A STUDY OF ENGLISH DIETS BY THE INDIVIDUAL METHOD

III. PREGNANT WOMEN AT DIFFERENT ECONOMIC LEVELS

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PERFECT health may be defined as a state of well being such that the possessor carries no stigmata to which a nutritional origin can be assigned and in whom no improvement in health can be effected by a change of diet. In other words, optimum nutrition in an adult implies and postulates optimum nutrition of that person as a child, that child as a foetus and that foetus of its mother. Now clearly a mother can only be in a state of optimum nutrition when all her nutritional requirements are being met, and it is therefore vitally important to know what her requirements may be. Reference to the recognized authorities reveals a lamentable lack of uniformity on this subject. "A pregnant woman will require rather more nourishment than when she is not so placed, and in most cases will take it. It is better for her to have meat only once a day, and she should avoid all rich, indigestible and highly seasoned articles of food in order to decrease the amount of waste products to be excreted. She should drink plenty of water" (White *et al.* 1935). "Meat should not be taken in the latter half of pregnancy because of its harmful toxic substances.....There is as much danger in overeating in pregnancy as in deficiency of diet" (McIlroy, 1935).

In sharp contrast to this vague *laissez faire* advice, emanating from the consulting gynaecologists, come the challenging demands of the experimental scientists. These are based upon the assumption that a healthy woman should be able to provide for the requirement of the foetus and finish her pregnancy without any drain upon her own resources. Food requirements during pregnancy should be assessed upon this basis. Unfortunately, only a limited amount of evidence is at present available as to the quantitative food requirements of pregnant women and the interpretation of it is not all entirely straightforward. Garry & Stiven (1936) have reviewed this evidence and have drawn certain conclusions from it. The League of Nations Technical Commission (1936) has, presumably, drawn upon this evidence also, though it is not acknowledged in the report. Since an important part of the present investigation has consisted in a comparison of the actual food intakes of 120 pregnant women with their requirements as determined by others, it is proposed to review very briefly the experimental work which has been carried out to elucidate the requirements of the different food constituents dealt with in this investigation.

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CALORIE REQUIREMENTS

It is usually assumed that women require about 2400–2500 cal. a day when they are not pregnant (Cathcart & Murray, 1931; League of Nations, 1936). Widdowson & McCance (1936), using the individual method, found that the average calorie intake of sixty-three non-pregnant women was somewhat lower, namely 2187. This lower estimate has now been confirmed by others (*vide* Orr & Leitch, 1938).

Evidence as to whether the calorie intake should be increased during pregnancy is conflicting. Basal metabolism appears to rise significantly during the second half of pregnancy (Sandiford *et al.* 1924–5, 1931; Rowe *et al.* 1931*a*, 1932; Spiga-Clerici, 1937), but, as Garry & Stiven suggest, this may be counterbalanced by the decrease in muscular activity at this time. The League of Nations Technical Commission (1936) recommended 3000 cal. a day for women engaged in household duties, whether pregnant or not. This allowance seems to be somewhat too high, particularly in the light of the present investigation (*vide infra*) and an even higher figure is implied in the dietary scheme for pregnant women where protective foods supply 1440 cal. and cereals 1000. Fats and sugar in sufficient quantities to make such a diet acceptable to a Western European or American woman could scarcely account for less than a further 1000 calories.

PROTEIN REQUIREMENTS

The amount of nitrogen in the average full-term foetus is of the order of 60 g. (Macy & Hunscher, 1934; Coons, 1935). The placenta contains about 17 g. and the amniotic fluid 1 g. In addition to this it has been estimated that about 17 g. of nitrogen have been laid down in the mammary glands and 39 g. in the uterus (Macy & Hunscher, 1934), which increases in weight from 30 to 1000 g. (Harding, 1925). Thus a total storage of 130–140 g. of nitrogen appears to be required.

A number of nitrogen metabolism studies during pregnancy have been made (Hoffström, 1910; Landsberg, 1912; Wilson, 1916; Coons & Blunt, 1930; Macy *et al.* 1931; Hunscher *et al.* 1933, 1935; Coons & Marshall, 1934; Coons, 1935; Hummell *et al.* 1937). Macy & Hunscher (1934) have calculated from 954 daily balances on pregnant women that the mother stores, on average, about 500 g. of nitrogen, or about 2·3 g. per day from the fourth to the ninth month of pregnancy (see also Hunscher *et al.* 1933). This is far greater than the amount actually required for the needs of the foetus and adnexa, but a similar storage in excess has been noted by other workers (Hoffström, 1910; Wilson, 1916) and must, at any rate for the present, be accepted as physiological. Macy and Hunscher suggested that this surplus might act as a reserve to make good losses during child birth and, in addition, to prepare the body for meeting the demands of lactation. Landsberg (1912) and Coons & Blunt (1930) found that the nitrogen retention varied directly with intake. Strauss (1935) considered that toxaemias of pregnancy could often be traced to a low

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protein intake over a number of years and that they could be greatly improved by increasing the protein intake to about 260 g. per day. Such intakes seem excessive in Europe or America, but in spite of the views of gynaecologists they can scarcely be regarded as harmful to healthy women for, as Mellanby (1933) pointed out, if they were, all Eskimo women would have long since died from eclampsia or kidney damage. Rabinowitch & Smith (1936) found no signs of renal disease among Eskimos even though their protein intake was 250–300 g. per day. The League of Nations accepted the principle that a generous intake of protein could not be harmful and was probably beneficial. They accordingly recommended an intake of 1 g. per kg. during the first 3 months of pregnancy, the same as for a non-pregnant adult, and an intake of 1·5 g. per kg. during the last 6 months. Garry & Stiven (1936) recommended an intake of 70–119 g. of protein per day.

Carbohydrate and fat requirements

There seems to be no direct evidence as to the optimum distribution of calories between these two constituents, and it is probable that wide variations are compatible with health. Experiments on rats have shown that certain unsaturated fatty acids are essential for reproduction (Burr & Burr, 1930; Evans *et al.* 1934), but no work of this kind has yet been carried out on human beings. The chief importance of fat in human nutrition appears to lie in its capacity to act as a carrier of vitamins A and D.

Calcium requirements

The full term human foetus contains on average 24 g. of calcium (Givens & Macy, 1933; Macy & Hunscher, 1934; Coons, 1935). It appears, from analyses of foetuses of different ages, that about two-thirds of this calcium is laid down during the last 2 months of pregnancy, i.e. about 0·25 g. a day. Macy & Hunscher (1934) have calculated that women on generous calcium intakes may retain up to 6 g. of calcium over and above the possible requirements of the foetus and adnexa. As with protein, therefore, the maternal organism appears to be able to store an amount in excess of the foetal requirements. It must be pointed out, however, that although probably physiological, these results were obtained on intakes of calcium far higher than those of many women in this or any other country. Thus the three women studied by Macy and her colleagues (1930, 1931) were taking about 2 g. of calcium per day and one subject (Hummell *et al.* 1936) had a mean daily intake of 3·1 g. of calcium. Toverud & Toverud (1931) found that intakes of 1·6–1·8 g. of calcium a day were necessary in order to maintain a positive balance during the last few months of pregnancy, when the needs of the foetus were taken into account.

There is some evidence that the amount of sunshine may be an important factor in determining the amount of calcium needed, for Coons (1935) found that a calcium intake of 1·4 g. a day was sufficient to maintain a positive

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balance in pregnant women living in the southern part of the United States, but not in women living in Chicago. There was 50% more sunshine in the South than in Chicago. This suggests that the supplies of vitamin D were suboptimal in Chicago, and that 1·4 g. calcium per day were enough in the presence of optimal supplies of vitamin D. It would seem that in considering the calcium requirements for optimum nutrition one should assume an optimum vitamin D intake.

The League of Nations Technical Commission, in the dietary scheme for pregnant women, advocated a calcium intake of 1·6 g. a day. Garry & Stiven recommended 1–2 g. and from the limited number of balance studies which have been carried out these would appear to be reasonable estimates. It is possible, however, that different results would be obtained on English women who are accustomed to lower levels of intake (*vide infra*).

Phosphorus requirements

Studies of phosphorus requirements have proceeded along similar lines to those of calcium. Chemical analyses of foetuses show that they contain about 14 g. at term (Macy & Hunscher, 1934; Coons, 1935). Balance studies, however, on generous intakes indicate that a mother may retain 60 g. of phosphorus during pregnancy (Macy & Hunscher, 1934). This large amount far exceeds the requirements of the foetus as does the nitrogen storage already discussed, but no data are available for the phosphorus requirements of the maternal tissues. There appears to be a relation between the amount of phosphorus in the diet and the amount retained (Macy & Hunscher, 1934; Coons, 1935) and most authorities agree that an intake of 1·5–2 g. a day is desirable (Macy & Hunscher, 1934; Garry & Stiven, 1936; League of Nations, 1936). In Coons' (1935) experiment, the retention of phosphorus appeared to be less affected by sunlight than that of calcium.

Calcium/phosphorus ratio

Experiments on rats (Cox & Imboden, 1934*a*, *b*, 1936) have shown that both the calcium/phosphorus ratio and also the absolute amounts of these elements in the diet during pregnancy have an influence on the weight and ash content of the young and the weight of the mothers. In general, the higher the level of calcium, the higher was the optimal ratio of calcium to phosphorus. Calcium/phosphorus ratios of 1 : 1 to 1·5 : 1 gave the best results. Unfortunately no information as to the importance of the calcium/phosphorus ratio in human nutrition is available.

Iron requirements

The determination of the actual iron requirement during pregnancy is complicated by the fact that the body appears to have a very large capacity for storing this element (Widdowson & McCance, 1937). The actual requirement however should be independent of any stores if the criterion for nutrition in

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pregnancy is correct—namely that the food of the mother should be sufficient to provide for the needs of the foetus and placenta and for the blood lost at delivery without any drain on the maternal organism.

Analyses of the human foetus show that it contains about 400 mg. (Coons, 1935). In addition to this, Coons (1932) has calculated that about 500 mg. are required for the placenta (see also Hilgenberg, 1930) and other maternal tissues, making a total requirement of 900 mg.

The amount of iron in the foetus, however, varies widely, new born infants containing amounts ranging from 266 to 937 mg. (Coons, 1935). These differences are attributed to the variations in foetal reserves. Probably higher values still would be found for infants born of mothers who had previously taken large doses of medicinal iron, but no data are available. From analyses of foetuses at different ages it appears that about half the iron is stored during the last two months of pregnancy, an average of 3·3 mg. a day.

A few iron balance studies during pregnancy have been carried out (Coons, 1932, 1935; Toverud, 1935). Up to the sixth or seventh month the positive balances were greater than the calculated amount for foetal need, but during the last two months of pregnancy the requirements of the foetus far exceeded the amounts retained. In the experiment of Coons (1935) on two groups of women, one living in the south and one in the north of the United States, it was found that although these women were eating similar diets, containing about 15 mg. of iron a day, and the whole experimental procedure was the same, the average daily iron retention of the southern women was 2·46 mg., while that of the Chicago women during corresponding periods of pregnancy was 3·16 mg.

The League of Nations dietary scheme allows for 12·7 mg. per day if milled cereals are eaten and 19 mg. per day if the cereals are unmilled. It is not clear from the report if 12·7 mg. is considered adequate. Macy & Hunscher (1934) consider that the daily intake of iron should be 20 mg. Garry & Stiven (1936) suggested 18 mg. as the daily human requirement.

The authors feel that 12·7 mg. per day is not sufficient for optimum nutrition and that probably 18–20 mg. would be better. It must be admitted, however, that Kyer & Bethell (1936) were able to maintain a normal haemoglobin level in a healthy young woman during the last 3 months of pregnancy on a diet supplying only 7·1 mg. of iron a day. The blood of the infant had high normal values. If the above suggestions for the iron requirements in pregnancy are correct, it would seem that this woman must have had adequate iron stores and drawn upon them extensively to supply the demands of pregnancy. It is however almost impossible at present to give any exact figure for iron requirements during pregnancy because factors other than the total quantity of iron in the diet appear to play an important part in the amount absorbed. This is of course also true of other metals, particularly calcium.

In conclusion one may say that the scientific evidence suggests that the daily intakes during pregnancy should probably be of the following order: calories 2500, protein 90 g., calcium 1·5 g., phosphorus 2 g., iron 20 mg.

Present investigation

Subjects

This dietary study was carried out by the "individual method" (Widdowson, 1936; Widdowson & McCance, 1936) and appears to be the first of its kind ever made in this country and the most comprehensive in any part of the world. 120 women have been investigated, and all were 3–9 months pregnant. Twenty-one women were wives of unemployed miners in Merthyr Tydfil, South Wales, thirty-two women were wives of unemployed miners in Gateshead, Northumberland, twenty women were wives of employed labourers in Bermondsey, London, twenty-one women were of the artisan class and lived in Camberwell, London and twenty-six women belonged to the professional classes and lived in various parts of the country.

Details of income, rent and size of family were obtained for all except the professional class. The wives of the unemployed miners may be taken as representative of women in the two distressed areas, South Wales and Tyneside. They were obtained through the assistance of the Medical Officers of Health in those districts, and it will be seen from Table I that the money available per head, after deduction of rent, for food and all the other necessities of life sometimes amounted to less than 5*s*. per week. In Gateshead the National Birthday Trust Fund was distributing a full cream dried milk (Glaxo) and Ovaltine to women during the last 3 months of pregnancy and most of the subjects who had reached this stage of pregnancy were receiving the foods. The South Wales women were allowed 1 pint of fresh whole milk from the seventh month by the local authorities.

The women living in Bermondsey were attending an out-patient clinic at Guy's Hospital. They were rather better off than the women in the distressed areas, but still their income per head after deduction of rent was only of the order of 14*s*. They were not receiving free food of any kind.

The Camberwell women were out-patients at King's College Hospital and were specially chosen for the investigation by the hospital almoner. These women were mainly primiparae. The husband's occupations varied from that of a tram driver to a Royal footman. The incomes were judged to be sufficient to buy a plain but adequate diet.

It was not possible to obtain information as to income from the women of the professional class, but it may be assumed that it was ample to enable them to buy all they required in the way of food. Their incomes have been assumed to exceed 40*s*. per head per week.

Method

Each subject was provided with a spring butter balance weighing by ¼ oz. up to 2 lb., printed instructions, and a set of forms on which to enter the results. All food eaten for the period of 1 week was weighed. All the women

Table I. *Chemical composition of the individual diets*

No.	District	Age, years	Height, cm.	Weight, kg. (corrected)	Stage of pregnancy in months	No. of previous pregnancies	No. of living children	Income less rent per head per week s.	d.	Haemoglobin % (Haldane)	Calories per day	Total protein g./day	Animal protein g./day	Fat, g./day	Carbohydrate g./day	Calcium, g./day	Phosphorus g./day	Total iron mg./day	Inorganic iron mg./day
1	Gateshead	22	147	50·8	4	1	0	10	6	85	1918	76	52	81	208	0·41	1·07	14·0	8·6
2	Gateshead	30	158	53·1	6	1	1	7	0	87	2643	79	35	107	323	0·57	0·97	14·0	9·8
3	Woodford	28	155	63·0	6	0	0	Over 40	0	—	1945	73	52	87	204	0·46	1·00	14·5	10·4
4	Acton	26	172	71·2	7	1	1	Over 40	0	—	2827	89	63	125	317	1·03	1·45	13·1	8·8
5	Gateshead	23	156	78·9	6	2	2	6	7	85	2594	86	48	92	338	0·47	1·15	15·3	10·6
6	Cambridge	31	163	60·6	7	0	0	Over 40	0	—	2315	68	37	88	297	1·03	1·58	14·2	10·7
7	Gateshead	25	152	53·1	8	2	2	6	8	63	1376	47	30	47	182	0·53	0·69	7·9	5·3
8	Bermondsey	20	170	64·9	8	0	0	—		87	2097	62	38	95	234	0·66	1·02	10·4	7·8
9	Thames Ditton	31	163	60·3	6	0	0	Over 40	0	—	2390	71	44	93	301	0·81	1·23	12·5	9·9
10	Gateshead	30	150	56·2	7	3	3	8	1	—	1312	28	13	60	156	0·32	0·48	5·5	4·7
11	Bermondsey	28	170	83·0	7	0	0	—		103	2329	84	57	101	255	0·49	1·07	16·2	9·8
12	Longfield	25	163	65·3	6	0	0	Over 40	0	—	1980	68	40	78	238	0·51	1·09	12·2	7·2
13	Camberwell	31	161	54·7	8	0	0	27	6	110	2933	80	48	106	395	0·86	1·22	11·6	8·2
14	Gateshead	39	142	52·2	7	3	3	7	6	88	1663	52	24	51	238	0·48	0·79	8·2	5·7
15	Grantchester	25	173	56·7	4	0	0	Over 40	0	—	2362	66	44	90	306	0·95	1·35	11·5	9·1
16	Gateshead	36	158	59·4	6	3	3	5	3	87	1557	40	15	44	240	0·32	0·51	7·0	5·0
17	Bermondsey	22	152	86·2	8	0	0	14	0	88	2962	72	33	105	401	0·52	1·06	12·6	9·6
18	Gateshead	35	152	64·0	7	7	5	4	3	68	2170	66	37	83	275	0·60	0·96	11·9	9·1
19	Gateshead	33	177	73·0	8	3	3	—		73	2234	63	35	93	271	0·52	0·89	10·9	8·2
20	Camberwell	31	161	61·2	4	0	0	31	6	87	2236	72	44	72	310	0·74	1·09	13·1	9·1
21	Merthyr	38	151	58·5	7	6	6	4	5	34	1725	46	22	66	225	0·46	0·68	4·9	3·5
22	Bermondsey	29	159	54·0	7	0	0	—		85	2454	83	53	88	294	0·63	1·20	13·8	7·7
23	Merthyr	22	156	59·7	4	3	3	5	6	79	2548	60	20	106	321	0·24	0·64	8·0	6·3
24	Merthyr	28	150	57·9	7	3	2	6	4	—	1819	47	28	84	206	0·51	0·72	6·8	4·8
25	Gateshead	24	170	69·9	8	3	2	8	3	71	1829	48	22	56	271	0·31	0·60	9·3	6·5
26	Gateshead	25	160	—	8	1	1	8	8	79	2576	77	41	94	338	0·69	1·23	12·6	10·2
27	Camberwell	23	168	57·0	5	0	0	38	9	110	3145	92	52	134	371	0·93	1·56	15·5	11·4
28	Merthyr	41	155	61·5	8	11	3	5	5	60	1249	34	18	58	139	0·45	0·57	4·2	3·2
29	Merthyr	27	158	55·3	4	1	0	—		62	1217	30	11	55	142	0·18	0·49	6·3	4·6
30	Norwood	23	168	64·9	8	0	0	Over 40	0	—	2516	90	68	114	265	1·31	1·76	14·7	11·3
31	Camberwell	26	168	68·3	5	0	0	22	6	90	2564	79	55	106	306	0·93	1·31	15·2	9·1
32	Gateshead	33	145	48·1	8	2	2	6	4	87	2664	97	63	100	326	1·02	1·51	17·9	12·5
33	Cambridge	30	165	60·8	5	1	1	Over 40	0	—	3164	92	64	133	378	1·04	1·79	18·4	14·7
34	Woodford Green	22	159	66·2	5	0	0	Over 40	0	—	3439	103	70	171	348	1·23	1·82	16·9	13·1
35	Camberwell	24	158	57·9	6	0	0	38	6	—	2648	84	59	111	310	0·85	1·34	15·0	11·0
36	Gateshead	39	147	61·2	9	4	3	—		91	1679	59	33	50	237	0·77	1·01	8·3	7·5

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37	Gateshead	21	158	52·2	7	1	1	7	4	73	1695	46	25	76	195	0·37	0·63	6·4	4·8
38	Esher	25	170	61·2	4	0	0	Over 40	0	—	1775	59	39	82	188	0·62	0·98	9·4	7·1
39	Bermondsey	29	160	62·1	7	1	1	8	2	70	2897	85	48	103	388	0·63	1·34	13·8	11·1
40	Camberwell	20	163	60·3	6	0	0	27	6	81	2278	64	40	92	283	0·58	1·02	10·8	8·2
41	Camberwell	28	170	58·1	7	0	0	24	9	65	2788	79	46	108	356	0·88	1·43	14·7	11·4
42	Camberwell	28	156	59·7	6	0	0	23	0	78	1958	69	46	77	234	0·58	1·06	9·1	6·7
43	Bermondsey	21	165	59·9	8	0	0	—		75	2410	76	32	93	301	0·83	1·22	13·6	11·1
44	Merthyr	28	152	59·9	9	0	0	11	3	75	2336	78	38	77	317	0·39	0·95	14·4	9·1
45	Gateshead	45	160	78·0	9	11	7	5	9	—	2059	56	27	68	292	0·45	0·81	10·4	7·5
46	Gateshead	28	162	72·4	8	2	2	6	9	90	2238	77	44	81	285	0·72	1·18	14·3	9·6
47	Putney	23	163	57·0	7	0	0	Over 40	0	—	3237	89	54	132	401	1·12	1·82	19·4	15·8
48	Merthyr	30	147	56·2	8	6	5	4	3	61	2319	77	38	88	289	0·83	1·02	8·1	6·3
49	Bermondsey	23	164	54·0	7	1	1	—		—	2334	63	33	102	275	0·41	0·87	12·1	9·3
50	Camberwell	27	159	55·8	6	0	0	31	6	89	2469	90	63	98	290	0·70	1·40	13·5	10·6
51	Gateshead	28	155	55·8	8	0	0	10	6	80	2326	66	33	87	304	0·61	0·95	12·4	7·9
52	Gateshead	37	156	55·3	9	5	5	5	1	83	2022	53	32	90	236	0·48	0·80	10·4	6·5
53	Gateshead	28	148	50·3	8	1	1	9	0	78	1495	50	33	62	174	0·46	0·83	9·1	6·7
54	Camberwell	32	160	54·0	5	0	0	19	6	80	3121	81	44	105	442	1·15	1·60	13·6	11·8
55	Wallington	31	163	68·0	5	0	0	Over 40	0	—	3075	103	77	130	352	1·11	1·72	16·6	10·3
56	Camberwell	33	170	79·8	7	0	0	28	9	80	3305	102	73	146	373	0·88	1·53	17·3	11·5
57	Wolverhampton	35	174	61·7	8	3	3	Over 40	0	—	2430	84	56	114	250	1·13	1·52	11·9	9·0
58	Gateshead	25	148	49·0	5	3	1	7	3	93	1449	47	26	54	184	0·29	0·56	9·1	5·9
59	Bermondsey	28	158	—	8	2	1	9	10	85	2381	75	41	93	291	0·74	1·21	13·5	8·9
60	Hassocks	29	165	50·3	5	0	0	Over 40	0	—	2358	74	49	94	288	0·91	1·36	12·6	10·3
61	Gateshead	28	160	63·5	6	4	4	4	8	—	2691	78	36	98	356	0·55	0·99	10·9	8·2
62	Merthyr	37	146	72·6	6	4	4	4	10	76	1620	46	19	65	226	0·34	0·56	5·7	4·5
63	Merthyr	30	155	65·2	7	1	1	7	0	—	1666	41	25	91	159	0·30	0·76	8·8	6·5
64	Merthyr	19	150	56·7	9	0	0	10	6	—	1170	26	7	42	164	0·22	0·36	4·1	3·6
65	Camberwell	24	166	62·6	5	0	0	25	0	85	3232	99	59	139	374	0·59	1·28	17·1	11·8
66	Camberwell	34	164	57·4	7	1	1	18	4	83	2816	85	58	111	350	1·20	1·67	15·3	11·4
67	Merthyr	23	166	62·6	6	0	0	10	6	82	2475	69	40	122	258	0·72	1·08	9·2	7·3
68	Camberwell	24	148	57·9	6	0	0	30	0	102	3142	88	55	165	304	0·48	1·14	16·1	10·6
69	Merthyr	21	158	57·1	6	0	0	19	0	80	2181	62	35	97	250	0·37	0·79	10·6	7·6
70	Merthyr	20	158	59·9	5	0	0	9	3	70	2181	54	26	93	267	0·30	0·65	9·0	6·2
71	Gateshead	31	166	56·2	8	5	5	5	0	92	2628	69	26	71	411	0·87	1·05	10·4	8·8
72	Bermondsey	22	154	53·1	9	0	0	13	0	89	2074	60	31	78	269	0·33	0·82	11·0	8·7
73	Gateshead	28	156	52·6	7	2	2	9	9	70	2501	85	48	93	314	0·74	1·22	12·0	7·3
74	Bermondsey	24	156	50·8	4	0	0	21	5	85	2693	86	55	100	344	1·04	1·59	17·9	15·2
75	Camberwell	28	155	61·2	6	0	0	37	6	80	2172	74	47	92	247	0·46	1·10	14·3	10·3
76	Norwich	34	152	52·2	7	1	1	Over 40	0	—	2584	91	53	94	326	0·86	1·52	18·0	14·1
77	Bermondsey	29	163	—	8	0	0	23	9	83	2747	76	46	127	306	0·55	1·06	14·6	9·1
78	Camberwell	26	164	59·2	4	0	0	26	0	79	2697	77	43	115	320	0·62	1·25	14·9	10·9
79	Bermondsey	22	163	57·6	7	1	1	14	10	77	2678	96	62	109	310	0·72	1·48	19·8	13·6
80	Bermondsey	18	173	—	6	1	0	15	0	87	1747	59	32	56	240	0·35	0·79	13·0	9·5
81	Bermondsey	23	165	70·8	6	2	1	7	0	—	2624	77	39	98	337	0·36	1·00	16·6	11·3
82	Herne Hill	—	163	54·0	3	0	0	Over 40	0	—	2421	96	73	102	263	1·18	1·72	17·9	12·6
83	Bermondsey	29	154	51·3	8	1	1	—		93	2444	65	34	85	320	0·62	1·01	12·8	9·2
84	Uxbridge	31	169	58·1	8	1	1	Over 40	0	—	2700	79	58	125	296	1·01	1·51	13·8	10·5

Table I (*contd*)

No.	District	Age, years	Height, cm.	Weight, kg. (corrected)	Stage of pregnancy in months	No. of previous pregnancies	No. of living children	Income less rent per head per week s.	d.	Haemoglobin % (Haldane)	Calories per day	Total protein g./day	Animal protein g./day	Fat, g./day	Carbohydrate g./day	Calcium g./day	Phosphorus g./day	Total iron mg./day	Inorganic iron mg./day
85	Merthyr	32	156	59·4	9	4	3	8	10	73	2606	67	42	125	285	0·59	1·01	10·5	7·8
86	Winchmore Hill	30	158	55·3	4	0	0	Over 40	0	—	2074	72	49	93	223	0·71	1·33	16·0	11·3
87	Merthyr	23	164	46·6	4	1	1	13	0	67	2259	50	23	112	247	0·28	0·76	9·3	7·7
88	Camberwell	25	155	66·2	5	0	0	26	3	—	3053	111	77	151	291	1·20	1·86	19·8	12·0
89	Camberwell	25	160	60·3	4	0	0	20	3	82	2229	66	39	73	312	0·42	0·86	11·2	7·7
90	Bermondsey	22	159	54·0	9	1	1	10	0	83	2022	71	40	64	277	0·40	0·96	14·3	8·9
91	Merthyr	34	152	67·4	9	1	1	8	0	—	2720	74	43	143	265	0·73	1·04	10·2	7·4
92	Bermondsey	31	152	—	8	0	0	14	3	—	2073	73	41	69	276	0·37	1·09	15·4	11·1
93	Gateshead	35	147	44·0	8	2	2	6	5	70	2137	64	30	83	269	0·61	0·89	9·5	7·2
94	Gateshead	26	145	42·6	6	1	1	7	8	73	2051	46	19	64	309	0·30	0·56	8·2	5·9
95	Gateshead	31	159	71·9	7	2	1	7	0	78	2309	65	35	90	294	0·32	0·85	12·9	8·0
96	Camberwell	31	160	53·8	8	1	0	25	3	85	2840	88	56	152	260	0·91	1·40	13·9	8·7
97	St Neots	34	156	64·9	6	0	0	Over 40	0	—	2100	75	57	101	208	0·76	1·24	13·5	9·6
98	Beckenham	25	159	62·6	5	0	0	Over 40	0	—	1880	61	40	91	191	0·61	1·08	11·0	8·5
99	Gateshead	36	163	66·2	8	4	4	5	6	—	1834	51	31	87	199	0·24	0·64	7·4	5·1
100	Gateshead	20	158	58·5	8	0	0	16	3	—	2906	95	55	96	396	0·95	1·66	15·5	13·6
101	Merthyr	41	152	63·0	4	7	7	3	10	85	3522	55	6	183	389	0·37	0·57	6·5	5·8
102	Merthyr	19	154	50·1	7	0	0	10	6	83	1163	29	15	58	123	0·27	0·62	6·4	5·3
103	Merthyr	30	156	69·7	8	2	2	5	4	95	2818	82	37	98	383	0·89	1·17	10·1	8·5
104	Merthyr	20	150	49·4	7	1	1	7	8	76	2012	51	26	77	265	0·53	0·79	7·7	6·2
105	Taplow	30	163	62·1	7	0	0	Over 40	0	—	2538	66	43	123	274	0·98	1·24	10·4	8·3
106	Bermondsey	27	164	52·6	9	0	0	13	0	—	2639	79	49	88	365	0·74	1·26	15·4	10·8
107	Merthyr	30	162	59·2	8	4	3	5	3	79	2157	65	42	86	266	0·72	0·99	9·0	6·2
108	Gateshead	30	150	47·6	7	3	3	6	1	100	1983	70	48	81	230	0·71	1·09	10·3	7·9
109	Camberwell	32	164	68·5	8	1	1	15	0	68	2460	67	35	101	304	0·71	1·09	13·8	9·9
110	Wolverhampton	33	166	63·0	8	3	3	Over 40	0	—	2894	83	57	134	319	1·21	1·61	17·1	13·0
111	Gateshead	19	160	54·4	6	0	0	8	5	58	2786	103	69	114	318	0·76	1·32	15·5	10·3
112	Cambridge	22	166	58·5	7	0	0	Over 40	0	—	2270	80	55	99	249	0·91	1·37	13·2	10·9
113	Gateshead	39	149	64·4	8	6	6	5	2	93	2457	77	37	113	266	0·43	0·89	13·1	9·1
114	Hammersmith	25	170	69·9	9	0	0	Over 40	0	—	3021	90	59	115	386	0·56	1·37	16·8	11·9
115	Bermondsey	33	160	54·0	8	1	1	14	9	85	2278	59	35	107	254	0·51	0·90	8·7	6·5
116	Greenford	28	151	54·4	6	0	0	Over 40	0	—	2450	88	67	106	269	1·75	1·91	14·8	12·3
117	Shortlands	31	165	61·2	8	2	2	Over 40	0	—	2206	76	52	93	251	0·77	1·20	14·6	10·5
118	Camberwell	33	147	55·8	3	0	0	17	0	88	2494	82	53	102	295	0·91	1·24	10·7	8·2
119	Bermondsey	21	155	57·2	8	0	0	19	0	—	1890	60	38	65	278	0·47	0·93	11·6	8·4
120	Gateshead	22	163	55·8	9	0	0	9	0	87	2741	90	51	95	363	1·06	1·52	17·2	13·2

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except a few of those in the professional class were interviewed personally at the beginning and the exact technique to be adopted was explained. The women in Merthyr Tydfil, Gateshead and Bermondsey were visited in their homes every day during the week of investigation, their day's entries inspected and discussed, difficulties explained and questions answered while the details were fresh in their memories. For the remainder of the women this was found to be unnecessary as the subjects were all sufficiently intelligent and co-operative to carry out the weighing without constant supervision.

Several records had to be discarded, but, generally speaking, the weighing and entering of the results was done with care, even in the poorest homes where there were sometimes six or seven children to be attended to. Once the confidence of the women had been established they regarded the daily visit of the investigator as an event, and they were rather proud to show her their daily record. The balances were treated carefully, and in no home did they receive any damage whatever.

At the end of the week the sheets were collected, and the chemical composition of the diets calculated from food analyses made in this laboratory (McCance & Shipp, 1933; McCance *et al.* 1936; Abrahams & Widdowson, 1937). Among the poorer classes practically no cooked puddings or savouries were eaten, but the amount of cooking done in the home increased with rising income. Where cooked dishes were eaten their composition was assessed as described by Widdowson (1936). Heights and weights of the women were recorded, and their weights were corrected from data given by Rowe *et al.* (1931*b*), Cummings (1934), Siddall & Mack (1933), Evans (1937) to corresponding non-pregnant weights. An average increase of 1 lb. per week during the last 16 weeks was assumed. Haemoglobin determinations were made on nearly all the women in Merthyr Tydfil, Gateshead, Bermondsey and Camberwell. In the first three of these districts blood collections were made by house to house visitation. In spite of assurances to the contrary by the Medical Officers of Health, permission from the women to do a "blood test" was readily obtained. Duplicate samples were always collected and estimations were carried out by Haldane's method (100 % = 13·8 g. haemoglobin per 100 c.c.).

Results

(1) *Data on individual women.*

The primary object of this investigation was to determine the weighed food intake of individual women. For purposes of discussion the women may be grouped in various ways, the results for each group averaged and compared one with another, but the individual remain the fundamental observations. These individual results are given in Tables I and II. They are difficult to discuss, but repay careful scrutiny and are given so that other investigators may make use of the data as they wish. The figures which are given in terms of intakes per day are in themselves averages of seven separate consecutive

Table II. *Analysis of the individual diets in terms of foods*

No.	Fresh milk including milk used in puddings, oz./day	Condensed milk, oz./day	Dried milk, oz./day	Cream, oz./day	Cheese, oz./day	Butter eaten with bread, oz./day	Margarine eaten with bread, oz./day	Eggs, no./day	Meat, cooked wt. oz./day	Fish, cooked wt. oz./day	Raw fruit, oz./day	Tinned and cooked fruit, oz./day	Potatoes, cooked wt., oz./day	Legumes, cooked wt. oz./day	Root vegetables cooked wt., oz./day	Green leafy vegetables, cooked wt. oz./day	Raw vegetables and salads, oz./day	White bread, oz./day	Brown bread, oz./day	Cakes, pastry and puddings, made with flour, oz./day	Breakfast cereals, raw weight, oz./day	Sugar, excluding sugar used in cooking, oz./day	Sweets, chocolate oz./day	Jam, marmalade oz./day	Soups and gravy, oz./day
1	3·5	0·6	0	0	0·2	0·7	0	0·6	4·2	2·1	0	0	3·3	0·6	0·4	0·4	0·6	4·2	1·9	2·9	0	0·6	0	0	1·5
2	4·4	0·7	0	0	0·3	1·9	0	0·6	2·6	0·6	0·9	0·1	2·4	0·2	1·1	0·9	1·4	10·1	0·4	2·4	0	0·9	0	1·4	13·0
3	5·9	0	0	0·4	0	1·1	0	1·1	3·9	2·2	6·4	3·4	3·4	0·9	0·6	2·6	0·5	4·3	0	0·4	0	0·1	0·1	2·1	2·9
4	21·4	0	0	0·1	0·2	1·1	0	0·4	3·9	1·1	1·9	3·4	5·7	0	1·1	2·6	0	3·1	0·4	4·8	0·5	1·6	0·6	0·3	0·9
5	1·6	0·7	0·3	0	0	1·0	0	0·8	4·1	2·5	0	0·8	6·2	1·1	0	0	1·2	10·0	0·2	2·4	0	1·6	0	0	2·6
6	20·7	0	0	0·2	0·2	1·2	0	0·4	1·0	0	3·6	4·9	0·4	1·1	0·6	3·7	4·0	1·3	0·9	5·5	2·0	0·9	0	1·0	2·8
7	0·8	0·6	0·9	0	0·5	0	0·6	0	2·1	0·4	0	0	4·1	0	0·3	0·3	0·3	4·9	0	0·5	0	1·4	0	0·1	1·1
8	9·4	0	0	0	0	1·1	0	0·4	3·0	1·8	8·7	1·7	3·0	0·6	0·5	2·4	0·6	6·6	0	0·9	0	1·2	0	0·2	1·1
9	13·6	0	0	0·2	0·4	1·2	0	1·0	1·4	0·9	3·2	0·6	4·8	0	0	0·2	0	5·6	0	7·5	0·8	0·6	0·5	0·8	1·6
10	1·0	0	0·7	0	0·1	1·6	0	0·4	0·7	0	0	0·3	2·6	0	0	0	1·0	3·9	0·6	0·9	0	1·4	0	0	0·5
11	5·1	0	0	0	0·1	1·3	0·1	1·0	5·5	1·2	7·0	0·9	5·0	0	0·2	4·4	0·3	7·6	0	1·3	0	1·1	0	0·6	0
12	7·4	0	0	0·4	0	0·3	0	0	3·3	1·1	4·2	1·4	3·7	1·1	0·4	0·8	0	1·0	0·3	3·4	0·7	0·8	1·3	0·5	2·6
13	19·3	0	0	0	0	1·1	0	0·3	3·5	0·7	5·8	3·0	4·7	0	0·4	3·9	0	6·8	0	3·8	0·7	2·7	0·9	0·7	3·5
14	1·6	0·2	1·2	0	0	0	1·1	0	1·7	0·3	0	0	1·9	0·1	0	0	0·3	8·1	2·6	0·5	0	0·7	0	0·5	1·5
15	16·1	0	0	0·1	0·4	0·9	0	0·6	1·7	1·1	8·0	2·2	1·5	0	0·4	0·7	3·2	1·7	3·4	3·9	0	2·0	0·3	1·1	0·3
16	0·5	0·9	0·4	0	0	0	0·8	0	1·4	0	0	0	3·3	0	0·4	0	0·5	6·9	0	2·1	0·1	1·2	0	0·8	1·1
17	3·9	0	0	0	0	1·5	0	0·1	2·9	1·4	12·4	0	9·2	0·1	0	1·0	0	8·6	0	4·6	0	1·6	2·6	0·8	2·0
18	0	0·7	0·9	0	0·4	0	1·9	0·4	2·0	1·4	0·4	0·7	3·6	0	0·1	0·6	0·6	8·8	0·7	1·2	0	1·5	0	0	0·8
19	0·8	1·1	0·7	0	0·3	1·6	0	0·3	3·1	0·4	0·3	0	8·5	0	0·3	0	0	6·5	0	2·2	0	1·1	0	0·1	0·1
20	12·7	0	0	0	0·1	0·5	0	0	4·0	0·5	6·0	2·1	6·2	0	0	3·9	0	4·4	0	2·6	0·6	2·2	0·3	0	1·9
21	4·9	0·5	0	0	0·6	0	1·3	0·4	1·3	0·2	0	0	0·7	0·6	0	0	0	8·4	0	1·5	0	1·5	0	0	0
22	7·9	0	0	0	0·4	0·9	0	1·6	4·2	0	5·4	1·3	3·2	0	0·6	1·4	0·3	8·1	0	2·2	0·3	2·1	0·6	0·3	0·1
23	0·8	0·5	0	0	0	3·4	0	0·7	1·6	0·6	0·9	0	1·2	0	0	0·7	0	14·9	0	0·4	0	0·9	0	1·2	0·2
24	10·3	0·2	0	0	0	2·0	0	0·9	1·4	0·4	0·6	0	2·0	0·3	0	0	1·3	6·3	0	0·4	0	2·2	0	0	0·6
25	1·0	0·7	0·2	0	0	0·9	0	0·1	2·6	0	1·4	0	2·1	0·9	0·8	0·5	0·3	6·0	0	2·6	0·1	2·2	0	1·0	0·7
26	0·3	0·6	1·0	0	0·6	1·9	0	0·7	2·6	1·2	2·9	0	3·6	1·3	0	0	1·2	9·9	2·4	0·3	0	2·1	0·2	0·2	0·3
27	15·6	0	0	0·5	0·4	1·4	0	0·6	2·6	2·6	4·7	1·8	5·2	0·3	0·1	1·0	0·4	6·6	0	4·6	0·7	0·6	1·2	1·1	0·6
28	10·6	0	0	0	0	1·5	0	0·6	0·6	0	0·3	0	0·6	0	0	0·5	0·3	5·9	0	0	0	0·9	0	0·1	0·2
29	1·4	0·7	0	0	0	1·5	0	0·4	0·9	0	0	0	1·8	0·4	0	0	0	3·0	2·2	1·5	0	0·8	0	0	0
30	23·6	0	0	0·6	0·6	1·0	0	1·1	2·6	1·9	10·9	2·5	2·9	0·3	1·2	1·9	4·2	2·4	3·4	3·5	0	0·8	0·3	0·3	0·4
31	18·0	0	0	0·1	0	0·9	0	0	5·0	0·8	3·2	0·6	6·1	0	2·1	4·2	0·4	3·0	0	2·6	0	2·1	2·0	0·2	2·3
32	1·9	1·4	1·6	0	0·5	0	0·4	0	5·1	1·7	4·1	0·7	5·5	2·0	0	2·9	0·7	6·8	0·5	2·2	0	1·5	0	0	1·2
33	17·8	0	0	1·3	0·1	1·7	0	0·6	3·1	3·0	2·4	8·6	4·0	0	0·2	3·2	2·1	0·2	4·4	10·8	1·4	0·2	0	2·2	0·3
34	21·1	0	0	0·6	1·0	2·5	0	0·9	4·3	1·7	3·1	1·6	4·1	0	0·1	1·0	0·8	4·4	1·0	3·2	1·7	0·9	1·4	0	2·4
35	17·5	0	0	0	0	1·0	0	0·1	5·4	1·3	4·1	3·3	4·2	0·3	1·1	2·9	0·6	3·3	1·8	4·3	0	0·6	0·7	0·9	2·9
36	0·3	0·3	1·7	0	0·4	0·3	0	0·7	0·3	2·1	1·0	0	4·1	0	0·4	0	1·7	7·4	0	0	0	1·4	0	0	0

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37	0·3	0·5	0·7	0	0	0	1·7	0·6	1·2	1·0	0	0	0·9	0	0	0·3	0	5·0	0·9	2·7	0	1·0	0	0	0·1
38	9·3	0	0	0·1	0·3	1·4	0	0·7	2·1	1·6	7·5	0·4	1·9	0·2	0·9	1·7	0·2	2·6	1·2	3·1	0	0·6	0	0·8	2·2
39	10·0	0	0	0	0	1·3	0	0·4	3·6	1·2	6·3	2·2	5·0	0	0	3·3	0	7·1	1·3	2·8	1·0	2·7	0·6	0·3	0·9
40	9·7	0	0	0	0	1·1	0	0·7	3·2	1·2	7·0	0	8·0	0	1·3	1·5	0	5·3	0·3	1·7	0	1·3	1·1	0	0·9
41	14·5	0	0	0	0·2	0·7	0	0·7	2·4	1·8	1·6	2·0	9·9	1·4	0·4	3·4	0	3·7	0	2·8	0·8	2·6	0·9	0·4	3·7
42	13·0	0	0	0	0	0·8	0	0·3	2·8	1·6	1·4	1·1	2·9	0	0·5	1·1	0	5·7	0	3·2	0·4	0·2	0·4	0·5	0·7
43	0·7	5·1	0	0	0·8	0	1·5	0·1	2·0	0·4	1·4	0	3·0	0·4	0·7	0·9	0	12·6	0	1·4	0·1	0·5	0	0	5·1
44	0	0·4	0	0	0·4	1·1	0	0·6	3·7	0	8·9	0·3	5·6	0·4	0	1·1	0·9	11·4	0	2·3	0	0·8	0	0	0·5
45	1·3	0·4	0·8	0	0	0·2	0	0	2·4	0	0	0	4·9	0·9	0	0	0	6·2	1·1	1·9	0	0·2	0	0	2·1
46	6·6	0·3	0·9	0	0·2	1·1	0	0·7	3·2	0·3	0·5	0·2	3·3	0·6	0·3	0·5	0·7	7·6	2·0	3·1	0	0·4	0	0·5	1·3
47	13·7	0	0	0·6	0·6	1·9	0	1·0	1·9	2·5	13·2	1·4	6·7	0·4	0·1	1·9	6·1	1·5	7·7	4·1	0	0·8	0·7	1·9	1·9
48	11·0	0	0	0	1·3	1·4	0	0·4	1·9	0·6	0	0·1	2·1	0·4	0	0·6	0·6	13·4	0	0·7	0	1·3	0	0	2·6
49	4·6	0	0	0	0	0·9	0·1	0·6	3·4	0·7	7·2	0·4	5·1	0	0·7	2·3	0	6·8	0	4·4	0	0	1·4	0	0·9
50	12·0	0	0	0	0	1·0	0	0·7	4·9	1·3	5·9	0	4·5	0	0·1	2·8	0·4	4·6	1·4	3·0	0·6	1·5	0·8	0·7	2·0
51	0	0·9	1·2	0	0	1·6	0	0·4	3·5	0	0·3	0	5·5	0	0·8	0	0·3	8·3	1·0	3·1	0·1	1·0	0	0	0·7
52	1·4	1·8	0·4	0	0	2·4	0	0·7	2·2	0	0	0	1·7	2·1	0	0·3	0	5·1	1·1	0·6	0	2·0	0	0·7	1·4
53	0	0·4	1·0	0	0·1	1·1	0	0·3	1·7	1·4	0·4	0	1·9	0·4	0·4	0	0·9	3·9	1·9	0·9	0	1·3	0	0	0·4
54	24·6	0	0	0	0	1·4	0	0·1	1·6	1·6	7·1	0·6	10·3	0·9	1·0	3·9	1·2	2·6	2·5	5·8	0·7	1·7	1·6	1·0	3·1
55	21·6	0	0	0·2	0·2	1·0	0	0·6	7·6	2·5	8·2	1·6	3·0	0	0	2·4	4·0	2·5	0·8	6·6	0·4	1·7	1·5	0·6	0·9
56	16·3	0	0	0	0	1·7	0	1·0	5·1	2·1	6·6	1·3	2·6	0·3	0·3	0·6	0	6·1	0	4·0	1·1	2·4	0·9	0·9	1·4
57	27·6	0	0	0	0·2	1·4	0	0·6	2·4	1·1	1·6	0	1·2	0	0·4	0·1	0·1	2·2	2·8	2·5	0·6	0·8	0·3	0·8	6·3
58	0·6	1·1	0	0	0·1	0·7	0	0·1	3·2	0·1	0·5	0	4·5	0	0·3	1·0	0·5	5·1	0·8	0·4	0	1·2	0	0	2·1
59	0	5·3	0	0	0	0	1·7	0	4·4	0·6	8·5	0	5·1	0	0	2·1	0	6·0	0	3·3	0·4	2·0	0	0	3·3
60	18·0	0	0	0	0·2	1·1	0	0·1	2·3	2·2	10·3	2·7	3·6	0	1·1	2·6	0·1	3·9	1·0	2·4	0·4	1·3	0	0·4	2·4
61	1·0	1·0	0·4	0	0·3	0	2·1	0	1·9	2·6	0·2	0·4	6·3	1·1	0	0·5	1·1	12·0	0	1·7	0·1	1·6	0·1	0	0·9
62	0	0·8	0	0	0·7	1·7	0	0·3	1·5	0	0·4	0	2·5	0·4	0	0·5	0	10·0	0	0	0	0·8	0	0·4	0·1
63	1·4	1·4	0	0	0	1·8	0	0·4	2·1	0·4	0	0·3	1·8	0·3	0	0·6	0	0	5·0	2·5	0	0	0	0·1	0·5
64	0	0·6	0	0	0·1	1·1	0	0·6	0	0	3·6	0	2·1	0·3	0	0	2·3	6·0	0	0·3	0	0·6	0·3	0	0·2
65	7·8	0	0	0	0	1·6	0	1·1	7·0	0·8	4·0	2·0	6·2	0	3·6	2·3	0·6	9·3	0	1·9	0	2·0	0·9	1·1	1·9
66	26·3	0	0	0	0·4	0·6	0	0·3	3·9	0	4·2	1·4	4·9	0	0	3·4	0·4	2·6	1·0	3·8	1·7	3·3	0·7	0	0·9
67	11·6	0·8	0	0	0·1	2·6	0	0·7	1·8	1·7	0·6	0	3·6	0	0	1·2	1·6	7·1	0	3·5	0	0·8	0	0·2	0·5
68	5·9	0	0	1·1	0	2·0	0	0·6	5·7	0·1	3·5	0·9	6·6	0	1·6	1·1	0	6·4	0	4·2	0·3	0·1	1·6	1·0	1·5
69	3·1	0	0	0·6	0·4	1·0	0	0·9	2·9	0·5	0	1·3	4·7	0·6	0	0·9	0·6	7·0	0	3·9	0	1·2	0	0·3	0·2
70	3·1	0	0	0	0·2	2·3	0	0·6	1·6	1·1	0	0·4	4·3	0·6	0	0·3	1·2	9·1	0	1·5	0	1·6	0·6	0	0·4
71	0·2	3·1	1·9	0	0·1	0·9	0·1	0	1·0	0	2·4	0	3·2	0·3	0	0	0	12·4	1·4	1·0	0	3·1	0	0	2·7
72	5·0	0	0	0	0	0·9	0	0·3	3·4	0·9	1·4	0·6	7·6	0	0·6	3·0	0·1	6·3	0	2·4	0	1·1	0·4	0·4	1·5
73	4·5	0·7	1·0	0	0	1·2	0	0·3	3·3	1·6	0·7	0	5·3	1·7	0·5	1·4	0	9·6	0	2·3	0	1·3	0	0	1·6
74	18·4	0	0	0	0	0·6	0	0·4	3·0	2·1	9·7	1·0	9·6	1·1	1·3	3·6	1·2	0·6	2·5	5·4	0·3	1·5	1·2	0·2	7·1
75	2·0	0	0	0	0·3	1·0	0·6	1·0	3·5	2·0	11·0	0	6·2	0	0·3	3·3	0·4	4·2	1·7	1·8	0·5	0·7	0·6	0·7	1·3
76	14·7	0	0	0	0·2	1·4	0	1·1	2·6	1·4	2·9	0·9	3·9	0·3	1·6	2·1	0·8	5·8	2·6	1·8	0·4	1·7	0·6	0·8	8·4
77	6·6	0	0	0	0·3	1·6	0	0·7	4·0	0·5	4·8	1·2	3·2	0	0·2	3·0	0·4	6·0	0	5·5	0	1·3	0·7	0·7	0·6
78	9·0	0	0	0	0·1	1·9	0	0·9	3·5	0·4	3·0	3·4	4·7	0	2·0	1·8	0·6	6·7	0·5	4·0	0	1·0	0	1·4	2·2
79	1·8	0·5	0	0	0·7	1·2	0	0·6	5·6	2·9	2·0	0·6	5·0	0·4	1·5	1·9	0·4	8·0	0	2·9	0	1·3	1·0	0·4	3·1
80	3·4	0	0	0	0	0·8	0·1	0·1	3·2	1·1	3·6	0	10·6	0	0	4·0	0	5·5	0	1·2	0	1·3	0	0·1	2·4
81	0·7	0	0	0	0	1·5	0	1·1	5·1	0·7	4·3	0	9·9	0	0	7·1	0	10·3	0	0·3	0	2·0	1·1	0·1	2·1
82	17·3	0	0	0·1	0·6	0·9	0	1·3	5·6	1·7	9·1	1·2	6·0	0·1	0	3·9	0	4·0	0	2·7	0	0	1·4	0·8	2·3

Table II (*contd*)

No.	Fresh milk including milk used in puddings, oz./day	Condensed milk oz./day	Dried milk, oz./day	Cream, oz./day	Cheese, oz./day	Butter eaten with bread, oz./day	Margarine eaten with bread, oz./day	Eggs, no./day	Meat, cooked wt. oz./day	Fish, cooked wt. oz./day	Raw fruit, oz./day	Tinned and cooked fruit, oz./day	Potatoes, cooked wt. oz./day	Legumes, cooked wt. oz./day	Root vegetables cooked wt., oz./day	Green leafy vegetables, cooked wt. oz./day	Raw vegetables and salads, oz./day	White bread, oz./day	Brown bread, oz./day	Cakes, pastry and puddings, made with flour, oz./day	Breakfast cereals raw wt., oz./day	Sugar excluding sugar used in cooking, oz./day	Sweets, chocolate oz./day	Jam, marmalade oz./day	Soups and gravy oz./day
83	5·3	0·3	0	0	0·1	1·0	0	0·4	2·1	2·1	14·1	0	4·0	0	0	2·3	0·1	6·1	0	4·0	0·2	1·3	0·6	0·6	2·4
84	19·8	0	0	0·9	0·2	1·4	0	0·6	3·1	1·6	3·3	0·2	1·4	0	0	1·9	0·3	0·2	5·2	5·4	0·4	2·2	0·5	0·7	1·9
85	9·1	0	0	0	0·2	3·0	0	1·0	2·6	1·2	2·9	0·6	4·0	0	0·8	0·8	1·1	6·8	0	1·3	0·1	2·6	0·6	0·5	2·1
86	8·9	0	0	0·3	0·4	0·8	0	0·4	2·9	1·7	6·9	2·9	2·9	0	0·4	3·2	0·7	0	4·2	2·6	0	0·1	0·4	0·5	3·2
87	0·3	0·9	0	0	0	2·9	0	1·0	2·3	0	1·6	0	3·9	0	0·6	0	2·5	6·6	2·5	1·3	0	0·9	0·4	0	0·4
88	27·4	0	0	0·1	0·3	1·9	0	0·3	6·1	0	2·1	0·6	3·6	0·6	1·1	2·9	0	5·2	0	3·3	1·2	0·9	0	0·2	1·1
89	7·2	0	0	0	0	0·9	0	0·3	3·6	1·4	1·8	1·0	4·7	0·2	0·2	2·4	0·1	5·7	0·5	3·2	0	1·2	1·0	1·1	0·6
90	5·3	0	0	0	0·1	0·6	0	0·6	4·8	0·4	3·0	0	4·1	0	0·1	2·7	0	8·3	0	1·5	0	1·4	0·6	0	2·0
91	13·0	0·3	0	0	0·4	3·4	0	0·6	2·7	0·6	0	0	1·9	0·3	0·5	0·4	0	11·3	0	1·6	0	0·9	0	0	0·9
92	1·7	0·4	0	0	0	0	1·1	1·0	3·5	1·1	7·3	0·7	5·7	0	0	2·0	0	6·4	3·2	1·9	0	0·7	0	0	0·4
93	2·0	0·4	1·1	0	0	0	1·4	0	2·3	0·4	1·8	0·3	1·9	1·1	0	0	0	8·0	0	3·4	0	0·7	0	0	0·4
94	0	1·5	0	0	0	1·0	0	0·2	2·4	0	1·4	1·2	4·5	0	0·3	0·3	0·7	7·0	0	2·8	0	2·3	0	0	0·2
95	4·1	0	0	0	0	1·1	0	0·6	3·2	0·6	0·9	0·2	5·4	0·3	0·4	0·6	1·5	7·2	1·2	2·6	0	1·4	0	0	0·6
96	13·4	0	0	0	0·2	2·3	0	0·4	4·8	1·3	7·4	0	4·3	0	0	3·1	0	5·9	0	0	0	2·4	0·1	0·1	1·9
97	13·0	0	0	0	0·1	1·1	0	0·4	3·9	2·1	9·4	1·1	3·1	0	0	3·3	0·5	2·7	0·4	2·8	0·2	0·2	0·6	0·5	2·2
98	7·0	0	0	0	0·8	1·3	0	0·7	3·3	0·3	2·5	0·9	3·6	0	0·7	4·5	0·2	3·0	1·3	4·4	0	0·1	0·3	0·4	1·1
99	0·4	0·5	0·2	0	0	2·4	0	0·4	1·7	2·1	0·6	0·1	3·1	0	0·3	0·3	1·0	5·9	0·3	2·2	0	1·5	0	0	0·4
100	4·1	3·3	0·7	0	0·3	1·2	0	0·4	2·9	2·4	2·0	1·4	7·4	0·4	0	1·7	1·4	7·2	3·7	2·4	0·6	1·9	0·3	0	3·3
101	0·5	1·8	0	0	0	5·9	1·1	0	0	0	0	0	1·7	0	0	1·9	2·7	18·4	0	0·4	0	1·8	0	0·3	0·4
102	4·1	0	0	0	0	1·6	0	0·3	0·3	1·2	0·9	0·9	2·0	0	0	0·9	1·6	1·0	3·8	0·5	0	0·2	0	0·1	0·6
103	13·0	1·0	0	0	0·6	1·4	0	0·9	1·4	0·3	3·6	0	5·4	0	0·3	1·7	0	15·4	0	0·6	0	1·0	0·3	0	0·7
104	11·7	0	0	0	0	1·1	0	0·6	1·3	0·2	1·1	1·4	3·0	0·4	0	0·9	0	7·4	0	1·9	0·1	1·9	0	0	0·4
105	17·7	0	0	0	0·7	2·3	0	0	1·3	1·7	3·2	0	3·7	0	0·9	1·5	2·4	1·7	2·0	5·8	0·1	1·1	1·5	0·5	2·5
106	8·7	0	0	0	0·7	1·0	0	0·6	2·6	2·3	6·1	0	6·4	0·9	0	2·4	0	5·3	0	4·1	0	3·1	1·6	0·5	0
107	7·0	1·3	0	0	0·9	1·3	0	0·9	2·9	0	1·1	0·6	0·7	0	0	0·6	0	7·4	1·0	1·6	0	2·0	0·1	0	0·2
108	1·2	2·0	1·0	0	0·1	1·3	0	0·4	2·8	1·4	5·1	0	3·4	0·8	0·9	0·3	0	5·5	0	1·3	0	0·7	0·1	0	0·4
109	10·8	0	0	0	0·4	1·1	0	0·1	2·1	0·8	6·0	2·6	3·6	0·6	0	2·1	2·1	7·0	0	2·1	0·7	1·0	1·4	0·9	0·1
110	22·6	0	0	0·6	0·1	1·5	0	0·6	3·7	0	6·0	1·7	4·8	0	0·4	2·7	1·9	3·3	0·5	5·0	0	1·5	1·1	1·0	4·6
111	9·7	0·8	0	0	0·3	0·6	0	1·1	6·7	1·6	4·6	0·5	3·0	0·3	0	1·1	0·9	7·2	0	4·5	0	1·2	0·6	0	0·5
112	16·4	0	0	0·7	0·4	1·4	0	0·6	3·0	1·6	2·7	2·5	3·0	0	0·4	3·7	1·7	2·9	0·9	3·0	0	1·4	0·1	0·9	7·7
113	1·0	0	0·4	0	0·4	0	2·5	0·6	3·9	0·4	0·9	0	5·4	0·6	0	0·7	1·3	10·5	0	1·0	0	0·5	0	0	5·2
114	3·7	0	0	0	0·2	0·8	0	0·9	5·9	0	5·3	1·6	8·7	0	0	7·1	1·3	3·7	0	8·8	0	1·7	1·4	1·7	0·1
115	8·9	0	0	0	0·1	1·6	0·1	0·3	2·0	1·7	3·8	0·8	3·1	0	1·5	1·7	0	5·8	0	3·6	0	1·2	0·8	0·5	1·0
116	37·5	0	0	0·2	0·5	0·8	0	0·4	1·6	1·6	7·0	3·1	4·4	0·4	0·4	2·9	0·8	0·1	4·0	2·7	0·4	0·5	0	0·9	1·3
117	11·1	0	0	0·7	0	0·9	0	0·4	3·2	2·3	5·0	3·4	5·3	0	1·8	4·6	0·9	2·0	1·9	2·5	0·5	0·1	0	1·4	2·4
118	21·3	0	0	0·1	0·3	1·6	0	0·9	4·0	0	5·2	2·9	5·2	0	1·1	2·1	0·8	8·6	0	1·2	0	1·0	0	0·4	0·4
119	2·6	1·2	0	0	0	0·6	0	0·4	4·5	0	8·0	1·6	8·6	0·4	1·3	2·2	0	2·0	0	3·1	0	2·3	0·6	0	3·0
120	7·4	0·4	1·2	0	0·5	0	0·7	0·7	3·4	0	4·7	1·7	6·1	1·5	2·2	2·2	0·9	7·5	2·2	2·1	0	0·6	1·1	0·8	1·9

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days, and before proceeding further it is well to examine the daily scatter of these individual intakes and the value of the 7-day average. Table III shows the composition of the diets of four women on each of seven consecutive days, together with the standard deviation for each food constituent. Minor

Table III. *Daily variations in the diets of four women*

Subject	Day	Calories per day	Total protein g./day	Animal protein g./day	Fat g./day	Carbo-hydrate g./day	Calcium g./day	Phos-phorus g./day	Total iron mg./day	Inorganic iron mg./day
No. 56	Sun.	3219	90	65	142	373	1·00	1·62	21·3	13·0
	Mon.	4043	104	70	202	424	1·10	1·87	19·3	16·6
	Tues.	3233	110	83	140	361	0·89	1·50	16·0	11·2
	Wed.	3468	118	82	152	383	0·82	1·50	20·8	11·7
	Thurs.	2774	96	72	110	331	0·61	1·28	15·6	9·2
	Fri.	3230	103	76	144	358	0·99	1·64	11·5	8·7
	Sat.	3172	91	62	133	381	0·75	1·33	16·7	10·5
	Mean	3305	102	73	146	373	0·88	1·53	17·3	11·6
	S.D.	358	9·4	7·4	25·8	26·4	0·153	0·180	3·18	2·49
No. 42	Sun.	2198	81	53	86	260	0·84	1·23	10·7	6·3
	Mon.	1629	49	28	57	219	0·31	0·61	7·6	4·7
	Tues.	1530	73	53	49	189	0·62	0·97	6·1	4·9
	Wed.	2258	78	59	92	264	0·73	1·38	11·8	11·3
	Thurs.	2475	74	47	110	280	0·66	1·11	10·6	6·5
	Fri.	1866	45	22	75	240	0·34	0·67	6·5	5·6
	Sat.	1753	77	55	73	185	0·62	1·42	9·8	7·4
	Mean	1958	68	45	77	234	0·59	1·06	9·0	6·7
	S.D.	332	13·6	12·8	16·4	34·6	0·183	0·300	2·09	2·06
No. 115	Sun.	2231	66	51	124	197	0·67	1·11	11·4	7·4
	Mon.	2766	62	31	129	320	0·46	0·84	9·4	6·4
	Tues.	1951	50	26	89	224	0·60	0·73	7·5	5·3
	Wed.	1908	47	24	88	219	0·36	0·73	6·6	5·6
	Thurs.	2420	63	32	102	296	0·43	0·76	9·6	6·4
	Fri.	2399	71	50	113	258	0·64	1·19	9·8	8·2
	Sat.	2276	61	38	101	265	0·41	0·95	6·9	6·9
	Mean	2279	60	36	107	254	0·51	0·90	8·7	6·6
	S.D.	274	7·9	10·1	14·8	40·8	0·116	0·175	1·67	0·93
No. 82	Sun.	2438	88	63	92	298	1·02	1·46	14·2	9·5
	Mon.	2702	90	62	104	333	1·42	1·72	11·3	8·4
	Tues.	2499	94	66	102	284	0·77	1·41	13·7	11·6
	Wed.	2350	113	86	112	206	1·96	2·38	26·8	16·0
	Thurs.	2902	107	87	137	290	1·62	1·92	19·1	13·4
	Fri.	2073	78	61	99	203	0·68	1·29	14·3	10·3
	Sat.	1991	102	86	73	218	0·80	1·88	25·0	18·6
	Mean	2422	96	73	103	262	1·18	1·72	17·8	12·5
	S.D.	318	11·1	11·6	18·5	50·7	0·455	0·349	5·6	3·4

differences between the mean values in Table III and the corresponding results for the same women in Table I are due to slide rule approximations. A number of other records have been worked out in this way and these are given merely as illustrative cases. Subject no. 56 was selected because she had a higher and 42 because she had a lower mean than the group average. The intakes of nos. 82 and 115 over the week were close to the average for the income group to which they belonged. It will be observed that there was a considerable day-to-day variation in the intakes of all constituents. This confirms the results of Wait & Roberts (1932). It is quite clear that one day's diet does not give a reliable estimate of the food intake of the individual.

A week would appear to be the shortest time for which any investigation into an individual's food habits should be carried out, and for particular purposes it might be necessary to investigate the food intake over a series of weeks. Statistically speaking, however, a week is quite sufficient to distinguish the large eater from the small eater. Subject 56, for example, ate so much more than subject 42 that there was practically no overlapping in the ranges of the intakes of any of the food constituents.

In Table I may be found the chemical composition of the diets of the individual subjects. The women are arranged in alphabetical order. The table also contains data as to the age, height, weight, period of gestation, previous reproductive history, income, residential district and haemoglobin level. In Table II may be found details of the various foods eaten by these same individuals arranged in the same order so that wide variations in the intakes of any one dietary constituent can be related to the actual foods consumed. Thus subject no. 101 had a very high calorie intake. From Table II it is clear that this was due to enormous quantities of bread and butter eaten (18·4 oz. of bread and 5·9 oz. of butter per day). It must be pointed out that this table does not include foods taken in very small amounts such as cocoa and pickles and proprietary foods such as Ovaltine and Marmite. The most obvious comment upon Tables I and II is the wide individual variation in the intakes of all foods and dietary constituents. To take only one example, the intake of calories varied from 1163 to 3522 per day. Curiously enough both the women concerned lived at Merthyr Tydfil and the income of the small eater was nearly three times that of the other. Intakes of all the food constituents show the same wide fluctuations, and the same holds true when the results are expressed per kg. of body weight. It is clear that average food intakes, as determined by the study of a group of persons, only very approximately indicate the intakes of the constituent individuals.

Statistical relationships

Meat is an important source of iron and milk is an important source of calcium. One would expect, therefore, that the intake of these two elements might vary directly with the intake of meat and milk respectively. In point of fact this has been found to be so, and significant correlations have been found in both instances. Thus the correlation coefficient of the intakes of meat and total iron was $0{\cdot}68 \pm 0{\cdot}05$ and of the intakes of total milk and calcium was $0{\cdot}87 \pm 0{\cdot}02$. On the other hand, most foods contain iron and calcium in appreciable quantities, so that to some extent one would expect the intake of these metals to depend upon the total intake of food. This has also been found to be so. The correlation coefficient for calories and calcium was $0{\cdot}54 \pm 0{\cdot}07$, and for calories and total iron $0{\cdot}66 \pm 0{\cdot}05$. One may conclude therefore that while certain foods are particularly valuable as sources of specific dietary constituents, on the whole large eaters stand a better chance of obtaining their necessary minerals than small eaters, and the practical aspect of the findings is that the latter require to choose their food more carefully than the former.

Widdowson (1936) and Widdowson & McCance (1936) did not find a significant correlation between the intake of calories and body weight for a group of middle-class non-pregnant women. The present group of women, however, showed a significant correlation (correlation coefficient $0{\cdot}26 \pm 0{\cdot}08$). There were also significant correlations between haemoglobin levels and total and inorganic iron intakes. The coefficients respectively were $0{\cdot}31 \pm 0{\cdot}10$ and $0{\cdot}35 \pm 0{\cdot}10$. This result emphasizes the importance of a generous iron intake.

Classification of the women into groups

(1) *According to income.*

An attempt was made to correlate income with intakes of various dietary constituents, and also with height and haemoglobin levels. This, however, was found to be impracticable for two reasons: first, the exact income of the professional class women and of a few of the others was not known; secondly, income did not show a normal frequency distribution. In order therefore to study the effect of income on diet and physique the subjects have been divided into six groups, based upon the income (less rent) available for each member of the family per week. In Table IV will be found the income range and the number in each group, the average height, weight, percentage of haemoglobin, calorie and other intakes. The maximum and minimum within each group are also given. It will be observed that the average height and average haemoglobin tended to rise with income. There was considerable scatter within each group, but when the averages of the first two and of the last groups were compared mathematically the differences in both instances were significant. Admittedly the numbers are small, but the evidence such as it is points to physical differences (almost certainly of nutritional origin) between the poor and the rich. Passing on to the intakes themselves it will be seen that the average calorie intake of the first three groups was almost the same, but attention must again be drawn to the wide fluctuations within each group. The calorie intake of the last three groups was higher, but the increase was not progressive. The intake of calories per kg. of body weight rose progressively from group I to group V, but the intake of group VI was lower than either group IV or V. Still, the average for the last three groups is so much higher than that for the first three groups that the lower intakes of groups I and II may have been dictated by financial stringency. The evidence is a little unsatisfactory, however, since group I were heavier than any of the other groups. The lower calorie intake in group VI, as compared with group V, may have been due to the fact that the women in group VI were less active in that they probably did not do their own housework, whereas the majority of those in group V certainly did so. It will be noted, however, that the intakes were all

Table IV. *Chemical composition of the diets according to income groups*

(The figures in heavy type are the averages for each group. Maxima and minima are given immediately below.)

Group	Income less rent/head/week	No. in group	Height, cm.	Weight, kg.	Haemoglobin % (Haldane)	Calories/day	Calories/kg. body wt./day	Total protein g./day	Protein, g./kg. body wt./day	Animal protein g./day	Fat, g./day	Carbohydrate g./day	% calories from protein	% calories from fat	% calories from carbo-hydrate	Calcium g./day	Phosphorus g./day	Total iron mg./day	Inorganic iron mg./day
I	Less than 6*s*.	16	**156**	**63·0**	**76**	**2211**	**35·4**	**60**	**1·0**	**28**	**88**	**281**	**11·2**	**36·3**	**52·5**	**0·51**	**0·80**	**8·6**	**6·4**
			166	78·0	95	3522	55·9	82	1·4	42	183	411	13·6	48·3	64·1	0·89	1·17	13·1	9·1
			146	55·3	34	1249	22·4	34	0·6	6	42	139	6·4	25·2	44·4	0·24	0·51	4·2	3·2
II	6*s*. to 9*s*.	23	**154**	**58·1**	**79**	**2155**	**37·6**	**64**	**1·1**	**36**	**86**	**267**	**12·0**	**36·9**	**51·1**	**0·53**	**0·92**	**10·9**	**7·8**
			170	78·9	100	2897	55·4	103	2·0	69	143	388	15·1	50·8	60·8	1·02	1·51	17·9	12·5
			142	42·6	58	1312	23·3	28	0·5	13	47	156	8·8	28·5	39·1	0·29	0·48	5·5	4·7
III	9*s*. to 15*s*.	19	**157**	**56·4**	**80**	**2194**	**39·0**	**66**	**1·2**	**37**	**86**	**273**	**12·3**	**36·8**	**50·8**	**0·52**	**0·99**	**12·0**	**8·5**
			166	86·2	89	2962	50·0	96	1·7	52	122	401	14·7	46·4	57·5	1·06	1·52	19·8	13·6
			147	46·6	67	1163	20·7	26	0·5	7	42	123	9·1	29·5	42·7	0·22	0·36	4·1	3·6
IV	15*s*. to 25*s*.	14	**161**	**58·8**	**81**	**2471**	**43·0**	**75**	**1·3**	**46**	**95**	**315**	**12·5**	**35·1**	**52·4**	**0·75**	**1·22**	**13·3**	**10·0**
			173	68·5	90	2906	57·7	95	1·9	58	127	442	14·5	43·1	60·2	1·20	1·67	17·9	15·2
			147	50·8	65	1747	32·8	59	1·0	32	56	234	10·6	26·8	45·6	0·35	0·79	9·1	6·7
V	25*s*. to 40*s*.	13	**161**	**60·6**	**90**	**2781**	**46·0**	**86**	**1·4**	**55**	**121**	**317**	**12·8**	**40·1**	**47·2**	**0·75**	**1·32**	**14·8**	**10·3**
			170	79·8	110	3305	55·2	111	1·7	77	165	395	14·9	49·6	56·8	1·20	1·86	19·8	12·0
			148	53·8	79	2172	35·4	64	1·1	43	72	241	11·2	30·0	37·5	0·46	1·02	10·8	8·2
VI	Over 40*s*.	26	**164**	**60·9**	—	**2498**	**41·0**	**80**	**1·3**	**55**	**108**	**284**	**13·3**	**40·2**	**46·5**	**0·94**	**1·45**	**14·4**	**10·8**
			174	71·2	—	3439	56·7	103	1·8	77	171	401	17·1	46·2	53·1	1·75	1·91	19·4	15·8
			151	50·3	—	1775	29·0	59	1·0	37	78	188	10·6	33·8	40·6	0·46	0·98	9·4	7·1

considerably lower than the recommendations of the League of Nations but reasons have already been given for believing that the latter are too high.

The intake of total protein and of animal protein rose convincingly with income. The differences between the first two and the last groups were statistically significant. The lower intakes were well below the scientific recommendations, the higher intakes were about "correct". The averages indeed indicate that there is no serious protein deficiency when the weekly income (less rent) exceeds 25*s*. per head, but the individual figures show that such generalizations are hardly justifiable. The fat consumption was high even among the poorest women. This is due to their high consumption of butter and margarine. Bread and "butter" formed a large proportion of their diet. The carbohydrate intake was not consistently affected by income.

The average intakes of calcium, phosphorus and iron rose steadily with income. The intakes of calcium and phosphorus would have shown a much more dramatic increase had it not been for the distributions of free foods to the poorer women. The differences between the first two and the last groups were however statistically significant. The average intakes, even of the well-to-do, were considerably below their probable requirements. Only one woman of the 120 investigated was taking as much calcium or phosphorus as she is stated to require and among the three lowest income groups the average calcium intake was less than one-third of the standard. Any conclusion as to the adequacy or otherwise of the well-to-do women's iron intakes depends upon the standard adopted. In the view of the authors all the intakes are suboptimal since none of them reach 20 mg. per day. The intakes of the poorer women are certainly inadequate whatever standard be adopted. Possibly the most convincing demonstration of their inadequacy is a comparison of the haemoglobin levels and iron intakes of groups I and II with those of group V. These differences are mathematically significant.

It is of practical importance to translate these differences into terms of food. This has been done (Table V). The results may be summarized in this way. The consumption of certain foodstuffs decreased with rising income. White bread is the most striking example, but total cereals, condensed and dried milks, are others. The consumption of some foodstuffs rose with income. Examples are fresh and total milk, fruit raw and cooked, vegetables both root and green, meat and fish. In some instances the increase was much more pronounced than in others. The consumption of some foods, such as cheese, was not really affected by income, and the consumption of others, such as potatoes, was affected in a special manner. The table will make the details clear. Some foodstuffs were eaten predominantly by one group. Group VI, for example, ate far more brown bread and salads than any other group. No estimates were made of the total consumption of butter or of margarine because it was impossible to determine whether butter or margarine had been used in many of the cooked dishes. The data given for butter and margarine represent the amounts eaten with bread. There was some evidence that the richer women

Table V. *Effect of income on the foods eaten*

(The figures in heavy type are the averages for each group. The maxima are given immediately below. The minima are omitted since they were usually 0.)

Income group	Total milk, fresh, condensed and dried (calculated as fresh milk), oz./day*	Fresh milk including milk used in puddings, oz./day	Condensed milk, oz./day	Dried milk, oz./day	Cream, oz./day	Cheese, oz./day	Butter eaten with bread oz./day	Margarine eaten with bread oz./day	Eggs, no./day	Meat, cooked wt., oz./day	Fish, cooked wt., oz./day	Raw fruit, oz./day	Tinned and cooked fruit oz./day	Potatoes, cooked wt., oz./day	Legumes, cooked wt., oz./day	Root vegetables, cooked wt. oz./day	Green leafy vegetables cooked wt., oz./day	Raw vegetables and salads oz./day	White bread, oz./day	Brown bread, oz./day	Cakes, pastry and puddings, made with flour, oz./day	Breakfast cereals, raw wt. oz./day	Total cereals calculated as flour, oz./day	Sugar, excluding sugar used in cooking, oz./day	Sweets, chocolate, oz./day	Jam and marmalade, oz./day	Soups and gravy, oz./day
I	**8·2**	**3·4**	**0·8**	**0·3**	**0**	**0·3**	**1·4**	**0·6**	**0·4**	**1·7**	**0·5**	**0·7**	**0·1**	**2·9**	**0·4**	**0·1**	**0·6**	**0·5**	**10·1**	**0·4**	**1·1**	**0**	**7·5**	**1·4**	**0**	**0·2**	**1·2**
	19·3	13·0	1·8	1·9	0·1	1·3	5·9	2·5	0·9	3·9	2·6	3·6	0·7	6·3	2·1	0·4	1·9	2·7	18·4	1·4	2·2	0·1	12·5	3·1	0·3	1·2	5·2
II	**9·1**	**4·1**	**0·6**	**0·4**	**0**	**0·1**	**1·2**	**0·2**	**0·5**	**2·9**	**0·7**	**1·7**	**0·4**	**3·6**	**0·4**	**0·2**	**0·9**	**0·6**	**7·0**	**0·8**	**1·9**	**0·1**	**6·3**	**1·4**	**0·1**	**0·2**	**1·5**
	18·9	13·0	2·0	1·6	0	0·6	3·4	1·7	1·1	6·7	2·5	6·3	1·2	9·9	2·0	1·1	7·1	1·5	11·3	5·0	4·5	1·0	8·8	2·7	1·1	1·4	13·0
III	**7·1**	**3·7**	**0·6**	**0·2**	**0**	**0·2**	**1·2**	**0·2**	**0·5**	**2·9**	**1·1**	**3·5**	**0·3**	**4·7**	**0·4**	**0·5**	**1·3**	**0·7**	**6·8**	**0·9**	**2·4**	**0**	**6·2**	**1·2**	**0·5**	**0·2**	**1·2**
	18·2	11·6	5·3	1·2	0	0·7	2·9	1·7	1·0	5·6	2·9	12·4	1·7	9·2	1·7	2·2	3·0	2·5	11·4	3·8	4·6	0·4	8·1	3·1	2·6	0·8	3·3
IV	**13·7**	**12·4**	**0·3**	**0·1**	**0·1**	**0·2**	**1·0**	**0**	**0·4**	**3·3**	**1·0**	**4·2**	**1·3**	**6·6**	**0·4**	**0·6**	**2·7**	**0·6**	**4·8**	**0·7**	**3·3**	**0·4**	**5·2**	**1·6**	**0·8**	**0·4**	**2·0**
	26·3	26·3	3·3	0·7	0·6	0·4	1·6	0·1	0·9	5·0	2·4	8·0	2·9	10·6	1·4	2·1	4·2	2·1	8·6	3·7	5·8	1·7	9·0	3·3	2·0	1·1	7·1
V	**13·0**	**13·0**	**0**	**0**	**0·1**	**0·1**	**1·4**	**0**	**0·6**	**4·6**	**1·1**	**5·5**	**1·4**	**5·2**	**0·1**	**0·9**	**2·4**	**0·2**	**5·8**	**0·4**	**3·0**	**0·4**	**5·8**	**1·4**	**0·7**	**0·7**	**1·8**
	27·4	27·4	0	0	1·1	0·4	2·0	0·6	1·1	7·0	2·6	11·0	3·4	8·0	0·6	3·6	3·9	0·6	9·3	1·8	4·6	1·2	7·3	2·7	1·6	1·4	3·5
VI	**16·4**	**16·4**	**0**	**0**	**0·3**	**0·3**	**1·2**	**0**	**0·6**	**3·1**	**1·5**	**5·7**	**2·1**	**3·8**	**0·2**	**0·5**	**2·6**	**1·4**	**2·5**	**1·9**	**4·2**	**0·4**	**4·7**	**0·9**	**0·6**	**0·9**	**2·5**
	37·5	37·5	0	0	1·3	1·0	2·5	0	1·3	7·6	3·0	13·2	8·6	8·7	1·1	1·8	7·1	6·1	5·8	7·7	10·8	2·0	7·8	2·2	1·5	2·2	8·4

* To convert condensed and dried milk to fresh weight the figures were multiplied by 3 and 8 respectively.

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ate more butter than the poorer with their bread but the results were not statistically significant.

It is interesting to compare the results obtained in the present investigation with those obtained by Orr and his collaborators (Orr, 1936) in their study of the amounts of different foods eaten by a large number of families with various incomes. Their method of investigation differed from the present one in that they estimated the total food eaten by the family and divided it by the number of persons in the family in order to determine the consumption per head. Their results, therefore, were average results for men, women and children. Here an individual method was used and the investigation applied to a special class of persons, pregnant women. Assuming that each of Orr's income groups contained the same proportion of men, women and children of various ages, it would be expected that the trend in consumption of any particular foodstuffs in passing from the lowest income group to the highest would be similar to that found in this study. Speaking generally this is so, but there are two striking differences. Orr found an increase in butter consumption from 4 oz. to 11 oz. per week from the poorest to the richest group. Here even the poorest women were eating an average of 10 oz. per week with their bread alone. Potatoes in the present study increased from 21 oz. per week in group I to 45 oz. in group IV and then fell again in the two richest groups. Orr's subjects, whatever their income, appeared to be eating about 56 oz. a week, or about 48 oz. excluding waste.

(2) *According to residential district.*

To some extent this is inevitably a repetition of the income classification (excluding the richest groups), but it brings some fresh features to light, and a summary of the chemical composition of the diets is given in Table VI. The variations in calorie intakes are covered by the discussion on p. 611, and the differences between the intakes of protein, calcium, phosphorus and iron in Merthyr Tydfil and in Camberwell are certainly related to income, but this

Table VI. *Variation in dietary composition with residential district*

(The figures in heavy type are the averages for each group. Maxima and minima are given immediately below.)

District	No. of women	Income less rent per head per week	Calories per day	Total protein g./day	Animal protein g./day	Fat g./day	Carbohydrate g./day	Calcium g./day	Phosphorus g./day	Total iron mg./day	Inorganic iron mg./day
Merthyr	21	**7·3**	**2081**	**54**	**27**	**92**	**247**	**0·46**	**0·77**	**8·1**	**6·1**
		13·0	3522	82	43	183	383	0·89	1·17	14·4	9·1
		3·10	1163	26	6	42	123	0·18	0·36	4·1	3·2
Gateshead	32	**7·5**	**2138**	**66**	**36**	**80**	**275**	**0·56**	**0·95**	**11·1**	**8·0**
		16·3	2906	103	69	114	411	1·06	1·66	17·9	13·6
		4·3	1312	28	13	42	156	0·24	0·48	5·5	4·7
Bermondsey	20	**14·2**	**2389**	**73**	**42**	**91**	**301**	**0·57**	**1·09**	**13·8**	**9·9**
		23·9	2962	96	62	127	401	1·04	1·59	19·8	15·2
		7·0	1747	59	31	56	234	0·33	0·79	8·7	6·5
Camberwell	21	**26·5**	**2700**	**82**	**52**	**112**	**320**	**0·79**	**1·31**	**14·1**	**10·0**
		38·9	3305	111	77	165	442	1·20	1·86	19·8	12·0
		15·0	1958	64	35	72	234	0·42	0·86	9·1	6·7

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will not explain the differences between the intakes in Merthyr Tydfil and Gateshead where the average incomes were the same. The differences moreover cannot be explained by differences in the foods distributed (see Tables VII and VIII). The Merthyr Tydfil women were theoretically allowed 1 pint of milk a day by the local authorities for the last 3 months of pregnancy. Actually, none of the women recorded as much as 1 pint of milk a day and the average milk intake of the group was about ¼ pint. Assuming that all the milk taken by the Merthyr Tydfil women who were 7–9 months pregnant was free milk, the food intake of this group with and without their supplements has been calculated and the results are shown in Table VII.

Table VII. *Composition of the diets of women in Merthyr Tydfil with and without free milk*

	Calories per day	Total protein g./day	Animal protein g./day	Fat g./day	Carbo-hydrate g./day	Calcium g./day	Phos-phorus g./day	Total iron mg./day	Inorganic iron mg./day
Av. for 11 women receiving no free milk	2130	52	23	95	252	0·33	0·68	8·5	6·3
Av. for 10 women receiving free milk	2044	57	31	88	242	0·61	0·87	7·7	5·9
Av. for same 10 women excluding free milk	1844	47	21	77	228	0·28	0·60	7·4	5·6
Av. composition of supplement	200	10	10	11	14	0·33	0·27	0·3	0·3

Table VIII. *Composition of the diets of women in Gateshead with and without free foods*

	Calories per day	Total protein g./day	Animal protein g./day	Fat g./day	Carbo-hydrate g./day	Calcium g./day	Phos-phorus g./day	Total iron mg./day	Inorganic iron mg./day
Av. for 7 women receiving no free foods	2191	67	37	80	286	0·45	0·87	11·7	7·7
Av. for 25 women receiving free foods	2146	65	36	80	277	0·59	0·97	11·0	8·1
Av. for same 25 women excluding free foods	1999	58	29	73	264	0·24	0·76	9·8	6·9
Av. composition of supplement	147	7	7	7	13	0·35	0·21	1·2	1·2

In Gateshead twenty-five of the women were given Ostermilk and Ovaltine by the National Birthday Trust. The foods were distributed monthly and they were an exceedingly popular gift. Three of the women took more than their weekly allowance of 8 oz. of Ostermilk and 4 oz. of Ovaltine during the week of study, the remainder less. The average composition of the diets of these twenty-five women, including and excluding their free foods, is given in Table VIII.

It is evident that in both districts the free distribution was doubling the calcium and appreciably raising the protein and phosphorus intakes of the recipients. It is possible that in the absence of gifts these women might have purchased some additional food themselves. That they would probably have done so may be concluded from the results obtained on women in the earlier stages of pregnancy who were not receiving free foods (Tables VII and VIII).

These women's intakes, although lower than those of the women in receipt of the foods, were higher than the intakes of these women when the free foods were excluded. It must be concluded that the difference between the diets in Merthyr Tydfil and Gateshead was due to wiser spending in the latter district. The Gateshead women, for example, baked their own bread, which considerably reduced its cost.

A further point to bear in mind, in comparing one geographical group with another, is that the dietary investigations in the different districts were carried out at different times of year. The investigation in Merthyr Tydfil was made in May, that in Gateshead in August and September, that in Bermondsey in January and that in Camberwell in October. Seasonal variations in the price of different foodstuffs certainly had some influence on the diets of the women. Thus, while the women in Bermondsey were weighing their food, oranges were exceptionally cheap and were eaten by all but one of the women, often in considerable quantity.

(3) *According to stage of pregnancy.*

When all the women were classified according to stage of pregnancy, it was found that on the whole the poorer women had been investigated at a later stage of pregnancy than those with higher incomes. Thus the relationship between the intake of food and the stage of pregnancy was complicated by the effect of income. For this classification, therefore, all the women living in the depressed areas were excluded. The remaining sixty-three women were divided into two groups: (1) up to and including 6 months, (2) over 6 months pregnant. The average daily calorie intakes of the two groups were 2525 and 2550 respectively. It was found that the difference between these was not statistically significant. Sandiford *et al.* (1931) found an increase in consumption of calories, proximate principles, calcium and phosphorus from the thirteenth week of pregnancy onwards in one subject whom they studied, but apart from this there appears to be no data in the literature on food consumption at different stages of pregnancy, so no further discussion seems to be profitable.

Vitamin B_1 intakes

It was decided that with the data at hand as to the quantitative food consumption of women during pregnancy, some attempt should be made to assess their vitamin intakes. So far as vitamins A, D, C, and most of the B complex were concerned this was found to be impossible because insufficient information was available as to the amounts present in the foodstuffs, particularly after cooking. For vitamin B_1, however, calculations were made from figures given by Cowgill (1934), Baker *et al.* (1935, 1937), Daniel & Munsell (1937) and Fixsen & Roscoe (1938). The values given by the different authors for the same foodstuff sometimes differed enormously. Further, some foods have not so far been analysed for B_1. Losses on cooking were largely a matter of guesswork. Boiling, for instance, was assumed to remove 50% of the vitamin. For this reason individual intakes have not been given and even the average results shown in Table IX are very approximate and must not be regarded with the same confidence as those given earlier for minerals and organic constituents. The B_1 intake, however, steadily rose with income, and indeed the well-to-do women appeared to be getting about twice as much as those in the lowest income group.

Table IX. *Effect of income on the intake of vitamin B_1*

Income/head less rent/week	Vitamin B_1 International units/day		
	Average	Minimum	Maximum
Less than 6*s*.	209	344	124
6*s*. to 9*s*.	287	717	120
9*s*. to 15*s*.	305	469	131
15*s*. to 25*s*.	410	586	260
25*s*. to 40*s*.	436	531	299
Over 40*s*.	454	741	277

Discussion

The present investigation shows that the food intakes of pregnant women differ very much from one woman to another but that certain generalizations are possible. The most important seems to be that the quality of the food consumed tends to improve progressively with rising income, and there are suggestions that these changes are accompanied by an improvement in physique. It is questionable to what extent the variations in food habits with rising income are really an expression of spending power and to what extent they represent the legacies of conservatism and ignorance. With this the present investigators are not directly concerned, but it is perfectly clear that whereas the very poor cannot afford to purchase at current prices a diet which would be as nutritious as that of the rich there is a large section of the community who could but who are not doing so. There are no standards of optimum physique with which to compare the present series of "well-to-do women", but it is safe to say that a critical examination of them and of their children would almost certainly have revealed some stigmata of nutritional origin. Turning to the diets themselves it is clear that in many respects they do not come up to the requirements suggested by the League of Nations and other bodies reviewed earlier in this paper. The deficiencies in calcium, phosphorus and iron are striking. In each case they are of the order of two-thirds of the suggested optimum and an increase would almost certainly be an advantage to the women. The calories are also considerably below the suggestions of the League. Since there is no evidence that these women, or indeed women in general among the professional classes, lose weight during healthy pregnancies, the present authors are of the opinion that the intakes of calories found in this investigation must be regarded as fully adequate for these women's requirements. This admission raises rather an interesting practical question. The intakes of protein, calcium, phosphorus, etc. were provided for in the League of Nations' dietary scheme by a daily consumption of protective foods which themselves accounted for 1440 cal. To suggest that a woman taking 3000 cal. a day should take 1440 in the form of protective foods still leaves plenty of the diet to her own free choice, but to insist that women whose calorie intakes are of the order of 2500 should obtain 1440 from protective foods is more of an imposition and becomes an almost insufferable one for the really small eater. It is possibly unfair to compare individual intakes with average requirements since individual requirements may vary as much as individual intakes. With this reservation the comparison may be allowed since it is rather an instructive one and since nothing is known of the requirements of the individual women taking part in this investigation.

Table X illustrates the practical difficulties that would face the woman whose calorie intake is considerably below that recommended by the League of Nations in arranging a diet which will contain the full complement of protective foods, and yet which will conform to her accustomed dietary habits. Examples of the daily records of two well-to-do subjects (nos. 113 and 95) are given, together with a suggestion as to how the day's meals may best be varied in order to include the protective foods without increasing the calorie value. Two of the days were chosen as approximating most closely to the individual's average food intakes over the week of investigation. A second day for subject 95 has been included to show that the arrangement of the menus is exceedingly difficult on days on which the calorie intake is lower than the weekly average. Changes in the diets have consisted mainly in reducing (or even eliminating entirely) the bread, butter, cakes, pastries, puddings, etc., and increasing milk, cheese and potatoes. The changes are based on the suggestions of the League of Nations. It is probable that many women would find such a regime difficult and the English canons of individual liberty effectively prevent them from being forced to adopt it. Education however and a growing sense of food consciousness will in all probability gradually improve the dietary habits of the well-to-do women in this country. But what of the less fortunately situated who cannot afford an "ideal" diet? There seem to be three possibilities. They could be given money to enable them to buy the food they need. This in itself would not be advisable unless it was accompanied by education and close supervision. Secondly, they could be fed. This is beset with practical difficulties. Thirdly, they could be given medicinal supplements, and while this is clearly not the ideal method of supplying dietary requirements, it seems to provide the best solution of the problem, until the food supplies of the world can be so organized and distributed that adequate nutrition is possible for all.

Table X. *Suggested modifications in the diets of two women*

(The weights given are all weights of edible portions and include no waste.)

Subject 113

	Actual diet	Suggested diet
Breakfast:	oz.	oz.
Porridge, cooked	3·0	3·0
Brown bread	2·0	2·0
Butter	0·75	0·75
Marmalade	0·5	0·5
Milk on porridge and in coffee	7·0	10·5
Lunch:		
Soup	6·5	—
Rissole, cooked	5·25	—
Meat, cooked	—	3·0
Potato, boiled	4·5	8·75
Greens, boiled	7·0	3·5
Legumes, raw weight	—	0·33
White sauce	1·5	—
Banana }	5·25	2·0
Custard (as milk) }		7·0
Biscuit	0·5	—
Milk to drink	—	3·5
Supper:		
Bacon, cooked	1·5	—
Egg	One	One
Cheese	—	1·0
Bread	1·0	1·0
Biscuit	0·5	—
Cake	2·0	1·0
Banana custard	3·0	—
Orange	3·0	3·5
Milk	5·5	7·0
Sugar	0·13	0·13
Extras:		
Milk	—	7·0
Apple	4·5	—
Orange	3·0	—
Calories	**2148**	**2145**

Subject 95

	Actual diet	Suggested diet
Breakfast:	oz.	oz.
Pork sausage	2·5	—
Lean ham	—	1·0
Fried tomato	0·5	—
White toast	0·75	0·75
Butter	0·25	0·25
Milk in tea	—	3·5
Lunch:		
Meat, cooked	2·5	2·0
Potato, cooked	5·5	8·75
Greens, cooked	4·0	3·5
Legumes, raw weight	—	0·33
Baked custard: Egg	—	One
Milk	—	7·0
Banana, raw	3·0	1·0
Milk in coffee	—	3·5
Tea:		
Brown bread	2·25	1·0
Butter	0·75	0·25
Celery, raw	1·5	1·5
Cake	2·5	—
Milk in tea	1·5	3·5
Supper:		
Sausage, cooked	2·25	—
Tomato, raw	1·0	1·0
Cheese	1·0	1·0
Pickle	1·0	1·0
Brown bread	1·25	1·0
Orange	3·25	3·5
Milk	—	7·0
Bedtime:		
Milk	—	10·5
Calories	**1844**	**1854**

Subject 95

	Actual diet	Suggested diet
Breakfast:	oz.	oz.
Bacon, fried	0·5	—
Fried tomato	1·0	—
Fried bread	0·75	—
Boiled egg	—	One
White toast	1·0	—
Butter	0·5	—
Milk in tea	—	3·5
Mid-morning:		
Milk	—	3·5
Lunch:		
{Macaroni	1·0	—
{Cheese }	1·0	1·0
{Milk }	3·25	4·0
Beans, raw weight }	—	0·33
Brown bread	1·5	—
Butter	0·5	—
Orange	3·25	3·5
Milk in coffee	—	3·5
Tea:		
Milk in tea	1·0	3·5
Supper:		
Eggs	One and a half	—
Meat, cooked	—	3·0
Potatoes, boiled	5·25	8·75
Greens, boiled	—	3·5
Curry sauce	1·5	—
Milk as custard	—	7·0
Bedtime:		
Milk	8·5	10·0
Calories	**1548**	**1542**

SUMMARY

1. The diets of 120 pregnant women at different economic levels have been studied by the individual method.

2. The intake of calories was found to be little affected by income, and this was true also of fat and carbohydrate. The intakes of protein, animal protein, calcium, phosphorus, iron and vitamin B_1 rose convincingly with income.

3. These differences were due to the fact that a rise in spending power led to an increased consumption of milk, fruit, vegetables and meat, and to a decreased consumption of bread and total cereals. Details are given in Table V.

4. Women taking the better diets were found on average to be taller and less anaemic than those taking the poorer diets. The differences were significant.

5. A comparison of the diets of the well-to-do women with the requirements suggested by the League of Nations and other authorities suggests that the requirement for calories has been set too high. The intake of calcium was suboptimal throughout and the diets of the poorer women were deficient in many respects.

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