

MISCELLANEA

(1) A STATISTICAL NOTE ON NUTRITIONAL INVESTIGATIONS IN COLLEGE HOSTELS IN CALCUTTA

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INTRODUCTION

1. The material relating to certain food constituents in college hostels in Calcutta was sent to us by Dr. B. C. Guha of the University College of Science. The primary material covers thirteen college hostels in each of which the two principal (day and night) meals for one individual were collected for seven consecutive days and were analysed for eight food constituents : Protein, Ether Extract, Calcium, Total Phosphorus, Phytin Phosphorus, Total Iron, Ionizable Iron and Copper. This was done in three different months, namely, in August, 1938, and April and December, 1939. These three months were selected as they are equally spaced, and are typical of the three well marked seasons in Calcutta, namely, summer, monsoon and winter.

2. The quantity of food collected in each case was supposed to be the average ration of one single individual ; but no attempt was apparently made to make any objective estimate either of the actual average or of variations between individuals. No information is available regarding the monthly expenditure in the different hostels in the different months ; neither is any information available regarding the age, health, or physical conditions of the students in the different hostels.

3. No information is available in the papers sent to us regarding the total weight of the food consumed during the three months in the different hostels. It is not clear how far this point was taken into consideration ; but Dr. S. Bannerjee, who actually carried out the chemical analysis, informed me that there was no appreciable variation in the total quantities in the months. He also informed me that the annual variation in the same season is not of importance, so that there was no objection to results for August 1938 being considered along with results for April and December 1939. All results stated in this Note are based on these assumptions ; but in the absence of relevant material I am unable to give any opinion on these points.

4. No definite statistical design was used in collecting the material, and separate independent determinations to serve as replications are not available. No objective estimate of the residual error is therefore possible ; and in using the method of analysis of variance we are obliged to adopt the interaction between hostels and months as the residual error. The validity of the statistical results is, therefore, subject to this serious limitation.

SEASONAL FLUCTUATIONS

5. The actual weights of different food constituents in one hostel in the different months are shown in Table (1). Differences between the different months for each hostel are shown in Table (2). Col. (2.1) shows that the differences between December and August are positive, that is, the values in December are greater than those in August for Protein, Ether Extract and Available Phosphorus in all the hostels, and for Calcium in nine hostels out of thirteen, but the differences are mostly negative for Copper, while no information is available for Ionizable Iron in August. From Col. (2.2) of Table (2) it may be seen that on average the Protein content is higher in December by about 27 per cent as compared with August ; but this percentage varies considerably from hostel to hostel. The weight of Ether Extract is proportionately still higher in December, by nearly 56 per cent ; and Available Phosphorus by over 50 per cent ; while Calcium shows the smallest relative improvement, namely, by only about 12 per cent in December.

6. Similarly, the April-August differences given in col. (4. 1) are positive, that is, values in April are higher for all the constituents studied in most of the hostels. The percentage differences are however smaller, about 20 per cent for Protein, 37 per cent for Ether Extract, and 21 per cent for Available Phosphorus. In the case of Calcium the percentage excess in April is very high and 69 per cent as compared to August.

7. The December-April comparisons given in col. (3.1) show that values in December are on the whole higher than corresponding values in April for Protein, Ether Extract, Available Phosphorus and Ionizable Iron; values for Calcium and Copper, on the other hand, are mostly higher in April than in December. The percentage differences are, however, generally smaller compared to differences between other months.

8. We find then that December shows the highest content of Protein, Ether Extract, Available Phosphorus and Ionizable Iron. In April the weights of these food constituents are generally lower than those in December except in the cases of Calcium and Copper which show the highest values in this month. In August the weights of practically all the constituents are lowest with the single exception of Copper for which this month occupies the middle position.¹

DIFFERENCES BETWEEN HOSTELS

9. The weights of different food constituents in different months in different hostels are shown in Table (3) in the form of percentages of the averages for all hostels. These figures thus practically supply index numbers of weights of different constituents in different hostels.² The mean index numbers for the different hostels based on five constituents, namely, Protein, Ether Extract, Calcium, Available Phosphorus and Ionizable Iron are given for each month in Table (4). These index numbers suggest that the different hostels may probably be classified in broad groups.

10. The hostel no. 1 (with an average index no. of 125), and no. 2 (124) come at the top; while no. 3 (115) occupies the third place. These three hostels appear to have the highest contents of the five food constituents among college hostels covered in the present enquiry.

11. Next comes a group of five hostels, nos. 4 (103), 5 (103), 6 (103), 7 (100) and 8 (101) with index numbers of about 100 or a little above. Nos. 9 (95) and 10 (92), occupy slightly lower places but belong practically to the same group. Nos. 11 (85), and 12 (83), on the other hand, occupy the two lowest places among men's hostels, and probably form a separate group.

12. The hostel no. 13, a girls' hostel with an average index of 69 occupies the last place. The lower index number content of the food constituents in the meals in the girls' hostel may probably be due to the total weight of food consumed being lower than that in men's hostels.

13. From Table (4) it will also be seen that the ranking of the hostels remains roughly the same in the three different months showing that the broad classification given above was probably stable.

CORRELATION BETWEEN THE CONSTITUENTS

14. The coefficients of correlation 'between hostels' given in Table (5) show that the hostels which had higher contents of Protein or Phosphorus had also higher contents of all other constituents except Copper. Similarly hostels with higher contents of Ether Extract, Calcium, or Phytin Phosphorus, had higher contents of all the other constituents except Total Iron and Copper. The content of Total Iron apparently increased only with Protein, Phosphorus and Copper; while variations in the weights of Copper had practically no connexion with other constituents except Total Iron and Phosphorus. The significant correlations "between hostels" broadly confirm the differences between hostels already discussed above.

1. The differences between months were found to be significant in the case of all the constituents when tested by the analysis of variance. This is, of course, otherwise quite obvious from Table (2).

2. Differences between hostels were found to be statistically significant in the case of Protein, Phosphorus, Phytin Phosphorus and Total Iron; but were insignificant in the case of Ether Extract, Calcium, Ionizable Iron and Copper. I have had no time to test the differences between index numbers.

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15. There was also a significant residual correlation of $+0.61$ between Protein and Ether Extract, and a significant negative correlation of about -0.50 between Calcium and Copper. This means that, after eliminating the variation between different seasons and between different hostels, the weights of Protein and Ether Extract tended to increase or decrease together, while the content of Copper decreased as the Calcium content was increased and vice versa.

COMPARISON WITH STANDARD REQUIREMENTS

16. For purposes of comparison we have used the following standards given by Stiebling for active boys above 15 years of age :

Protein 67.0 gms., Calcium 0.68 gms., Phosphorus 1.32 gms., Ionizable Iron 15 gms.; and Ether Extract 50 gms. (supplied by Dr. Banerjee).

17. The averages of all hostels for the different months as well as for three months taken all together are given in columns (2)—(5) of Table (6). The standard requirements are given for comparison in col. (6) of the same table. It will be noticed that with the exception of Calcium the food constituents in Calcutta hostels are practically all below "standard."

18. The figures given in columns (2)—(4) of Table (6) converted into percentages of annual average (col. 5) are shown in columns (7)—(9); while the percentages in terms of standard requirements are shown in columns (10)—(13). It will be noticed that the food constituents in December and April, as compared to the annual mean values, are generally above average; but the figures for August are, with one exception, always below average. Comparatively speaking, the difference between December and April is not large; while August falls far below the other two months.

19. From col. (10) of Table (6) it will be seen that in December the diet approaches most nearly to standard requirements. In Protein, Ether Extract and Calcium the values fall short only slightly, and are nearly 94 per cent of the standard; Available Phosphorus is 55 per cent and Ionizable Iron 59 per cent of the standard. In April, Protein is 86 per cent, Ether Extract 79 per cent, and Calcium 156 per cent of the standard; but Available Phosphorus is only 42 per cent and Ionizable Iron only 38 per cent of the standard. In August all the constituents are in large defect: Protein is 70 per cent, Ether Extract 52 per cent, Calcium 79 per cent and Available Phosphorus only 33 per cent of the standard.

20. The percentage figures for the average of three months taken together are shown in col. (13) of Table (6). It will be noticed that Calcium is above normal, being 110 per cent of the standard; but all the other food constituents fall appreciably below standard: Protein (84 per cent) and Ether Extract (75 per cent) are not so bad, but both Available Phosphorus (43 per cent) and Ionizable Iron (48 per cent) are less than half the standard requirement.

21. On the whole we find that in December and April the shortage in Protein and Ether Extract is comparatively small; Calcium is slightly below normal in December, but above normal in April; but there is a serious shortage of Available Phosphorus and to a larger degree of Ionizable Iron. In August on the other hand all the food constituents are in large defect, the shortage being most serious in the case of Available Phosphorus which is only 33 per cent of the standard, while no information is available regarding Ionizable Iron.

22. One word of caution, however, is necessary in regard to the seasonal differences. It will be remembered that the data for December and April were collected in 1939 while the material in August belongs to the previous year 1938. The fact that differences between December and April are comparatively small while differences between August and the other two months are much higher may be due to a real difference in the quality of the food in the two years 1938 and 1939. It will not be safe therefore to accept the comparative results for August without further investigation.

SUMMARY OF CONCLUSIONS

23. The chief results may now be summarized.

(1) There were significant differences in the weight of practically all the food constituents studied here in the three months December, April and August.

(2) On the whole December had highest content of all the food constituents except Calcium; April had the highest Calcium content but came next to December in all other constituents. August apparently had the lowest weights of all the food constituents studied here. It must be remembered however that the material for August was collected in 1938 while the data for April and December were collected in 1939. It is quite possible that the exceptionally low values in August were due to real differences in the quality of the food in the two years 1938 and 1939 rather than to seasonal fluctuations.

(3) There were appreciable differences between hostels on the basis of which it is probably possible to classify the hostels in broad groups;

- (i) The hostels nos. 1, 2 and 5 come at the top and are distinctly better than the other hostels.
- (ii) Then comes a second group of six or seven hostels: nos. 4, 5, 6, 7, 8 and 9 with 10 at the bottom.
- (iii) The two hostels, nos. 11 and 12 occupy the two lowest places among men's hostels.
- (iv) The hostel no. 13 comes last with an appreciably lower contents of all the food constituents.

(4) Compared to standard requirements we find that in December there is only a small shortage of Protein, Ether Extract and Calcium with a serious shortage in Available Phosphorus and Ionizable Iron. In April the Calcium contents are above the standard requirement; Protein and Ether Extract are in moderate defect; while Available Phosphorus and total Iron are in large defect. In August all the food constituents fall far short of standard requirements; but it is not clear how far this is due to a difference in the quality of the food in 1938 and 1939 or due to a real seasonal change.

(5) Considering the average of three months we find that there was no shortage in Calcium; but there was a moderate defect in Protein (84 per cent) and Ether extract (75 per cent) while Available Phosphorus (43 per cent) and Ionizable Iron (48 per cent) fell far short of the standard requirements. As regards food constituents studied here the greatest need for improvement thus appears to be in Ionizable Iron and Available Phosphorus and to a smaller extent in Protein and Ether extract.

24. The results given in this Note appear to be of considerable practical importance. It is therefore certainly desirable that the present enquiry should be continued and that appropriate statistical designs should be used for this purpose.

TABLE 1. MEAN WEIGHTS OF FOOD CONSTITUENTS OF A HOSTEL *

Serial No.	Food Constituents	Mean weight			
		December 1939	April 1939	August 1938	Average (3 months)
(1.1)	(1.2)	(2.1)	(2.2)	(2.3)	(2.4)
1	Protein	65.24	65.16	53.84	61.41
2	Calcium	0.76	1.44	0.54	0.91
3	Ether Extract	53.45	56.23	39.70	49.79
4	Available Phosphorus	0.88	0.83	0.41	0.70
5	Ionizable Iron	13.4	6.5	**	9.95
6	Copper	1.1	3.6	3.8	2.83

* Similar information is available for other hostels which however, could not be given or lack of space.

** This figure is not available.

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TABLE 2. SEASONAL DIFFERENCES FOR DIFFERENT HOSTELS

Hostel No.	December (1939)	August (1938)	December (1939)	April (1939)	April (1939)	August (1938)
	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean
(1.1)	(2.1)	(2.2)	(3.1)	(3.2)	(4.1)	(4.2)

(1) *Protein*

1	11.40	18.56	-0.08	0.13	11.32	18.43
2	31.13	46.21	17.05	25.31	14.08	20.90
3	20.37	32.56	8.52	13.62	11.85	18.94
4.	15.80	25.76	15.02	24.49	0.78	1.27
5	31.99	57.36	22.39	35.95	9.60	15.41
6	14.76	24.32	-0.50	0.82	15.26	25.14
7	20.01	36.39	8.87	16.13	11.14	20.26
8	22.32	43.62	14.12	27.59	8.20	16.03
9	3.81	7.37	11.97	23.15	15.78	30.52
10	17.66	33.99	3.39	6.52	14.27	27.46
11	5.81	10.79	-6.47	12.01	12.28	22.80
12	6.41	11.77	4.55	8.35	1.86	3.41
13	2.74	8.06	-9.02	26.53	11.76	34.59
All Hostels	15.71	26.98	5.08	7.35	10.63	19.63

(2) *Calcium*

1	0.22	24.17	-0.68	74.72	0.90	98.90
2	0.30	29.10	-0.50	49.50	0.80	79.21
3	0.35	41.18	0.04	4.71	0.31	36.47
4	-0.13	20.63	-0.18	28.57	0.05	7.94
5	0.28	43.75	0.00	0.00	0.28	43.75
6	-0.10	11.90	-0.85	101.09	0.75	89.28
7	-0.11	15.28	-0.08	11.11	-0.03	4.17
8	0.23	28.75	-0.70	87.50	0.93	116.25
9	0.02	2.78	-0.39	54.17	0.41	56.94
10	0.09	11.84	0.71	93.42	0.80	105.26
11	0.28	47.46	-0.08	13.56	0.36	61.02
12	-0.11	16.18	-0.61	89.71	0.50	73.53
13	0.07	12.50	-0.65	116.07	0.72	128.57
All Hostels	0.10	11.88	-0.42	54.99	0.52	68.69

TABLE 2. (Contd.) SEASONAL DIFFERENCES FOR DIFFERENT HOSTELS

Hostel No	December (1939)	August (1938)	December (1939)	April (1939)	April (1939)	August (1938)
	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean
1.1	(2.1)	(2.2)	(3.1)	(3.2)	(4.1)	(4.2)

(3) Ether Extract

1	13.75	27.61	-2.78	5.58	16.53	33.20
2	13.31	29.53	6.28	13.93	7.03	15.59
3	21.07	48.71	10.77	24.90	10.30	23.81
4	41.50	112.37	26.21	70.97	15.29	41.40
5	39.87	103.02	24.55	63.44	15.32	39.59
6	12.86	33.69	-1.19	3.12	14.05	36.81
7	26.93	82.96	25.18	77.57	1.75	5.39
8	28.65	74.77	6.84	17.85	21.81	56.92
9	18.95	52.13	1.75	4.81	17.20	47.32
10	18.91	53.77	1.92	5.96	16.99	48.31
11	16.05	54.85	-10.09	34.48	26.14	89.34
12	11.30	34.66	12.70	38.96	-1.40	4.29
13	4.49	14.41	-11.51	37.70	16.00	52.41
All Hostels	20.59	55.58		18.23	13.62	37.37

(4) Available Phosphorous

1	0.47	67.14	0.05	7.14	0.42	60.00
2	0.25	35.17	0.19	27.14	0.06	8.57
3	0.25	33.33	-0.43	57.33	0.68	90.67
4	0.14	21.54	0.28	43.08	-0.14	21.54
5	0.73	128.07	0.46	80.70	0.07	47.37
6	0.45	80.35	0.34	60.71	0.11	19.64
7	0.13	22.03	0.20	33.90	-0.07	11.86
8	0.18	34.61	0.26	50.00	-0.08	15.38
9	0.05	8.62	0.12	20.69	-0.07	12.07
10	0.47	94.00	0.32	64.00	0.15	30.00
11	0.56	127.27	0.29	65.91	0.27	61.36
12	0.11	24.45	0.14	31.11	-0.03	6.67
13	0.12	31.58	-0.02	5.26	0.14	36.84
All Hostels	0.29	50.88	0.17	29.82	0.12	21.05

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TABLE 2. (Contd.) SEASONAL DIFFERENCES FOR DIFFERENT HOSTELS

Hostel No.	December (1939)	August (1938)	December (1939)	April (1939)	April (1939)	August (1938)
	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean	Difference	Percentage to Hostel Mean
(1.1)	(2.1)	(2.2)	(3.1)	(3.2)	(4.1)	(4.2)

(5) Ionizable Iron (gm)

1			6.90	69.35		
2			6.90	77.09		
3			3.30	45.52		
4			-2.30	28.57		
5			-1.10	13.17		
6			2.20	31.43		
7			3.50	41.92		
8			7.90	95.76		
9			1.60	24.62		
10			3.50	56.00		
11			4.10	60.74		
12			1.60	36.36		
13			1.40	31.11		
			3.04	40.63		

(6) Copper

1	-2.70	95.41	-2.50	88.34	-0.20	7.07
2	-1.60	47.48	-4.30	127.60	2.70	80.12
3	-0.50	10.80	-4.70	101.51	4.20	90.71
4	-0.80	24.02	-4.10	123.12	3.30	99.10
5	-0.10	2.24	-7.90	176.73	7.80	174.50
6	-1.30	45.94	-2.70	95.41	1.40	49.47
7	-0.10	2.58	-6.30	162.79	6.40	165.37
8	-0.50	18.73	-1.50	56.18	1.00	37.45
9	-0.20	4.51	-3.50	79.01	3.30	74.49
10	-1.10	33.33	-4.90	148.48	3.80	115.15
11	0.70	30.84	-0.20	8.81	0.90	39.65
12	-0.70	40.46	-0.90	52.02	0.20	11.56
13	-0.80	42.78	-0.90	48.13	0.10	5.35
	-0.73	25.56	-3.42	97.56	2.69	71.99

TABLE 3. INDEX NUMBERS OF FOOD CONSTITUENTS FOR DIFFERENT HOSTELS

Food Constituents	Serial Nos. of Hostels													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	TABLE (3.1) 3 MONTHS AVERAGE													
Protein	110	120	112	110	111	108	98	91	92	93	96	97	61	
Ether Extract	133	120	116	99	103	102	87	102	97	94	78	87	82	
Calcium	121	135	113	84	85	112	96	107	96	101	79	91	75	
Available Phosphorus	122	132	132	114	100	98	104	91	102	88	77	79	67	
Ionizable Iron	137	123	100	111	115	96	115	113	89	86	93	61	62	
Mean	125	124	115	103	103	103	100	101	95	92	85	83	69	
	TABLE (3.2) DECEMBER, 1939													
Protein	104	133	115	114	128	129	104	103	101	78	94	85	92	51
Ether Extract	115	111	116	128	129	90	107	108	93	90	67	87	60	
Calcium	119	147	153	83	114	81	103	100	94	86	103	69	58	
Available Phosphorus	122	117	96	110	135	114	97	93	89	106	100	75	57	
Ionizable Iron	152	141	101	78	89	92	115	139	83	91	100	59	59	
Mean	122	130	116	103	119	96	105	108	87	93	91	76	57	
	TABLE (3.3) APRIL, 1939													
Protein	113	115	110	98	100	114	96	85	105	96	104	93	71	
Ether Extract	114	114	109	84	90	109	62	109	105	101	104	70	100	
Calcium	136	136	88	67	69	129	70	126	93	119	70	99	96	
Available Phosphorus	149	117	201	92	92	86	90	74	94	79	77	72	77	
Ionizable Iron	113	96	97	160	155	103	115	75	99	78	82	63	66	
Mean	131	116	122	100	101	108	87	94	99	95	88	80	82	
	TABLE (3.4) AUGUST, 1938													
Protein	114	111	110	118	103	108	94	87	96	87	101	110	62	
Ether Extract	153	147	126	69	78	112	88	83	93	89	58	113	91	
Calcium	100	119	117	122	83	115	143	76	107	85	70	102	56	
Available Phosphorus	96	139	104	153	56	87	134	115	139	68	38	101	68	
Ionizable Iron	2	1	5	3	11	7	3	9	6	10	13	7	12	
Mean	116	129	114	115	80	106	115	90	109	82	67	106	69	

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TABLE 4. MEAN INDEX NUMBER OF FOOD CONSTITUENTS

Hostel No.	Index Number			
	December 1939	April 1939	August 1938	Average
(1)	(2)	(3)	(4)	(5)
1	122	131	116	125
2	130	116	129	124
3	116	122	114	115
4	103	100	115	103
5	119	101	80	103
6	96	108	106	103
7	105	87	115	100
8	108	94	90	101
9	87	99	109	95
10	93	95	82	92
11	91	88	67	85
12	76	80	106	83
13	57	82	69	69

TABLE 5. "BETWEEN HOSTELS" CORRELATION

Food Constituents	Protein	Ether Extract	Calcium	Phosphorus	Phytin Phosphorus	Total Iron	Copper
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Protein	..	0.6605*	0.6030*	0.8322***	0.7429**	0.5662*	0.4800
Ether Extract	0.6605*	..	0.8198***	0.8485***	0.6591*	0.4885	0.3208
Calcium	0.6030*	0.8198***	..	0.7651**	0.7733**	0.5267	0.1949
Phosphorus	0.8322***	0.8485***	0.7651**	..	0.7909**	0.6568*	0.5990*
Phytin Phosphorus	0.7429**	0.6591*	0.7733**	0.7909**	..	0.5046	0.3587
Total Iron	0.5662*	0.4885	0.5267	0.6568*	0.5046	..	0.6038*
Copper	0.4800	0.3208	0.1949	0.5990*	0.3587	0.6038*	..

Level of Significance

5% *

1% **

0.1% ***

TABLE 6. SEASONAL AVERAGES FOR ALL HOSTELS AND COMPARISON WITH STANDARD REQUIREMENTS

Food Constituents Serial No.	Seasonal Averages for all Hostels				Standard Requirements 1939	Seasonal Averages in the form of Percentages			Percentages in terms of Standard Requirements			
	Dec. 1939	April 1939	Aug. 1938	Average		Dec. 1939	April 1939	Aug. 1938	Dec. 1939	April 1939	Aug. 1938	Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A Protein (gm)	62.94	57.86	47.23	56.00	57.00	1.12	103	84	94	86	70	84
B Ether Extract (gm)	46.62	39.65	26.03	37.43	50.00	125	106	70	93	79	52	75
C Calcium (gm)	0.64	1.06	0.54	0.75	0.68	85	141	72	94	156	79	110
D Phosphorus (gm)	0.92	0.94	0.75	0.87	..	106	108	86	..	..	..	..
E Phytin Phosphorus (gm)	0.20	0.39	0.32	0.30	..	67	130	107	..	..	..	..
D-E Phosphorus-Phytin Phosphorus (gm)	0.72	0.55	0.43	0.57	1.32	126	97	75	55	42	33	43
F Total Iron	34.58	22.02	12.83	23.16	..	149	95	55	..	..	..	..
G Ionizable Iron gm	8.79	5.75	..	7.27	15.00	121	79	..	59	38	..	48
H Copper (gm)	1.85	5.27	2.58	..	..	..	..	..	..	..	..	..