in M.C.V. Normoblasts and macroblasts, on the other hand, increased or decreased with the red cell count. These facts meant that a factor (or factors) contained in the weekly 20-oz. ration of meat and needed for maturation of megaloblasts and prevention of macrocytic anaemia was not always present in the required

amount in the diet of vegetarians. Both groups seemed to be deficient in iron, as indicated by the low M.C.H.C. The finding of koilonychia and flattened nails supported this idea.

Clinically the two dietetic groups presented no differences. Relevant past illnesses and helminthic infection were scarce, but, as has already been emphasized, four of the ten vegetarians with a possible precipitating factor showed appreciable macrocytic anaemia. Of the 32 remaining vegetarians to whom no precipitating factor could be assigned four showed a comparable degree of macrocytic anaemia (red cells below 4,000,000 and M.C.V. above 110 c. μ). This difference in the incidence of anaemia was, however, not significant. Thirteen meat-eaters had similar precipitating factors but, as already stated, none showed anaemia; the higher incidence of anaemia amongst the vegetarians with precipitating factors (4 out of 10) was thus significant. In other words, there was strong evidence to show that under the particular conditions of diet, work, and coincident illness 20 oz. of fresh mutton a week was sufficient to prevent the development of macrocytic anaemia.

The incipient macrocytic anaemia among the vegetarians doing full duties and the high yearly admission rate to hospital (54.1 per 1,000) of vegetarians with nutritional macrocytic anaemia, often severe and serious, could be linked. Any factor putting the bone marrow of such "normal" men to a haemopoietic stress can be understood to bring out a complete picture of haemopoietic failure and gross anaemia of the macrocytic type. That this did happen is borne out by the significantly higher incidence of precipitating factors among vegetarian anaemia patients as compared with men at work. All except one of the vegetarian anaemia cases in hospital had one or more of such factors operating. On the other hand, there were only ten instances (out of 42) of this happening in the vegetarians at work. Malaria, bacillary dysentery, and hookworms were the three commonest precipitating factors in the anaemia series.

Three of the vegetarians showing moderate to severe macrocytic anaemia were admitted to hospital for fuller investigation, including repeated stool examinations, Kahn test, gastric analysis, and skiagram of chest. In one case there was a history of an attack of bacillary dysentery six months previously, but nothing abnormal was observed at the time of the present investigation. The other two had had no illness for at least the previous eighteen months, and thorough clinical and laboratory investigation in hospital revealed no other abnormal findings. Rest in bed and the unit diet led in both cases to return of a normal blood picture within four weeks (Table V).

TABLE V.—Result of Treatment of Two Cases of Anaemia Among the Vegetarians

Case No.	Time	R.B.C. (millions)	Hb (g.)	M.C.H.C. %	M.C.V. c. μ
1	On admission	2.7	11.64	28.1	153.4
	4 weeks after unit diet and bed rest	4.8	14	31.1	93.7
2	On admission	3.7	14.7	30.6	128.6
	4 weeks after unit diet and bed rest	5	14.7	32.6	90

At the time of the investigation it was questioned whether diet alone without precipitating factors was capable of producing a nutritional macrocytic anaemia. According to Thomson (1944), "It is doubtful if this nutritional macrocytic anaemia has ever been described in cases without some unusual strain on haemopoiesis, such as that of pregnancy or malaria." There appears to be little doubt that this does happen under certain conditions of hard physical work even when the total daily calorie intake is over 3,000 and

vegetable protein over 80 g. The part played by work on a borderline diet is easily understood, and was well illustrated by the brisk haematological recovery of the two anaemia cases on being put to bed on the very diet which had produced their anaemia. Several workers have recently recorded cases of nutritional macrocytic anaemia due to diet alone and without precipitating factors (Moore *et al.*, 1944; Watson and Castle, 1946; Spies *et al.*, 1948).

Summary

Haematological investigation of a group of vegetarian and meat-eating Indian soldiers doing full duties in a desert garrison of about 17,000 meat-eaters and 1,188 vegetarians, the latter of whom showed a high hospital admission rate of nutritional macrocytic anaemia, revealed that on the average the vegetarians exhibited a statistically significant lower blood level, with macrocytosis. A number were suffering from frank nutritional macrocytic anaemia. The vegetarians' sternal-marrow nucleated red cell percentages were also significantly different from those of the meat-eaters and had a higher megaloblast-erythroblast level.

In the absence of any constant aetiological factor other than diet the haematological differences were concluded to be due to the lack of the weekly ration of 20 oz. of fresh mutton in the vegetarians' diet and the consequent insufficiency of haemopoietic requirements. The daily rations contained over 3,000 calories and over 80 g. of vegetable protein.

It was shown that under conditions of hard physical work diet alone, unassisted by precipitating coincident diseases, could bring about a frank nutritional macrocytic anaemia.

There was suggestive evidence of widespread iron deficiency in both groups.

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TOTAL CYSTECTOMY

BY

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Malignant disease of the urinary bladder is fairly common and if untreated usually causes great suffering, especially in its later stages. Cystectomy itself is not a difficult operation, but the diversion of the urinary flow which it necessitates is not so simple. A cystitis is often present quite early in malignancy; this responds poorly to the usual forms of treatment, and in elderly people soon leads to an ascending infection with dilatation of the ureters and renal insufficiency. In such cases transplantation of the ureters into the colon becomes a very hazardous procedure, and the general surgeon has been loath to undertake it. The choice of technique, too, has been a difficulty. The simple ones have not been satisfactory, and the more elaborate seemed suitable only for the specialist. This at any rate has been my own experience.

Some years ago, however, a method was introduced of implanting the ureters into the colonic wall, without