C H A P T E R III

RESULTS AND DISCUSSION

CHAPTER III

RESULTS AND DISCUSSION

PART I. Comparative data on the physical status, dietary intake, clinical and biochemical status of children of the school going age in the lower and upper classes

(a) Physical Status

Data on heights, weights and weight/height ratio of boys in the lower and upper classes are compared with those based on combined norms of American, British and Canadian subjects (Hawkins, 1964) are presented in Table 17. A wide gap is evident between the lower and upper class with regard to both height and weight at all age levels. There is a similar gap between the upper class and western norms. The differences in weight cannot be accounted for in terms of those in height as the weight per unit height is also lower in the lower class (Figs.1, 2 and 3). In the case of boys upto 15 years, heights and weights in the lower class were found to be about 90% (87-94) and 80% (76-86) of those for the upper class. The present study confirm those of other investigators who have demonstrated the

Table 17. Data on heights, weights and weight/height ratio of boys (7-12 years) in the lower and upper classes compared with Western Norms.

Age (Years)	No. of subjects		Height (cm)			Weight (kg)			Weight(kg)/Height(cm)		
	Lower class	Upper class	Lower class	Upper class	Western* Norms	Lower class	Upper class	Western Norms	Lower Class	Upper Class	Western norms
7	69	74	106.7 (86.2-121.9)	114.3 (92.1-124.9)	122	16.4 (14.1-22.3)	20.0 (15.2-26.3)	23.0	0.154	0.175	0.189
8	99	59	111.8 (91.4-127.4)	119.4 (97.0-132.8)	128	17.3 (14.2-23.6)	21.4 (16.5-27.5)	25.7	0.155	0.179	0.201
9	82	71	115.0 (94.0-129.5)	124.3 (110.7-138.2)	133	19.1 (13.9-23.6)	23.2 (15.0-30.5)	28.5	0.166	0.186	0.214
10	68	97	119.4 (96.5-234.6)	129.5 (112.5 148.1)	139	21.4 (16.9-26.0)	25.0 (19.7-32.4)	31.3	0.179	0.193	0.225
11	83	97	124.5 (111.8-138.6)	134.6 (119.2-152.0)	143	22.8 (19.6-26.9)	27.5 (20.2-35.2)	34.5	0.183	0.204	0.241
12	81	112	129.5 (106.7-152.4)	138.4 (124.3-156.1)	147	24.6 (17.8-32.0)	29.8 (22.6-39.0)	37.8	0.190	0.215	0.257

Range given in parenthesis ; * Data taken from Hawkins (1964)

FIG 1. HEIGHTS OF BOYS (7-12 YEARS) IN THE LOWER AND UPPER CLASSES COMPARED WITH WESTERN NORMS

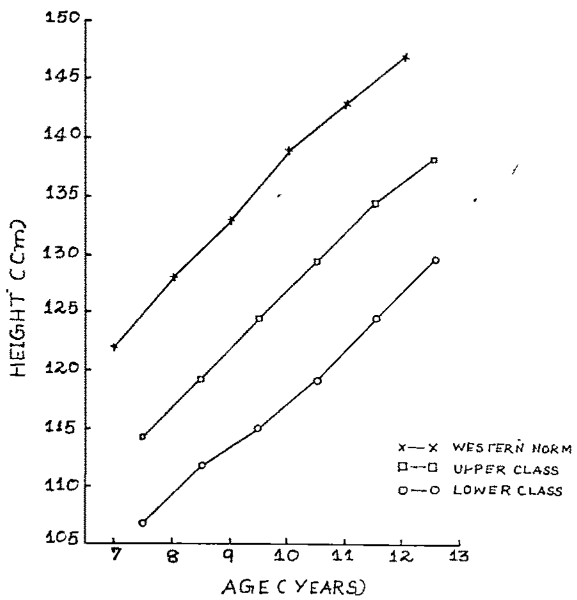


FIG.2. WEIGHTS OF BOYS (7-12 YEARS) IN THE LOWER AND UPPER CLASSES COMPARED WITH WESTERN NORMS.

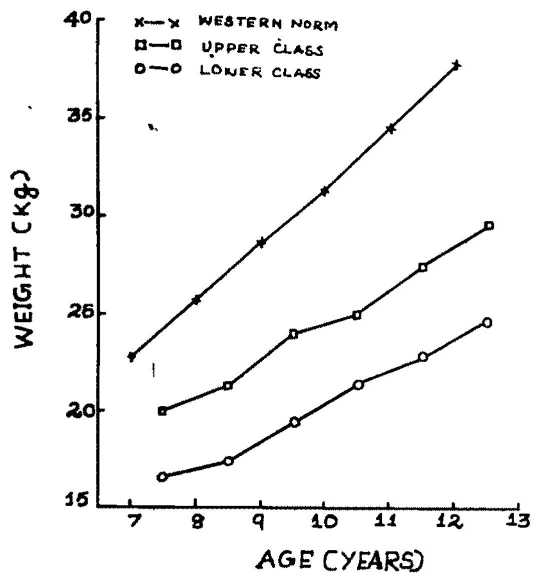
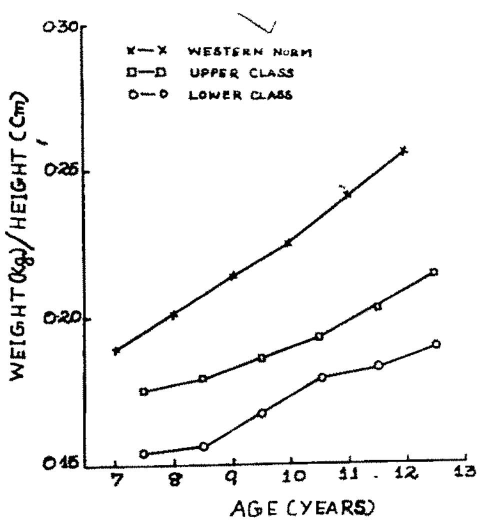


FIG.3. WEIGHT (Kg) PER UNIT HEIGHT (Cm) OF BOYS (7-12 YEARS) IN THE LOWER AND UPPER CLASSES COMPARED WITH WESTERN NORMS.



superior physical growth of children in the affluent sections of the population (Clements,1953; Collis et al, 1962; Udani, 1963; Currimbhoy, 1963a; Ascheroft and Lovell, 1964; Walker et al, 1965; Rowlands et al, 1968).

The data on heights and weights are in reasonable agreement with those reported by Someswara Rao (1961) for poor Indian children. No comparative data seems to be available on upper classes. The clear cut difference between the two groups underlines the importance of nutritional factors on growth. The values obtained for the upper class must be considered as norms which can be easily attained by the lower class if adequate nutrition is available.

Some of the subjects belonging to the lower class in Raipura and Bhaili and upper class subjects in Baroda were subjected to more extensive investigations. Their selection was made on the basis of their willingness to co-operate in the investigations. Data on the age, economic status and physical stature of the subjects are given in Table 18.

Table 18. Age, height, weight and economic status of the school boys (7-12 years) in the lower and upper classes selected for the study

	Lower class		Upper class	Western norms **
	Raipura	Bhaili	Baroda	
Income (Rupees per month per family)	Below 100	Below 100	Above 500	-
Average age (years)	9.6	9.9	9.6	9.5
Number of subjects	60	30	21	-
Height (cm) *	126.0 ± 0.96	~~120.9~~ ± 0.19	129.4 ± 3.05	135.3 ± 3.86
Weight (kg) *	20.8 ± 0.83	19.7 ± 0.31	24.6 ± 2.60	30.1 ± 2.25
Weight(kg)/ Height(cm) *	0.165 ± 0.005	0.162 ± 0.006	0.193 ± 0.015	0.221 ± 0.010

$ 1 (U.S.) = Rs. 7.7

* Values are means ± S.E's.

** Data taken from Hawkins (1964)

(b) Dietary Intake

Comparative data on the dietary and nutrient intake of the lower and upper class families of the children selected for the extensive studies were obtained using the oral questionnaire method and they are presented in Tables 19 and 20. The dietary intake of the families in Raipura and Bhaili are almost the same except that there is an increased cereal and reduced milk intake in Raipura as compared to Bhaili. The diet of the upper class seems to be more or less adequate on the basis of recommended allowances.

It can be seen from Table 20 that the diets of the lower class families are deficient not only in nutrients such as calcium, vitamin A and riboflavine but also in calories.

The typical meals consumed by the subjects in the different groups studied are shown in Table 21. The meals pattern of the lower class subjects is monotonous and is almost exclusively based on cereals whereas the upper class diets include more of milk, legumes, vegetables, fats and sugar.

Table 19. Comparative data on the dietary intake of the families in the lower and upper classes

Foodstuff	Amount (g) consumed per capita per day			Recommended allowance per adult ICMR (1966)
	Lower class		Upper class	
	Raipura	Bhaili	Baroda	
Cereals	400–450	350–400	250–300	400
Pulses	30–40	40–50	50–60	85
Milk	60–70	100–150	400–500	284
Leafy vegetables	5–10	10–15	10–15	114
Other vegetables	75–100	100–150	150–200	170
Fruits	10–15	20–30	50–75	85
Flesh foods	Negligible	Negligible	0–30*	25
Fats and Oils	10–15	20–30	40–50	57
Sugar and Jaggery	15–25	20–30	40–50	57

* Usually eggs.

Table 20. Nutrient content of diets consumed by the families in the lower and upper classes

Nutrients	Amount per capita per day			Amount recommended as nutrient (ICMR, 1966)
	Lower Class		Upper class	
	Raipura	Bhaili	Baroda	
Calories	1750–2070	1780–2210	2020–2550	2800
Protein (g)	51–59	50–60	53–68	55
Calcium (mg)	300–360	400–550	1030–1310	1000
Iron (mg)	28–32	27–32	23–29	20–30
Vitamin A(i.u.) as preformed vitamin	60–70	100–250	400–500	–
as carotene	960–1440	1350–1890	1450–2640	–
Total	1020–1510	1450–2040	1850–3140	3000–4000
Thiamine (mg)	1.43–1.65	1.38–1.58	1.33–1.65	1.0–2.0
Riboflavine (mg)	0.63–0.65	0.69–0.87	1.00–1.27	1.5
Vitamin C (mg)	26–34	47–65	74–103	50
Nicotinic acid (mg)	20–22	13–15	11–13	–

Table 21. Typical meal consumed by subjects in the different groups studied

Time	Lower Class		Upper Class	
Morning	Tea	1/2 - 1 cup	Tea or Milk	1 cup
	Rotla (Bajra)	1/4 - 1/2	Bread	2 - 4 slices
			Chapatie(wheat)	1 - 2
Nooh	Rotla (Bajra)	1 - 2	Rice	1 - 2 serving
	dal (liquid)	30 - 50 g	Chapatie (wheat)	2 - 4
	Vegetables	30 - 50 g	Vegetables (including leafy vegetables)	50 - 60 g
			dal (liquid)	50 - 60 g
Evening	Tea	1/2 cup	Tea	1 cup
	Rotla (Bajra)	1/4 - 1/2	Bread	1 - 2 slices
			Biscuit or Groundnut	25 g
			Fruit	50 g
Night	Khichri	1 - 3 serving	Rice	1 - 2 serving
	Vegetables	30 - 50 g	Poori (wheat)	6 - 8
			dal (liquid)	30 - 50 g
			Vegetable	50 - 60 g
			Milk	1 Cup

The composition of the diets consumed was calculated using the recipe method. The conversion tables used for the purpose are shown in Table 22.

The dietary and nutrient intake of the school boys in the different groups are presented in Tables 23 and 24. The difference in the meal patterns of the families is, as might be expected, reflected in the food intake of the subjects studied. The children in fact are getting less than their due share if we compare the amounts consumed by them with those available per capita in the families studied. This may be because of preferential treatment for the adult wage earner in most families.

The calorie requirements were calculated on the basis of age, sex, height and weight of the upper class subjects using Aub-DuBois standard (Aub and DuBois, 1917) for basal metabolic rate and adding an appropriate allowance for activity (Table 25). The requirements of other nutrients were taken from appropriate standards. The nutrient content of the diets consumed was compared with the amounts recommended. It can be seen from Table 24 that there was a deficiency in calories, protein, calcium, vitamin A and riboflavine when compared to recommended allowances.

Table 22. Conversion tables used for the estimation of raw ingredients in cooked foods

Preparation	Weight(g) of one serving	Raw ingredients(g) in one serving *
Liquid foods		
Tea	150	Milk, 25 + sugar, 10
Milk	150	Milk, 150.
Liquid dal	25	Redgram dal, 5.
Curd	50	Milk, 50.
Solid foods		
Rotla	75	Bajra, 50.
Roti	75	Wheat, 50.
Rice	150	Rice, 40.
Khichri	150	Rice or Kodri, 35. Redgram dal, 5. Oil, 2.
Debra	75	Bajra, 50. Fenugreek, 2, Oil,3.
Dhokla	120	Bajra, 35. Bengalgram dal, 15, oil,3. Leafy vegetables,15.
Poora	75	Wheat,20. Bengalgram dal,5,oil,3. leafy vegetables, 5.
Vegetables (cooked)	30	Vegetables, 25. Oil,2.

* The ingredients calculated using the recipe method. Salt, Water and spices used in cooking were not taken into account.

Table 23. Dietary intake of the school boys (7-12 years) in the lower and upper classes.

Foodstuff	Amount (g) consumed per day *		
	Lower class		Upper class
	Raipura	Bhaili	Baroda
Cereals and millets	241	184	180
Pulses	27	32	60
Milk	46	142	300
Leafy vegetables	-- negligible	--	10
Other vegetables	49	65	100
Fruits	-- negligible	--	40
Fats and oils	8	12	30
Sugar and Jaggery	8	13	30

* Matched collection of all the foods consumed were obtained over a five days period in Raipura and Bhaili and their composition calculated from data simultaneously obtained on the weights of raw ingredients used and cooked foods. Records of food intake were kept in the case of upper class subjects and their composition calculated using the recipe method.

Table 24. Nutrient intake of the school boys (7-12 years) in the lower and upper classes

Nutrients	Amount consumed per day			Requirements (a)	Reference
	Lower Class		Upper class		
	Raipura	Bhaili	Baroda		
Calories	1080	1050	1570	1583	Aub and DuBois (1917)*
Protein (g)	31	32	44	57	FAO(1957)
Calcium (mg)	210	410	800	600-700	FAO(1962)
Iron (mg)	18	16	23	20-30	ICMR(1966)
Vitamin A(i.u.): as preformed vitamin	50	140	300	-	-
as carotene	410	410	1130	-	-
total	460	550	1430	1405	Mitchell (1964)
Thiamine (mg)	0.80	0.80	1.10	0.84	Mitchell (1964)
Riboflavine (mg)	0.41	0.49	1.00	1.16	Mitchell (1964)
Vitamin C (mg)	15	22	55	15	Mitchell (1964)
Nicotinic acid(mg)	8	7	8	11	Mitchell (1964)

* See Table 25

(a) The calorie requirements were calculated from the age, sex, height and weight of the upper class subjects using Aub-DuBois standard for B.M.R. and adding an appropriate allowance for activity (Table 25). The dietary standard used for the other nutrients were selected on the basis of their suitability for Indian conditions.

Table 25. Energy requirement of the school boys (7-12 years) in the lower and upper classes

	Lower class	Upper class
Age (years)	(7-12)	(7-12)
Sex	Male	Male
Mean height (cm)	126.0	129.4
Mean weight (kg)	18.6	24.6
Surface area (sq.meters)	0.83	0.96
BMR per square meter of surface area per hour according to age and sex	49.50	49.50
BMR per day (49.50x24xSurface area)	986	1140
BMR per kg of body weight	53	46
Reduction for sleep (8 hours)	33	38
Net BMR	953	1100
Total energy cost of activities *	294	401
Energy requirements for BMR+activity	1247	1506
Allowance for fecal losses **	63	76
Dietary calories required	1310	1583

*Daily routine		Activity cost (calories per kg) per hour	per hour
Attendance in the class	(5 hours)	0.50	2.50
Study at desk	2 hours	0.50	1.00
Personal care	1½ hours	0.50	0.75
Meal time	1½ hours	0.50	0.75
Walking	1 hour	2.00	2.00
Relaxation	2 hours	0.50	1.00
Play	3 hours	3.00	9.00

* Allowing 5% for fecal losses and assuming that losses due to specific dynamic effect and the effects of warm environmental temperature cancel out each other.

(c) Clinical Status

The clinical status of the school boys in the lower and upper classes and the criteria used to assess the clinical symptoms are shown in Tables 26 and 26 a. The data on clinical status are also presented graphically in Figure 4. Stunted physical growth and deficiency of adipose tissue are common in the lower class. The incidence with regard to deficiency of protein, vitamin A and riboflavine are more than 75% in the Raipura children. Those in Bhaili showed a smaller incidence of protein deficiency. The clinical picture obtained is consistent with expectations based on dietary intake. The pattern of deficiency is similar to that observed in other parts of the country (Rao et al, 1961). A deficiency of vitamin C and calcium was found in a few children. The only symptom of vitamin C deficiency was bleeding gums. This may be due to causes other than vitamin C deficiency. This might well be the case as only 4% of the children in Raipura were found to have deficient values for vitamin C in serum.

The upper class subjects were generally free from clinical symptoms but some showed a deficiency of vitamin A and riboflavine. The higher incidence of dental caries in the upper class may be due to a greater consumption of

Table 26b. Clinical status of the school boys (7-12 years) in the lower and upper classes

Clinical Symptoms	Raipura (n=60)	Bhaili (n=30)	Baroda (n=21)
Eyes			
Conjunctiva			
Xerosis			
Normal	15(25)	8(26)	18(86)
Slightly dry on exposure for 1/2 mt. lack of luster	44(73)	15(57)	3(14)
Dry and wrinkled	0(0)	3(10)	0(0)
Bitot's spot present	1(2)	2(7)	0(0)
Pigmentation			
Normal colour	23(38)	21(70)	20(95)
Slight discolouration	34(57)	9(30)	1(5)
Moderate browning in patches	3(5)	0(0)	0(0)
Cornea			
Vascularisation			
Normal	54(90)	27(90)	20(95)
Circumcorneal injection of blood vessels	6(10)	3(10)	1(5)
Total No. showing eye symptoms	45(75)	22(73)	3(14)
Tongue			
Appearance			
Normal	6(10)	5(17)	15(71)
Pale but not coated	54(90)	25(83)	6(29)

Table 26b. (continued)

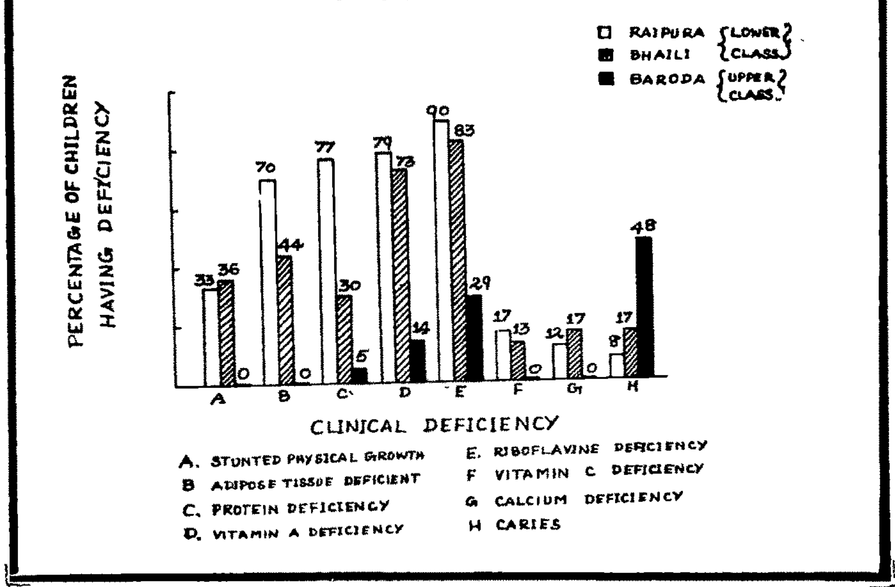
Clinical Symptoms	Raipura (n=60)	Bhaili (n=30)	Baroda (n=21)
Surface			
Normal	26(43)	17(57)	16(76)
Fissured	34(57)	13(43)	5(24)
Gums			
Normal	50(83)	26(87)	21(100)
Bleeding and/or gingivites	10(17)	4(13)	0(0)
Caries			
Absent	55(91)	25(83)	11(52)
Slight	4(7)	5(17)	6(29)
Marked	1(2)	0(0)	4(19)
Skin			
Appearance			
Normal	53(88)	27(90)	21(100)
Loss of luster	7(12)	3(10)	0(0)
Adipose tissue			
(To be judged by the examination of the arm over the biceps)			
Normal	18(30)	17(57)	21(100)
Deficient	42(70)	13(43)	0(0)
Bones			
Normal	53(88)	25(83)	21(100)
Stigmata of past rickets	7(12)	5(17)	0(0)

Percentage shown in parenthesis

Table 26a. Criteria associated with deficiency of particular nutrients

Deficient nutrient	Item No. in the ICMR schedule (1948)	Symptoms
Vitamin A	7	conjuctiva; slightly dry on exposure for 1/2 minute, lack of luster, very dry, wrinkled and Bitot's spots
	8	Slight discoloration of the conjuctiva
Riboflavine	11	Cornea: circumcorneal injection of blood vessels
"	17	Tongue: pale but not coated, red and raw.
"	18	tongue : fissured, ulcered, glazed and atropic.
Protein	8	pigmentation of the conjuctiva.
"	23	hair : loss of luster, discoloured and dry.
"	24	skin : dry, rough and lusterless
"	31	oedema
Vitamin C	20	bleeding gums
Calcium	32	stigmata of past rickets
Calories (adipose tissue)	30	adipose tissue deficient

FIG. 4. CLINICAL DEFICIENCY OF BOYS (7-12 YEARS) SELECTED FOR STUDY FROM THE LOWER AND UPPER CLASSES



sugar. No difference was found in the fluorine content of drinking water in the three areas. This is consistent with reports of the association of dental caries with increased westernization and consumption of refined foods as bread (Shourie, 1941) and excessive consumption of sugar (Chapin and Mills, 1942; Shourie and Marshall - Day, 1950). The incidence is low in rural areas (Amatayakul et al, 1960) and among people not consuming much sugar (Shourie, 1941 ; Phillippas, 1955; Hutarte and Scrimshaw, 1955).

(d) Intestinal Infestation

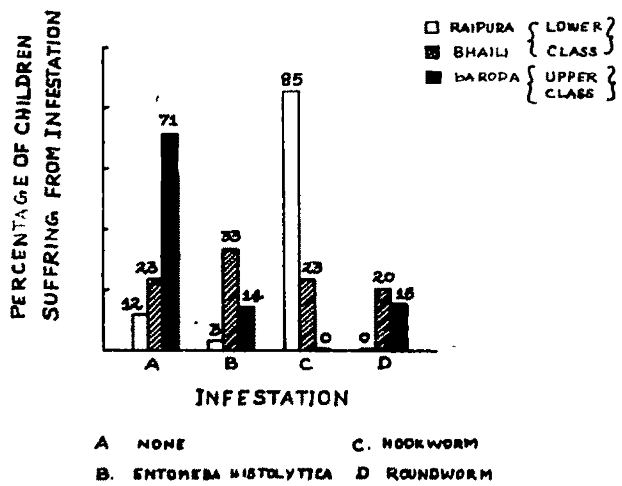
Data on incidence of intestinal infestation in the different groups studied are presented in Table 27. It can be seen from the same that most of the subjects in Raipura suffer from hookworm infestation (85%) whereas infestation with Entomeba histolytica (33%) is more common in Bhaili. The proportion of subjects showing some infestation or other was most in Raipura and least in Baroda (Fig. 5). The difference may be due to the better sanitary conditions in urban areas. In this connection it must be mentioned that Bhaili is somewhat more urbanised. Application of the Chi square test to the ssignificance of the differences between these centres with regard to

Table 27. Incidence of intestinal infestation in the school boys (7-12 years) in the lower and upper classes.

Parasite present	Number and percentage in *		
	Lower Class		Upper class
	Raipura (n=60)	Bhaili (n=30)	Baroda (n=21)
None detected	7(12)	7(23)	15(71)
Entomeba histolytica	2(3)	10(33)	3(14)
Hook worm (Necator americanus and Ankylostoma duodenale)	32(53)	5(17)	0(0)
Hook worm along with other parasites such as EH, E.Coli and H. nana.	19(32)	2(6)	0(0)
Round worm (Ascaris lumbricoides)	0(0)	3(10)	2(10)
Round worm along with other parasites such as EH and E.Coli	0(0)	3(10)	1(5)

* Percentage shown in parenthesis.

FIG.5. PERCENTAGE INCIDENCE OF INTESTINAL INFESTATION IN BOYS (7-12 YEARS) SELECTED FOR STUDY FROM THE LOWER AND UPPER CLASSES



subjects not having any infestation gave a value of 28.4 ($P < 0.001$).

It is also possible that the difference in nutrient intake might have contributed to the infestation as the relation between nutrition and susceptibility to infections has been postulated by a number of investigators (Scrimshaw, 1964; WHO, 1965; Scrimshaw, 1966). Poor nutrition and parasitic infestations are believed to act synergistically with each other (Scrimshaw et al, 1959).

Some of the children in Bhaili and all the subjects in Baroda wore foot-wear. None of the Raipura children had slippers or shoes. Wearing of shoes undoubtedly has an important influence on the incidence of hookworm infection (Patel, 1954). This may also have contributed to the low incidence of hook-worm infection among upper class children.

(e) Biochemical Status

Data on the composition of blood and serum are shown in Table 28. The values obtained for Raipura children are less than those obtained for Bhaili children and the latter, less than those of the upper class children. This is consistent with expectations. The biochemical data

Table 28. Composition of blood and serum of the school boys (7-12 years) in the lower and upper classes

Constituents	Lower Class		Upper Class
	Raipura (n=55)	Bhaili (n=30)	Baroda (n=20)
<u>Values per 100 ml</u> :			
Hemoglobin in blood(g)	8.0 ± 0.25*	10.1 ± 0.34	11.9 ± 0.25
<u>Serum</u>			
Total protein (g)	6.5 ± 0.15	6.8 ± 0.10	7.5 ± 0.08
Albumin (g)	3.4 ± 0.09	3.7 ± 0.05	4.4 ± 0.08
Albumin : Globulin ratio	1.15 ± 1.01	1.22 ± 0.02	1.42 ± 0.02
Carotene (μg)	28.6 ± 2.1	46.3 ± 3.6	60.0 ± 9.4
Vitamin E (mg)	N.E.	0.28 ± 0.07	0.37 ± 0.09
Vitamin C (mg)	0.50 ± 0.03	0.56 ± 0.06	0.65 ± 0.05
Alkaline Phosphatase (Enzyme units/litre)	5.2 ± 0.89	5.5 ± 0.21	6.0 ± 0.24

Values are means ± S.E's ; N.E. = Not estimated

* Mean for 60 subjects

presented for the lower class compares well with studies carried out in Baroda on the effect of CARE feeding on school going children. (Rajalakshmi *et al*, 1968).

The differences between the subjects of Raipura and Bhaili with regard to blood hemoglobin may be due to the greater incidence of hookworm infestation in the former; that in serum protein may be due to increased efficiency of protein utilization with improved supply of vitamin A; that in carotene is consistent with the difference in dietary intake. The differences between these two groups and the upper class children are in the expected direction. Tests of significance of differences between means of blood or serum constituents are presented in Table 29. From this it is evident that the differences in blood or serum constituent are significant between the lower and upper classes except with regard to vitamin C and alkaline phosphatase.

A similar trend is found in the data on the composition of urine presented in Table 30. A low level of creatinine excretion in undernourished children has been reported by several investigators (Arroyave and Wilson, 1961; Luyken *et al*, 1964). Creatinine excretion has been used as a means of evaluating body composition with respect to protein (Arroyave, 1963). An average of 472 mg per day

Table 29. Tests of significance of differences between means of blood and serum constituents

Groups compared	't' value Raipura and Bhaili	 Raipura and Baroda	 Bhaili and Baroda
Hemoglobin in blood	4.61	8.89	3.15
	p < 0.001	< 0.001	< 0.001
Serum			
Total protein	1.11	3.44	2.02
	p n.s.	< 0.001	< 0.05
Albumin	2.03	5.61	3.98
	p < 0.05	< 0.001	< 0.001
Albumin : Globulin ratio	0.30	3.51	2.66
	p n.s.	< 0.001	< 0.02
Carotene	4.88	7.93	2.94
	p < 0.001	< 0.001	< 0.001
Vitamin E	-	-	1.14
	p		n.s.
Vitamin C	1.06	1.88	0.99
	p n.s.	< 0.10	n.s.
Alkaline Phosphatase	0.50	1.19	0.89
	p n.s.	n.s.	n.s.

n.s. Not significant

Table 30. Composition of urine in the school boys (7-12 years) in the lower and upper classes

Constituents	Lower class		Upper class
	Raipura (n=60)	Bhaili (n=30)	Baroda (n=20)
Creatinine			
mg per 24 hours	365 ± 10.5	382 ± 19.3	492 ± 14.2
Values per g of creatinine :			
Nitrogen (g)	8.7 ± 0.85	8.4 ± 0.25	11.6 ± 0.31
Thiamine (µg)	695 ± 112.2	1020 ± 116.4	1600 ± 59.8
Riboflavine (µg)	414 ± 89.7	536 ± 61.6	1682 ± 72.3
N'methyl nicotinamide (mg)	10.3 ± 1.42	10.7 ± 1.81	12.5 ± 2.18
Vitamin C (mg)	26 ± 2.7	58 ± 2.8	87 ± 4.4
Amount in 24 hour excretion :			
Nitrogen (g)	3.1 ± 0.05	3.2 ± 0.03	5.7 ± 0.06
Thiamine (µg)	248 ± 9.8	389 ± 12.1	790 ± 15.2
Riboflavine (µg)	146 ± 7.8	204 ± 9.9	825 ± 16.1
N'methyl nicotinamide (mg)	3.68 ± 0.07	4.08 ± 0.08	6.10 ± 0.07
Vitamin C (mg)	9.2 ± 1.2	21.5 ± 1.8	42.5 ± 2.1

Values are means ± S.E's

has been reported for upper class children 6-9 years old in Guatemala (Arroyave et al, 1961).

Urinary nitrogen excreted per g of creatinine in the case of children (7-12 years) in the present study compares well with other studies reported in the literature. In Macy's study (1943) in U.S.A. on young white children the value of obtained was varied between 7.8-11.0 g. In the investigation of McCance and Widdowson (1954) on German children the mean figure was 9.5 g of nitrogen per g of creatinine. In the study reported by Arroyave (1962) the nitrogen excreted per g of creatinine was 7.8 and 12.2 respectively in rural poor children and urban upper class children. Observations in Walker's laboratory (1966) indicate mean urinary nitrogen per g of creatinine of 7-8 g in the poor schools and 9-10 g in the schools attended by upper class children.

The actual values for thiamine and riboflavine per g of creatinine for the lower class are similar to those published for rural children in Puerto Rico (Plough et al, 1963 ; Fernandez et al, 1965, 1966, 1968). Tests of significance of differences between means of urinary constituents are presented in Table 31. It can be concluded

Table 31. Tests of significance of difference between means of urinary constituents

	Groups compared	't' Value Raipura and Bhaili	Raipura and Baroda	Bhaili and Baroda
Creatinine				
Per 24 hours		0.97	6.86	3.67
	P	n.s.	0.001	0.001
Values per g of Creatinine				
Nitrogen		0.90	5.87	5.42
	P	n.s.	0.001	0.001
Thiamine		2.28	5.15	3.11
	P	0.05	0.001	0.001
Riboflavine		2.34	23.48	11.10
	P	0.05	0.001	0.001
N'methyl nicotinamide		0.47	2.05	2.02
	P	n.s.	0.05	0.10
Vitamin C		9.41	14.5	6.17
	P	0.001	0.001	0.001

n.s. Not significant

from the Table that the differences between the lower and upper classes are significant as can be expected with regard to all the constituents studied. Those between the subjects of Raipura and Bhaili are significant with regard to thiamine, riboflavine and vitamin C.

The blood and serum values are classified in Table 32 as deficient, low, acceptable or high according to ICNND standard (1963). In the case of blood hemoglobin and serum carotene about 20% of the upper class children are having deficient or low values where as in the case of other constituents they are in the accpptable or high range. The lower class subjects in Raipura, on the other hand, are having 80-90% values in the deficient and low range with regard to blood hemoglobin and serum carotene, and 30-40% in the case of protein and albumin. The lower class subjects in Bhaili are having 25-50% values in the deficient and low range with regard to all the constituents in blood or serum except vitamin C. The vitamin C status in the different groups seems satisfactory. (Figure 6).

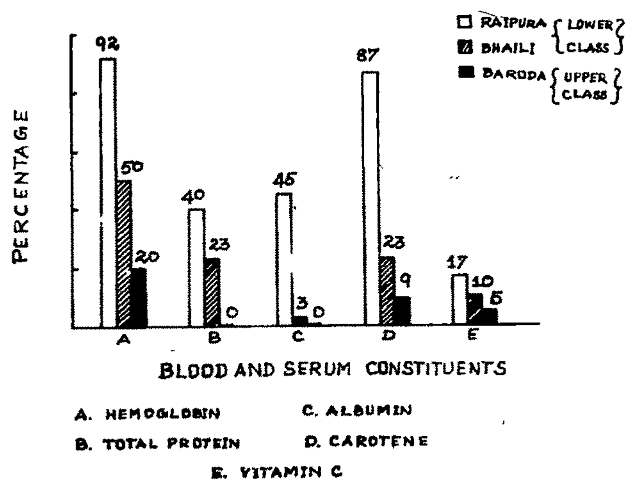
The ICNND has used the vitamin excretion per g of creatinine as a means of judging the vitamin status in many

Table 32. Biochemical status of the school boys (7-12 years) in the lower and upper classes on the basis of ICNND (1963) standards.*

Constituents	Place	No. of subjects	Percentage of children			
			D	L	A	H
Blood						
Hemoglobin	Ra	60	82	10	8	0
	Bh	30	43	7	43	7
	Ba	20	10	10	55	25
Serum						
Total Protein	Ra	55	29	11	11	49
	Bh	30	0	23	13	64
	Ba	20	0	0	0	100
Albumin	Ra	55	16	29	42	13
	Bh	30	0	3	74	23
	Ba	20	0	0	10	90
Carotene	Ra	55	24	63	13	0
	Bh	30	0	23	74	3
	Ba	20	0	9	67	24
Vitamin C	Ra	55	4	13	20	63
	Bh	30	0	10	57	33
	Ba	20	0	5	25	75
Urine (Values per g of creatinine)						
Thiamine	Ra	60	0	16	32	52
	Bh	30	0	0	7	93
	Ba	20	0	0	0	100
Riboflavine	Ra	60	2	50	41	7
	Bh	30	0	17	50	33
	Ba	20	0	0	0	100
N' methyl nicotinamide	Ra	60	0	23	54	23
	Bh	30	0	10	57	33
	Ba	20	0	5	35	60

* ICNND Laboratory Manual for Nutrition surveys (1963)
Ra = Raipura ; Bh = Bhaili ; Ba = Baroda
D = Deficient ; L = Low ; A = Acceptable; H = High

FIG. 6. DEFICIENT AND LOW VALUES OF BLOOD AND SERUM CONSTITUENTS OF BOYS (7-12 YEARS) SELECTED FOR STUDY FROM THE LOWER AND UPPER CLASSES.



population groups. Unfortunately the standards used by the ICNND are applicable to adults only. Pearson (1962) has, therefore, used a tentative guide for the interpretation of urinary thiamine and riboflavine excretions of children expressed in terms of µg per g of creatinine which takes the age of the child into account.

When Pearson's modified ICNND standard was applied to the present investigations with respect to the urinary excretion of vitamins in the subjects they were not found to be seriously deficient although many of them were found to have clinical deficiency symptoms.

Similar studies have been made in independent investigations in this laboratory on preschool children, and adult women including pregnant and lactating women (Chittemma, 1966; Rajalakshmi et al, unpublished). These studies raise questions regarding the validity of the norms suggested for Indian children and for people with low levels of creatinine excretion as the same will increase the amount of vitamin excretion per g of creatinine. It was felt that a better picture might be obtained if in calculating the ratio, a higher excretion of creatinine closer to that prevailing with normal levels of protein intake is assumed. When the values used for creatinine excretion are arbitrarily raised by

50% the proportion of deficient values compares better with the incidence of clinical deficiency (Table 32). The increase by 50% was made on the assumption that about 500 mg. of creatinine excretion per day may represent a satisfactory state of protein nutrition. Whatever the validity of this assumption it is clear that the ICNND norms cannot be applied as such for population groups with low levels of creatinine excretion.

The satisfactory values obtained for serum vitamin C, protein and albumin in upper class subjects, none of whom were found to have deficient values, indicates the adequacy of the diets with regard to protein and vitamin C. On the other hand, their diets would appear to be somewhat deficient in iron on the basis of the relatively lower values obtained for hemoglobin.

In summary, the upper class children in Baroda are found to have more satisfactory diets than poor children in Bhaili or Raipura and this difference is reflected in physical, clinical and biochemical status. Factors other than diet are likely to be involved in the difference with regard to infestation with parasites in the intestine.

PART II. Effect of low cost balanced school lunch on the physical, clinical, biochemical and psychological status of selected school children (7 - 12 years) in Raipura

As stated earlier, some of the children studied in Raipura were given a lunch for a period of five months and studies made of the effects of the same on their nutritional status. The lunch aimed at removing the basic deficiencies in the home diet of protein, vitamin A and riboflavine by including more of legumes and leafy vegetables and by using procedures such as sprouting and fermentation. Cereal and pulse were used in two proportions namely 8:1 and 4:1, the former because of its being more a realistic target for the village and the latter, because studies in this laboratory showed this proportion to result in a satisfactory lysine content. The lunch was varied within a framework as indicated in Table 16. The frequency with which the various preparations were used are shown in Table 33. The botanical names of the ingredients used are shown in Table 33a. The lunch provided compared favourably with those provided in the similar programmes in this country and with the school lunch provided in British schools (Burrows and Evison,1968). Table 34 shows the comparative nutritive value of the some of the school lunches provided in India.

Originally it was planned that Raipura would serve as the experimental village and Bhaili as the control village.

Table 33. Lunch provided in the Programme.

Foodstuff	Ingredients	No. of times prepared
Khichri *	Kodri or rice	51
	Mothbeans, redgram, chavli or peas	
Roti *	Bajra	18
	Sprouted mothbeans or greengram	
Dhokla *	Bajra	13
	Bengalgram	
Poora *	Wheat	15
	Bengalgram	
Debra *	Bajra	11
	Sprouted mothbeans	
Vegetable Preparation	Leafy vegetables (30g)	
	Other vegetables (30g)	
Fruits	Seasonal fruits (30g)	
Buttermilk	Buttermilk (curd : water, 1 : 6) (140g)	

* In these preparations the cereals and pulses specified were used in the ratio of either 8:1 or 4:1. These dishes were served ad libitum

Table 33a. Cereals, pulses and carotene-rich vegetables used in the lunch programme

Foodstuff	Scientific name
Cereals :	
Kodri	Paspalum Scorbiculatum
Bajra	Pennisetum typhoideum
Rice	Oryza sativa
Wheat	Triticum aestivum
Pulses :	
Mothbean	Phaseolus aconitifolius Jacq
Bengalgram	Cicer arictinum
Chavli	Vigna sinensis
Peas	Pisum sativum
Greengram	Phaseolus aereus, Roxb
Redgram	Cajanus cajan
Carotene-rich vegetables :	
Cabbage	Brassica oleracea var. capitata
Fenugreek leaves	Trigonella foenum-graecum
Spinach	Spinacea oleracea
Drumstick leaves	Moringa oleifera
Radish tops	Raphanus sativus
Carrot	Daucus carota
Amaranth	Amarantus gangcticus

Table 34. Nutritive value of the lunch provided as compared to that in other programmes.

Authors	Region	Calories	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (i.u)	Thiamine (mg)	Riboflavine (mg)	Vitamin C (mg)
Geervani (1961)	Madras	366	26	424	3	NR	0.16	0.11	NR
Devadas and Radharukmani (1964)	Coimbatore	522	23	670	15	3442	0.47	0.47	75
Devadas *et al*.(1964)	Coimbatore	524	20	300	5	1315	NR	NR	21
Devadas *et al*,(1967)	Coimbatore	614	20	642	18	3698	0.80	0.67	22
Devadas *et al*,(1968)	Coimbatore	652	20	654	18	7802	0.49	0.70	109
Burrows and Evison (1968)	England	880	29	NR	NR	NR	NR	NR	NR
Present study	Baroda	880	25	190	17	3030	0.67	0.34	30

NR = Not reported.

As it turned out the children in Bhaili were not found to be matched with those in Raipura for the parameters measured. So some of these children who did not attend the lunch programme in Raipura were used as controls. These children happened to be somewhat older on an average than those in the experimental group and this resulted in a somewhat uneven distribution of age, height and weight at the start of the programme (Table 35 and 35a). They also had a slightly greater dietary intake as might be expected on basis of the difference in age and body weights at the start of the investigations. They were, however, matched with regard to clinical and biochemical status.

(a) Dietary intake

Data on the dietary intake of the fed and the control children during experimental period are presented in Table 36. It can be seen from the table that the school lunch provided increased amounts of pulses, leafy and other vegetables, fruits and fats and oils. The nutrient intake of the diets consumed by the fed and the control children are presented in Table 37. There was an increase in calories, protein, carotene, riboflavine and vitamin C intake during the experimental period.

Apart from the increase in protein content, the protein quality of the diet was improved by the addition of pulses, leafy vegetables and buttermilk. As pointed out earlier the addition of pulses to cereals and millets is found to improve

Table 35. Age, height and weight of the subjects selected for study

	Experimentals (n=44)	Controls (n=16)
Age (years)	9.4	10.3
Height (cm)	125.3 ± 2.37	128.5 ± 2.46
Weight (kg)	20.6 ± 0.91	21.4 ± 1.19

Table 35a. Age distribution of the subjects

Age (years)	No.of subjects	
	Experimentals	Controls
7	5	0
8	5	1
9	14	3
10	6	5
11	10	5
12	4	2

Table 36. Dietary intake of the fed and the control children during the experimental period

Foodstuff	Amount (g) consumed **								
	Experimentals						Controls		
	A			B					
	Lunch	Breakfast & dinner	Total	Lunch	Breakfast & dinner	Total	Lunch	Break-fast & dinner	Total
Cereals and Millets	165	115	280	145	120	265	115	140	255
Pulses	21	18	22	37	25	52	14	9	23
Milk	20*	52	72	20	54	74	Nil	52	52
Leafy vegetables	24	Negligible	24	24	Negligible	24	Negligible	Negligible	Negligible
Other vegetables	38	30	68	38	30	68	22	18	40
Fruits	27	Nil	27	26	Nil	26	Nil	Nil	Nil
Fats and oils	20	3	23	18	4	22	4	3	7
Sugar and Jaggery	1	8	9	1	8	9	Nil	8	8

* Equivalent of buttermilk provided; A-Cereal-pulse ratio, 8:1 ; B-Cereal-pulse ratio, 4:1.

** Values derived from records of food intake using the recipe method.

Table 37. Nutrient intake of the fed and the control children durihg the period of lunch

	Amount in the diet provided								
	Experimentals						Controls		
	A			B					
	Lunch	Breakfast & dinner	Total	Lunch	Breakfast & dinner	Total	Lunch	Breakfast & dinner	Total
Calories	900	620	1520	860	640	1500	490	630	1120
Protein (g)	24	19	43	26	18	44	15	18	33
Calcium (mg)	190	170	360	190	170	360	55	170	225
Iron (mg)	17	9	26	17	9	26	8	10	18
Vitamin A(i.u.) as preformed vitamin	20	50	70	20	50	70	Nil	50	50
as carotene	3010	240	3250	3010	240	3250	200	230	430
total	3030	290	3320	3030	290	3320	200	280	480
Thiamine (mg)	0.66	0.50	1.18	0.68	0.49	1.17	0.43	0.50	0.93
Riboflavine (mg)	0.33	0.30	0.63	0.36	0.29	0.65	0.18	0.12	0.40
Ascorbic acid (mg)	30	20	50	30	20	50	.6	9	15
Nicotinic acid (mg)	6	5	11	6	5	11	4	5	9

A - Cereal-pulse ratio, 8:1 ; B-Cereal-pulse ratio, 4.1

the protein nutritive value. Similarly protein quality is also found to be improved by the addition of leafy vegetables to a millet-legume mixture (Table 13, page 69). In other experiments the addition of milk powder at 5 per cent level is found to have a similar effect. It is felt that the improvement on protein quality brought about by the regular addition of legume, leafy vegetables and butter milk was more crucial than the increase in protein content. In animal experiments carried out by co-investigators, rats were fed either the home diet or the school lunch or the whole day diet of the experimental children. In these studies, animals fed the latter two diets had a superior nutritional status even though food intake was not appreciably different in the three groups. Some relevant data are reproduced below :

	Home diet	Diet at centre+ diet at home	Diet at the centre
Body composition			
Weight gain(g) in 8 weeks	70 ± 6.5	85 ± 4.8	90 ± 4.9
Blood hemoglobin (g/100 ml)	13.5 ± 0.14	13.5± 0.14	14.0 ± 0.12
Liver enzymes			
Xanthine oxidase * (activity number)	6.2 ± 0.10	7.6± 0.13	7.6 ± 0.06
Succinic dehydrogenase**	18.5 ± 0.28	22.0± 0.41	29.5 ± 0.91
Psychological performance			
Error scores on the Hebb-Williams Maze	241 ± 9.2	184± 13.4	171 ± 11.7

Values are means ± S.E's.

*Time required for reduction of methylene blue at 37°C under assay conditions

** μ moles of 2,3,4 Triphenyl tetrazolium chloride reduced per g of wet tissue per hour at 37°C under assay conditions.

(b) Physical stature

Data on heights and weights of fed and control children are presented in Tables 38 and 39. There was no significant difference in the increments in height and weight achieved by the experimentals and controls. The data are difficult to interpret because of the differences in age between the experimentals and controls. The latter were closer to puberty and might therefore be expected to show normally greater increments in height and weight on the basis of data presented earlier. (Table 17, page 85).

When the increments in weight were considered as percentages of the expected annual increments after considering into account the age distribution of the subjects, (Table 40) it was found that the increment in weight found in the experimentals were 65 and 55 percent of expected value for lower and upper classes respectively whereas the corresponding figures for controls were 57 and 43 percent. It is, therefore, felt that the effects of the lunch programme on weight gain have been obscured by the difference in the age between experimentals and controls. It is also likely that the sensitivity of the measurements was reduced by the use of bath-room scales at the start of the investigation.

(c) Clinical status

The change in the clinical status of the fed and the control children during the period of treatment are shown in

Table 38. Data on heights of the fed and the control children in Raipura

Group	Cereal pulse ratio in lunch	Worm treatment	Age (years)	No. of subjects	Height (cm)		
					at start	at end	increment
EXPERIMENTALS	8:1	Not given	9.4	11	125.4 ± 2.58	127.8 ± 2.28	2.4 ± 0.81
		Given	9.7	12	126.9 ± 2.42	129.4 ± 2.29	2.5 ± 0.77
	4:1	Not given	9.3	10	124.5 ± 2.18	127.0 ± 2.33	2.5 ± 0.75
		Given	9.3	11	124.2 ± 2.24	127.5 ± 2.13	3.3 ± 0.94
CONTROLS	12:1	Not given	10.3	8	126.6 ± 2.57	129.4 ± 2.41	2.8 ± 0.87
		Given	10.3	8	130.5 ± 2.36	133.3 ± 2.32	2.8 ± 0.83

Values are means ± S.E's.

Table 39. Data on weights of the fed and the control children in Raipura

Group	Cereal pulse ratio in lunch	Worm treatment	Age (years)	No. of subjects	Weight (kg) at start	Weight (kg) at end	Weight (kg) increment
EXPERIMENTALS	8:1	Not given	9.4	11	20.4 ± 0.83	21.7 ± 0.90	1.3 ± 0.22
		Given	9.7	12	20.9 ± 0.91	22.0 ± 0.91	1.1 ± 0.18
	4:1	Not given	9.3	10	20.4 ± 1.01	21.4 ± 0.94	1.0 ± 0.15
		Given	9.3	11	20.6 ± 0.90	22.0 ± 0.91	1.4 ± 0.28
CONTROLS	12:1	Not given	10.3	8	20.5 ± 1.16	21.4 ± 1.13	0.9 ± 0.11
		Given	10.3	8	22.3 ± 1.23	23.5 ± 1.16	1.2 ± 0.26

Values are means ± S.E's.

Table 40. Increment in weight (kg) of the fed and the Control Children as percentages of the expected annual increments of lower and upper classes.

Group	Age (years)	Increment in Weight (kg)		
		Raipura	Expected per year	
			Lower class	Upper class
Experimentals (n = 44)	9.4	1.2	1.84(65)	2.20(55)
Controls (n = 16)	10.3	1.0	1.83(57)	2.46(43)

Percentage shown in parenthesis.

Tables 41 and 41a. The most common symptoms found were those such as xerosis and pigmentation of the conjunctiva, fissured tongue etc. It must be pointed out in this connection that the clinical examination was done by Dr.K.Bagchi, Nutrition Adviser to the Government of India and he was not aware of the group to which the subjects were assigned. In the case of the experimentals the clinical symptoms showing deficiency of adipose tissue and riboflavine were reduced by about 50% whereas protein and vitamin A were reduced by 75%. No such changes were observed in controls (Figure 7).

This is reflected in the overall decrease in deficiency scores. Ninety per cent of the experimentals showed a decrease in scores from 4 - 10 to 0 - 3. No such improvement was found in the controls.

(d) Intestinal infestation

Data on the incidence of intestinal infestation in the fed and the control children at the start and end of the investigations in Raipura are presented in Table 42. About half the children were treated once for worm infestation at the beginning of the programme by administering 'Alcopar' (Bephenium Hydroxynaphthoate, Burroughs Welcome & Co. (India) Pvt. Ltd.). However 30% of the children were reinfected when they were examined at the end. (Figure 8). A hundred per cent reinfection has been reported under unhygenic conditions (Patel 1954; WHO Chronicle, 1961). In the present study also,

Table 41a. Changes in the clinical status of the fed and control children in Raipura

Clinical symptoms	Experimental (n=44)		Control (n=16)	
	Initial	Final	Initial	Final
Eyes				
Conjunctiva				
Xerosis				
Normal	6(14)	36(82)	6(37)	5(31)
Slightly dry on exposure for 1/2 mt. lack of luster	37(84)	7(16)	10(63)	11(69)
Bitot's spot present	1(2)	1(2)	0(0)	0(0)
Pigmentation				
Normal colour	11(25)	36(82)	3(19)	4(29)
Slight discolouration	31(71)	8(18)	13(81)	12(76)
Moderate browning in patches	2(4)	0(0)	0(0)	0(0)
Cornea				
Vascularisation				
Normal	42(96)	44(100)	12(75)	13(81)
Circumcorneal injection of blood vessels	2(4)	0(0)	4(25)	3(19)
Total No. showing eye symptoms	37(84)	8(18)	13(81)	12(76)
Tongue				
Appearance				
Normal	3(7)	24(55)	3(19)	3(19)
Pale but not coated	41(93)	20(45)	13(81)	13(81)

Clinical symptoms	Experimental (n=44) Initial	Experimental (n=44) Final	Control (n=10) Initial	Control (n=10) Final
Surface				
Normal	20(45)	30(68)	6(37)	6(37)
Fissured	24(55)	14(32)	10(63)	10(63)
Gums				
Normal	37(84)	44(100)	13(81)	13(81)
Bleeding and/or Gingivitis	7(16)	0(0)	3(19)	3(19)
Adipose tissue				
(To be judged by the examination of the arm over the biceps)				
Normal	14(32)	30(68)	4(24)	5(31)
Deficient	30(68)	14(32)	12(76)	11(69)
Bones				
Normal	42(95)	43(98)	11(67)	11(67)
Stigmata of past (rickets)	2(5)	1(2)	5(33)	5(33)

Percentage shown in parenthesis

Table 41. Changes in the clinical status of the fed and the control children in Raipura.

Clinical symptoms showing deficiency of[b]	Number and percentage showing symptoms[a]			
	Experimentals (n=44)		Controls (n=16)	
	at start	at end	at start	at end
Calories :				
adipose tissue deficient	30(68)	14(32)	12(76)	11(69)
Protein	33(75)	8(18)	13(81)	12(76)
Vitamin A	38(86)	8(18)	10(63)	11(69)
Riboflavine	41(93)	20(45)	13(81)	13(81)
Vitamin C	7(16)	0(0)	3(19)	3(19)
Calcium	2(5)	1(2)	5(33)	5(33)
Clinical assessment score, ICMR(1948)[d]				
0	1(2)	5(11)	1(6)	0(9)
1 - 3	4(9)	34(78)	2(12)	1(6)
4 - 6	27(62)	5(11)	9(57)	8(50)
7 - 10	12(27)	0(0)	4(25)	7(44)

(a) Percentage shown in parenthesis

(b) Criteria used for assessment of deficiency are shown in Table 26a

(c) Children having less than 75% of the average body weight of upper class subjects

(d) Zero score indicates normal clinical status and the score increases with deficiency symptoms.

Table 42. Incidence of intestinal infestation in the fed and the control children at the start and end of the investigations in Raipura

Parasite present		Number and percentage in *					
		Experimentals				Controls	
	Cereal pulse ratio in lunch	8:1		4:1		12:1	
	Treatment for worms	Not given	Given	Not given	given	Notgiven	given
	No.of subjects	11	12	10	11	8	8
None detected	at start	1(9)	1(8)	1(10)	2(18)	1(12)	0(0)
	at end	6(54)	8(66)	4(40)	8(72)	0(0)	1(13)
Entomeba histolytica(EH)	at start	0(0)	0(0)	1(10)	0(0)	0(0)	0(0)
	at end	0(0)	0(0)	1(10)	0(0)	0(0)	0(0)
Hook worm(Necator americanus and Ankylostoma duodenale)	at start	7(64)	7(58)	6(60)	3(27)	5(63)	5(63)
	at end	3(27)	3(24)	3(20)	1(9)	6(75)	5(63)
Hook worm along with other parasites such as EH, E.Coli and H.nana	at start	3(27)	4(32)	2(20)	6(55)	2(25)	3(37)
	at end	2(18)	1(8)	2(20)	2(18)	2(25)	2(25)

* Percentage shown in parenthesis

FIG. 7 CLINICAL DEFICIENCY OF THE FED AND THE CONTROL CHILDREN IN RAIPURA AT THE START AND END OF THE INVESTIGATION

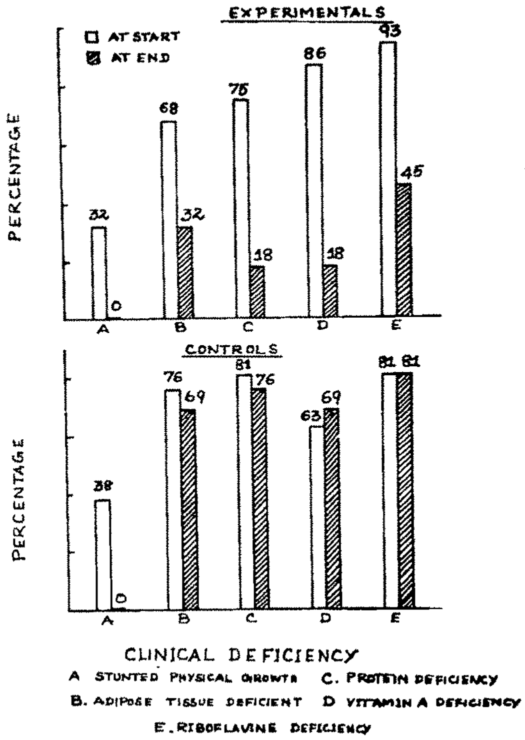
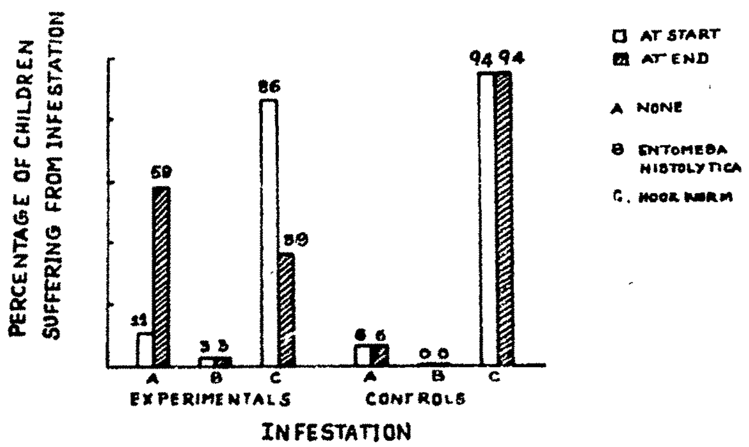


FIG. 8. PERCENTAGE INCIDENCE OF INTESTINAL INFESTATION IN THE FED AND THE CONTROL CHILDREN IN RAIPURA AT THE START AND END OF THE INVESTIGATION.



all the treated children in the control group were reinfected. This raises the question whether the lower incidence of reinfection in the experimentals was due to the improved diet. Platt has found a similar reduction in parasite infestation with dietary improvement in studies on rats. (Platt and Heard, 1965).

(e) Biochemical status

At the outset it must be admitted that the data on biochemical parameters suffer from the limitation that the number of subjects in each group was small. The composition of the blood and serum of the fed and the control children in Raipura at the start and end of the investigation are presented in Table 43. The changes in blood and serum constituents in the fed and the control children in Raipura during the experimental period are shown in Table 44. Contrary to expectation, no significant improvement was found in blood hemoglobin. There are other reports of a similar lack of response in blood hemoglobin (Dumm et al, 1966, 1966a; Devadas et al, 1967), 1968). In one study it was actually found to show a decrease which could not be explained. (Arroyave et al, 1964). In other studies in this laboratory some response was found in blood hemoglobin to dietary improvement but this was much less clear-cut than that in other parameters such as serum protein.

Table 43. Composition of blood and serum of the fed and the control children in Raipura at the start and end of the investigation

Constituents		Experimentals				Controls	
	Cereal pulse ratio in lunch	8:1		4:1		12:1	
	Treatment for worms	Not given	Given	Not given	Given	Not Given	Given
Values per 100 ml							
Blood Hemoglobin (g)	at start	8.7(8) ±0.41	7.8(11) ±0.65	7.8(6) ±1.15	7.9(9) ±0.74	7.6(3) ±0.07	7.3(4) ±0.56
	at end	9.0(8) ±0.57	8.8(11) ±0.24	7.9(6) ±0.85	9.3(9) ±0.33	9.1(3) ±0.30	8.8(4) ±0.27
Serum							
Total protein (g)	at start	6.3(6) ±0.42	6.5(9) ±0.34	6.0(7) ±0.62	6.4(8) ±0.36	7.2(3) ±0.14	6.8(4) ±0.15
	at end	7.1(6) ±0.03	7.3(9) ±0.18	6.9(7) ±0.39	7.1(8) ±0.33	6.6(3) ±0.40	6.5(4) ±0.33
Albumin (g)	at start	3.4(6) ±0.12	3.5(9) ±0.13	3.2(7) ±0.31	3.3(8) ±0.17	4.1(3) ±0.12	3.9(4) ±0.19
	at end	4.6(6) ±0.17	4.4(9) ±0.19	4.2(7) ±0.25	4.4(8) ±0.15	4.0(3) ±0.24	3.8(4) ±0.33
Albumin : Globulin Ratio	at start	1.18(6) ±0.20	1.16(9) ±0.09	1.14(7) ±0.08	1.01(8) ±0.12	1.32(3) ±0.06	1.34(4) ±0.08
	at end	1.85(6) ±0.21	1.52(9) ±0.12	1.56(7) ±0.06	1.64(8) ±0.19	1.53(3) ±0.34	1.40(4) ±0.20

Table 43 (continued)

Constituents		Experimentals				Controls	
	Cereal pulse ratio in lunch	8:1		4:1		12:1	
	Treatment for worms	Not given	Given	Not given	Given	Not given	Given
Carotene (μg)	at start	23.6(8) ±3.9	25.2(9) ±4.4	23.0(6) ±5.2	22.7(8) ±3.2	19.5(2) ±1.8	24.0(4) ±4.3
	at end	47.6(8) ±5.4	49.4(9) ±5.2	53.0(6) ±3.9	43.9(8) ±4.5	20.8(2) ±2.6	26.6(4) ±4.2
Alkaline phosphatase (Enzyme units/litre)	at start	5.7(6) ±0.93	5.3(11) ±0.60	4.1(5) ±0.67	6.6(8) ±0.99	4.8(3) ±0.38	6.4(4) ±0.82
	at end	5.0(6) ±0.83	5.6(11) ±0.37	5.5(5) ±0.67	6.3(8) ±0.99	4.5(3) ±0.38	5.8(4) ±0.75

Values are means ± S.E's ; Number of subjects given in parenthesis

Table 44. Changes in blood or serum constituents in fed and control children in Raipura during the experimental period

Constituents	Increment(+) or decrement(-) Experimentals	Controls		't' value
Values per 100ml				
Hemoglobin in Blood (g)	+0.8(34) ± 0.39	± 1.5(7) ± 0.38	p	1.6 0.20
Serum				
Total protein (g)	+0.8(30) ± 0.20	- 0.4(7) ± 0.28	p	2.79 0.01
Albumin (g)	+0.7(30) ± 0.13	- 0.1(7) ± 0.18	P	2.76 0.01
Albumin:Globulin ratio	+0.5(30) ± 0.09	+ 0.1(7) ± 0.08	P	2.11 0.05
Carotene (µg)	+22.8(29) ± 2.9	+ 2.1(6) ± 2.8	P	11.12 0.001
Alkaline phosphatase (Enzyme units/litre)	+0.7(30) ± 0.46	- 0.5(7) ± 0.61	P	1.21 n.s.

Values are means ± S.E's

n.s. = not significant

There was a significant increase in the experimentals in the serum content of the total protein, albumin and carotene.

The blood and serum values of the fed and the control children are classified in Table 45 as deficient, low, acceptable or high according to ICNND standard (1963). The improvement of the experimentals is reflected in the smaller percentage of subjects with low or deficient values.

Data on the urinary excretion of selected constituents in the experimentals at the start and end of the treatment are presented in Tables 46 and 47. The urine samples of the control children could not be collected at the end of the study. The blood samples were collected first and this was resented by the parents of the control children who withheld co-operation for the urine collection.

The data on urinary excretion are classified in Table 48 according to Pearson's modified ICNND standard. As discussed earlier, when the values used for creatinine excretion were arbitarily raised by 50 per cent the proportion of deficient values compares better with incidence of clinical deficiency.

(f) Psychological status

The data on psychological performance on the WISC Block Design test (Wechsler, 1949) of the fed and the control children are shown in Table 49. The experimental children were found to show a significant improvement in the same whereas the control children showed no change. The testing was done

Table 45. Biochemical status (blood and serum) of the fed and the control children in Raipura on the basis of ICNND (1963) standards. *

Constituents	Group	Period	Percentage of children			
			D	L	A	H
Blood	E (n=34)	I	82	6	12	0
		F	76	6	18	0
	C (n=7)	I	100	0	0	0
		F	86	0	14	0
Serum						
Total Protein	E (n=30)	I	37	16	10	37
		F	10	3	10	77
	C (n=7)	I	0	14	14	72
		F	29	29	14	29
Albumin	E (n=30)	I	13	51	16	20
		F	0	7	26	67
	C (n=7)	I	0	29	29	43
		F	0	72	14	14
Carotene	E (n=31)	I	32	62	6	0
		F	0	23	77	0
	C (n=6)	I	17	83	0	0
		F	0	100	0	0

* ICNND Laboratory Manual for Nutrition Surveys (1963).
E – Experimentals ; C–Controls ; I – at start; F – at end
D – Deficient ; L – Low ; A – Acceptable ; H – High

Table 46. Composition of urine of the fed children at the start and end of the investigation

Constituents		Experimentals			
	Cereal pulse ratio in lunch	8:1		4:1	
	Treatment for worms	Not given	Given	Not given	Given
	No. of subjects	11	12	10	11
Creatinine mg per day	at start	370 ± 21.1	355 ± 16.1	360 ± 24.9	353 ± 25.2
	at end	4.45 ± 22.7	450 ± 25.0	454 ± 21.0	467 ± 20.5
Values per g of creatinine					
Nitrogen	at start	7.9 ± 0.56	8.3 ± 0.52	8.8 ± 0.59	8.3 ± 0.56
	at end	7.7 ± 0.03	8.7 ± 0.55	8.7 ± 0.53	8.9 ± 0.52
Thiamine	at start	674.0 ± 98.7	542 ± 99.3	663.8 ± 102.5	842.8 ± 102.5
	at end	751.8 ±108.6	855.7 ± 118.4	933.9 ± 132.8	1255.0 ± 127.0
Riboflavine	at start	406.2 ± 50.7	334.4 ± 31.7	340.0 ± 58.4	448.4 ± 84.6
	at end	394.2 ± 40.6	458.0 ± 29.1	428.9 ± 55.9	537.5 ± 58.6

Values are means ± S.E's.

Table 47. Biochemical status (urine) of the fed children on the basis of ICNND (1963) standards. *

Constituents	Period	Percentage of children**			
		D	L	A	H
Values per g of creatinine :					
Thiamine	I	0	16	32	52
	F	0	0	18	32
Riboflavine	I	2	50	41	7
	F	0	30	63	7

* ICNND Laboratory Manual for Nutrition Surveys (1963)

** Data on 44 subjects

I = at start ; F = at end

D = Deficient ; L = Low ; A = Acceptable ; H = High

Table 48. Data on psychological performance in the fed and the control childfen in Raipura

Groups	Scaled score on WISC Block Design Test *			
	at start	at end	difference	't' values**
Experimentals (n=43)	7.5 ± 0.31	9.2 ± 0.31	+1.7 ± 0.27	2.86 P 0.005
Controls (n=16)	7.4 ± 0.65	6.9 ± 0.74	-0.5 ± 0.56	

Values are means ± S.E's

* The scores should be about 10 for an IQ of 100

** For scores at the end.

by a co-investigator who was not aware of the group to which the subject belonged. The scores obtained compare with those obtained on poor children in rural areas in Indonesia (Liang et al, 1967).

Some investigators have suggested that nutritional improvement beyond the pre-school years has no effect on Intelligence test performance. No improvement was found in children fed under the CARE programme in other investigations in this laboratory in which the author participated (Rajalakshmi, et al, unpublished). But co-investigators have found improvement with a similar lunch at the end of two years of treatment, though they found no effect at the end of the first year (Rajalakshmi et al, unpublished). It is difficult to reconcile these differences and it is possible that the effects depend on the initial nutritional status as well as the period of treatment. Per se, we cannot assume that nutrition has nothing to do so with intelligence in older children as even adults are found to show mental symptoms with undernutritional and vitamin deficiencies (Eiduson et al, 1954). Even if intellectual callibre is not affected actual performance on an intelligence test may depend on factors such as attention, ability to concentrate and freedom from fatigue which may be affected by nutritional status. Besides the test used in the present studies is a speeded task in which credit is given for speed of performance. This could be affected by nutritional status even in older subjects.

In conclusion, feeding an improved lunch for a period of five months was found to result in a significant improvement in clinical, biochemical and psychological status of poorly nourished boys aged 7-12 years. It is felt that the improvement in vitamin A and riboflavine status would have been greater had a greater quantity of leafy vegetables been included in the diet. A simultaneous improvement in environmental sanitation might also have increased the benefit of the programme. The results of other studies also emphasize the role that a good school lunch can play in safeguarding the health of growing children who are specially vulnerable to malnutrition.