FOOD HEALTH AND INCOME

Report on

A Survey of Adequacy of Diet in Relation to Income

by

JOHN BOYD ORR

MACMILLAN AND CO., LIMITED
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NOTE OF ACKNOWLEDGMENT.

THIS investigation was made by the staff of the Rowett Institute in co-operation with the staff of the Market Supply Committee. Valuable assistance was obtained from a number of individuals interested in the different aspects of the problem. Special mention should be made of the assistance obtained from Dr. Leitch, of the Imperial Bureau of Animal Nutrition, on the health aspect of the investigation, from Mr. Colin Clark, University Lecturer in Statistics at Cambridge, and Mr. H. W. Macrosty, an Hon. Secretary of the Royal Statistical Society, on the statistical work involved; and from Mr. David Lubbock, who assisted in all stages of the work and also in seeing this Report through the press.

The present Report gives a general account of the investigation. Papers dealing at greater length with various parts of the enquiry are being prepared for publication in the appropriate technical journals. The first of these, "Food Supplies and Consumption at Different Income Levels," by Mr. E. M. H. Lloyd, was read to the Agricultural Economic Society on December 11th, 1935, and will be published in the forthcoming issue of the Proceedings of the Society.

FOREWORD.

THE state of nutrition of the people of this country is surveyed here on a broad scale and from a new angle. Instead of discussing minumum requirements, about which there has been so much controversy, this survey considers optimum requirements. Optimum requirements are based on the physiological ideal, which we define as " a state of well-being such that no improvement can be effected by a change in the diet." The standard of adequacy of diet adopted is one which will maintain this standard of perfect nutrition.

The average diet of each of six groups into which the population has been divided according to income are compared with these requirements for perfect nutrition. The health of the population is reviewed to see to what extent inadequacy of diet is reflected in ill-health and poor physique.

It is difficult in the present state of knowledge to lay down precise and detailed criteria of perfect nutrition. The basis of comparison taken for health is, therefore, the state of health and physique of those groups of the population who can choose their diets freely, without any economic consideration seriously affecting their choice. For the purposes of this large scale survey individual errors of diet can be ignored. These errors are undoubtedly common. The diets, even of those who are able to purchase unlimited amounts of any foodstuff available, will improve as the knowledge of dietetics extends. Meantime, however, the state of nutrition of the higher income groups, whose diet is not limited by income, can be taken as a standard which can be attained with the present dietary habits of the people of this country.

The tentative conclusion reached, is that a diet completely adequate for health, according to modern standards, is reached at an income level above that of 50 per cent. of the population. This means that 50 per cent. of the population are living at a level of nutrition so high that, on the average, no improvement can be effected by increased consumption.

The important aspect of the survey, however, is the inadequacy of the diets of the lower income groups, and the markedly lower standard of health of the people, and especially of the children in these groups, compared with that of the higher income groups.

The method of grouping the population according to income is new and may be open to the criticism, among others, that it over-emphasises the importance of children as an economic factor affecting standard of living. The basis of the grouping is the total family income divided by the number of persons, including children, supported by it. Thus an average income of 30*s.* per head per week is reached by a man earning £550 a year, with a wife, four children, and one domestic servant. It is also reached by a manual worker earning £3 a week with only a wife to support. The " higher income " and " lower income " groups cannot be simply identified with " rich " and " poor " in the generally accepted sense of these terms.

The lowest of the six income groups contains a disproportionately high number of children—rather more than a fifth of all the children in the country. This is the group whose diet falls furthest below the standard of adequacy for health. Great improvements in health have been and are being effected in these children by improved nutrition. The picture presented in the survey justifies all and more than all the efforts which have already been made, but opens up a prospect of still further improvement.

As is noted in the report, the data are too scanty to yield a picture fully accurate in detail. Moreover, both the technique of the investigation and the standard of dietary requirements adopted are new and must be regarded as still on trial. There is need for further investigation and further discussion of the whole question in all its complicated relationships, in order that the measures taken to deal with the situation may be based on generally accepted facts and well-informed public opinion.

J. B. ORR.

Aberdeen, February 1936.

CONTENTS.

I. THE PROBLEM.

THE NEW KNOWLEDGE OF NUTRITION.

THE rapid advance in the science of nutrition in recent years has shown that the influence of diet on health and physique is profound. It has been proved that much of the ill-health which afflicts human populations can be attributed directly to deficiencies in diet, and there is a certain amount of evidence indicating that increased susceptibility to certain infectious diseases, such as tuberculosis and other pulmonary and intestinal disorders in young children, may also arise from a faulty diet.

These results of research are now to some extent being applied. Already efforts to improve nutrition are bearing fruit in a reduction of the grosser forms of deficiency diseases such as rickets, and in decreased infant mortality.

Public interest has been aroused in this "newer knowledge of nutrition," as it has been called. The centre of interest is passing from the research laboratory to the application in everyday life of the results of the researches. Consequently there is now a good deal of discussion on the extent to which malnutrition due to faulty diet is prevalent, on the relative importance of ignorance and of poverty as the cause of faulty diets, and on the means which should be taken to ensure that every member of the community may have a diet adequate for perfect health.

MEASURES AFFECTING FOOD SUPPLY.

The importance of the subject has been increased by the measures taken to relieve the depression in agriculture which accompanied the world-wide economic depression of the last five years. Some of these measures were designed to raise wholesale prices of foodstuffs to a level remunerative to the producer by limiting the amounts marketed. Measures adopted in the United Kingdom were mild compared with those adopted in some Continental countries, where the

price of certain foodstuffs is being maintained at over twice the world price. Further, in this country, the measures adopted were not based to any considerable extent on restriction. Agriculture was largely assisted by subsidies which do not raise prices. Everyone is agreed that, while it is economically desirable to make agriculture prosperous, it is equally desirable to ensure that the food supply of the nation is sufficient for health, and is available at a price within the reach of the poorest.

The necessity for reconciling the interests of agriculture and public health has raised questions of the utmost importance on Government measures affecting the food supply. The issues may be debated but they cannot be decided except in the light of the fullest possible information on the amount of food required to maintain the health of the community, the extent of malnutrition due to under-consumption, and the extent to which under-consumption is due to poverty.

The importance of obtaining this information has been recognised. So soon as the measures designed to relieve the agricultural crisis were put into force, the Minister of Agriculture for England and Wales and the Ministers concerned with Agriculture for Scotland and Northern Ireland set up the Market Supply Committee. One of its main functions has been to bring together information on the food position of the country, especially on total requirements in relation to market supply and the effect of changes in price on consumption. The Ministers responsible for health, who are consequently concerned with the effect of the national dietary on public health, appointed the Advisory Committee on Nutrition " to enquire into the facts, quantitative and qualitative, in relation to the diet of the people and to report as to any changes therein which appear desirable in the light of modern advances in the knowledge of nutrition."

ORIGIN OF PRESENT INVESTIGATION.

In 1935 the Rowett Research Institute was asked by one of the main branches of the food industry for certain information on food consumption. The information asked for could not be given without a special enquiry into the food habits of the country. It was thought that the results of such an enquiry would be of interest also to the agricultural Marketing Boards. The Boards agreed to co-operate, and Lord Linlithgow, then Chairman of the Market Supply Com-

mittee, approved of arrangements whereby data accumulated by his Committee should be made available and the staff of the Committee should give assistance in the analysis of the data and the framing of statistical estimates.

After the results of the special enquiry had been communicated to the Marketing Boards and Trade organisations concerned, it was decided that, in view of the importance of the subject, an attempt should be made to combine these results, with previously collected information, to give some idea of the diets and of the standards of health attained in different sections of the community. The results of this attempt are recorded in the following pages.

II. METHODS, STANDARDS AND DATA USED IN THE INVESTIGATION.

Methods.

The investigation was made in the following stages :—

1. The total national supplies of the main foodstuffs were estimated.

2. To get an idea of the nature of the diet in different sections of the community, the whole population was classified in six groups according to family income, and an estimate based on family budget data was made of the consumption of the various foodstuffs in each of the groups.

3. The composition of the average diet of each group was examined, the amounts of each of the constituents present being compared with the amounts required for health.

4. The state of health of the country was reviewed to get an idea of the extent to which inadequacy of diet is reflected in poor physique and impaired health.

Standards.

The standard of health adopted is the physiological or ideal, viz., a state of well-being such that no improvement can be effected by a change in the diet. It is based on fundamental physiological principles, and it will not alter with any change either in dietary habits or in average health of the community. In an investigation of this nature the standard by which adequacy of diet is measured obviously determines the degree of inadequacy which will be found. The question of the standard to be used is so important that a section has been devoted to a discussion of it (page 32).

The standards of dietary requirements adopted are those of Stiebeling of the Government Bureau of Home Economics, U.S.A. These standards provide a sufficiency, with a safety margin, of all essential dietary constituents.

The standard requirements with which the diets of the different groups are compared are on a per head basis calculated on the requirements of children, adolescents, and adults, male and female, and weighted according to the distribution of these in the total population. Hence the data on food consumption were calculated on a per head basis. The reasons for adopting a per head basis in preference to a per man value basis are given in Appendix I.

Data.

The total food supply of the country was estimated from agricultural statistics, returns of imports and exports and output of manufacturers and processers.

The classification of the population into groups according to income was based on Income Tax statistics, wage statistics and data relating to unemployment, Old Age Pensions and other forms of social income, combined with a sample investigation of the 1931 Population Census designed to yield information as to the sizes of families and the ratio of earners to dependants in different occupation groups.

The estimates of the distribution of the total food supply between the different groups were based on the data from family budgets.

Details of the data and method of treatment are given in Appendices II–VI.

This is the first attempt which has been made to get a picture of the food position of the country showing the relationship of income, food and health. It was recognised that the data were inadequate and some of the existing data of doubtful accuracy, and that therefore the best that could be done would be to make an approximation to the picture which might be drawn if all the requisite data were available. It is believed, however, that the picture is the most accurate which can be drawn under the circumstances, and that therefore it can serve as a working hypothesis, provided that it is always kept in view that it is only an approximation which will need to be revised from time to time as further information accumulates. If this communication helps to increase interest in the subject and to show the need for further investigation, it will serve a useful purpose.

III. TOTAL FOOD SUPPLIES AND EXPENDITURE ON FOOD.

Estimates of total food supplies in 1909–13 and 1924–28 were given by Sir Alfred Flux (14). Independent estimates were made by Mr. A. E. Feavearyear for 1924–27 and 1932 (13). Mr. Feavearyear gives not only total consumption, but estimates of total national expenditure at retail prices on each food. With his assistance similar estimates have been compiled by the Market Supply Committee for 1934 and are given in summarised form in Table I opposite. Detailed figures for 1909–13, 1924–28 and 1934, showing the proportions produced at home and imported and the value in terms of calories and proximate principles, are given in Appendices III and IV.

It will be seen that the nation spends on food roughly £1,075 millions per annum or about 9s. per head per week. The total national income for 1934 has been estimated at £3,750 millions, or about 30s. per head per week. Hence expenditure on food accounts for rather less than one-third of the total national income.

The most expensive items are :—total meat, £294·5 millions; fruit, £119 millions; and milk, including condensed milk and cream, £106 millions. Bread and cereals account for less than 9 per cent. of the total, and meat and fish for over 32 per cent.

Meat, fish, eggs, milk and cheese, which are the sources of animal protein, account for nearly half the total expenditure. Vegetables other than potatoes contribute less to the total than sugar, though they are more important for health.

TABLE I.

ESTIMATED QUANTITIES AND RETAIL VALUES OF FOOD SUPPLIES OF THE UNITED KINGDOM IN 1934.

Commodity.	Total Supply.	Total Retail Value.	Per head per week.	Per head per week.
	Thousand Tons.	Million £	ozs.	d.
Total Meat	3,001	294.5	44.0	29.1
Fish	902	52	13.2	5.1
Bread	3,000	51	44.0	5.0
Flour	1,850	32	27.1	3.1
Other Cereals	286	5	4.2	0.5
	Millions.		No.	
Eggs	7,156	42	2.9	4.1
	Thousand Tons.		ozs.	
Egg Products	41	2.5	0.6	0.2
	Million gals.		pints	
Milk, Fresh	860	89	2.8	8.7
	Thousand Tons.		ozs.	
Milk, Condensed	240	10	3.5	1.0
Butter	533	54.5	7.8	5.4
Cheese	221	23	3.2	2.3
Cream	34	7	0.5	0.7
Margarine	164	8	2.4	0.8
Lard	187	11	2.7	1.1
Fruit	2,427	119	35.1	11.7
Potatoes*	4,400	37	64.5	3.6
Other Vegetables	2,085	40	30.2	3.9
Sugar	1,917	49	27.7	4.8
Tea, Coffee and Cocoa	278	48	4.0	4.7
Total value of primary foodstuffs	—	974.5	—	95.8
Add for preparation of complex foodstuffs†	—	100.5	—	9.9
TOTALS		1,075		105.7

* Excluding seed.

† e.g. jam, confectionery, cakes, biscuits, etc.

The quantity given for meat is computed from dressed carcase weights and thus exceeds the weight of meat, as purchased in the shop, by the quantity of bone, trimmings and waste not sold for human consumption. An allowance of perhaps 20 per cent. should be made on beef and veal, and of not more than 5 per cent. on other meats.

The weight given for fish is that of the total supply as recorded at the ports, and thus includes heads, tails and inedible offal, in addition to a fluctuating and unknown quantity which is not sold for human consumption. The deduction to be made on this score may be as much as 30 per cent.

Separate estimates are given for bread and flour, but the figure for flour includes an unknown quantity used for home baking of bread. Using the factor 77 per cent. for converting bread into flour, the total for all flour is 4,150,000 tons.

The estimate of fresh milk consumption given here is based upon the Milk Marketing Boards' figures, which are lower by about 10 per cent. than the estimates of the Agricultural Departments based upon the number and yield of cows. The possible error involved has considerable significance from the nutritional standpoint, especially with regard to calcium supply.

The figure of 187,000 tons for lard excludes lard produced from pigs killed in the United Kingdom, since this is already included in the weight of home-produced pig meat. In the case of home-produced crops, including potatoes and vegetables, a deduction has been made for seed and wastage on farms, but allotment produce and estimated consumption on farms have been included.

In estimating total expenditure on these quantities at retail prices, it is impossible to attain a high degree of precision. For most commodities there are no complete records of retail prices covering all grades and all areas. The Ministry of Labour's retail prices, collected in connection with the Cost of Living index, are the most useful source of material; but they have to be used with care since they consist of prices of particular grades corresponding with the average items purchased by working-class households in the 1904 budget enquiry, and do not purport to give an average weighted price of all grades and qualities. Mr. Feavearyear based his estimates for 1932 largely on market surveys undertaken by the Empire Marketing Board, and he has supplied unpublished estimates for 1934, which have been checked against the Ministry of Labour's Cost of Living figures.

The total supply of each food is estimated at the average retail price at which it is sold as such in the shops. The added value given to the primary products by manufacturing processes is allowed for in a quantity added at the end "for preparation of complex foodstuffs," which is based upon Census of Production figures. Thus, the ingredients of cakes, biscuits, jams and confectionery, viz., flour, sugar, eggs and fruit, are included at their retail value under each item, and the aggregate added value of all the made-up products is estimated separately.

IV. CHANGES IN THE NATION'S DIET. HISTORICAL COMPARISONS.

A comparison of food consumption and food prices of to-day with those of a hundred years ago, shows some interesting changes.

A hundred years ago McCulloch (29) estimated the income per head of the United Kingdom at £16–17 per annum, and the expenditure on food at £8. Corresponding figures to-day are £78 and £23 8s. The rise in the standard of living of the last 100 years has been accompanied by a decrease in percentage of the income spent on food.

In 1835 the prices of bread and flour were much the same as they are to-day, but the average consumption per head was 80 per cent. greater. The consumption of sugar was 20 lbs. per head. Now it is five times as great. Better class industrial workers in Manchester in 1836 consumed about ½ oz. of tea per head per week and 7 ozs. of sugar (32). Workers of a corresponding type to-day consume 3 ozs. of tea and nearly 35 ozs. of sugar in all forms. This five-fold increase in sugar consumption is the most striking change in the nation's diet during the last 100 years. It has, of course, been rendered possible by the great fall in price. A hundred years ago sugar cost about 6d. a lb. (39). It now costs less than half.

From the nutritional standpoint this increase in the consumption of sugar is not so desirable as an increase in certain other foodstuffs, such as milk, would have been. A hundred years ago milk cost about 1½d. a pint. To-day it costs more than double. Information on consumption of milk is scanty, but the consumption per head does not appear to have been lower a hundred years ago and in rural areas was possibly higher.

A Committee of the British Association (7), appointed in 1881, gave the first detailed estimates of food consumption. Comparing the figures for 1934 with those given by the Committee for 1881, the most striking changes are: Consumption per head of bread and

potatoes is 30 per cent. less, of meat 45 per cent. more, of sugar 40 per cent. more, of tea and butter double.

Comparison of the estimates for 1934 with those given by Sir Alfred Flux for 1909–13 and 1924–28, as given in Table II below, shows a continued change in the national dietary.

TABLE II.

ESTIMATED ANNUAL CONSUMPTION PER HEAD OF CERTAIN FOODS IN THE UNITED KINGDOM AT THREE PERIODS.

	1909–13.	1924–28.		1934.	
		Quantity.	As Percentage of 1909–13.	Quantity.	As Percentage of 1909–13.
	lbs.	lbs.		lbs.	
Fruit	61	91	*149*	115	*188*
Vegetables (other than potatoes)	60	78	*130*	98	*164*
Butter	16	16	*100*	25	*157*
Eggs	No. 104	No. 120	*115*	No. 152	*146*
Cheese	7	9	*128*	10	*143*
Margarine	6	12	*200*	8	*133*
Sugar	79	87	*110*	94	*119*
Meat	135	134	*99*	143	*106*
Potatoes	208	194	*93*	210	*101*
Wheat flour	211	198	*94*	197	*93*

It will be seen that, with the exception of wheat flour and potatoes, there has been a substantial increase in the consumption of most of the principal foods since before the war. The largest increases have been in fruit, fresh vegetables, butter and eggs. In each case the rate of increase has been greater since 1924–28 than in the previous fifteen years.

The movement of butter consumption should be considered in relation to that of margarine consumption. In 1924–28 margarine consumption was twice the pre-war level, while that of butter remained unchanged. Since then margarine has fallen by one-third, while butter has increased by 57 per cent. The increase in

consumption coincides with a fall of 48 per cent. in price. The consumption of butter and margarine together is now 50 per cent. higher than before the war.

Table III below, gives a comparison of calorie, protein, fat and carbohydrate intake in the three periods. The increase in intake of total calories since 1909–13 is about 6 per cent. Consumption of carbohydrate and of vegetable protein has fallen, while that of animal protein has risen slightly. The most marked change is the rise of 25 per cent. in the consumption of animal fats.

TABLE III.

FOOD CONSUMPTION, AS SHOWN IN TABLE II, IN TERMS OF CALORIES AND PROXIMATE PRINCIPLES.

	Average 1909–1913.	Average 1924–1928.	Average 1934.
	Per head per day.	Per head per day.	Per head per day.
Animal protein grams	43	43	46
Vegetable ,, ,,	43	42	41
Total ,, ,,	86	85	87
Animal fat. . ,,	87	91	109
Vegetable fat . ,,	12	19	15
Total ,, ,,	99	110	124
Carbohydrates . ,,	436	431	425
Calories . . .	3,057	3,139	3,246

These increases in consumption of animal fat, and of fruit and fresh vegetables, are increases in foods of high biological value. It will be seen from the detailed analysis of budget diets below that they represent an increased intake of essential vitamins and mineral salts. It may therefore be said that, on the average, the national diet improved between 1909 and 1934.

An alternative statistical method of comparison is to compile an index number of food consumption by applying to the quantities of food consumed at different dates the same set of price values. At current prices this index of food consumption shows an increase of 7·5 per cent. in the first period, and of 25 per cent. over the whole interval.

V. DISTRIBUTION OF NATIONAL INCOME AND FOOD EXPENDITURE AT DIFFERENT INCOME LEVELS.

The figures given in the preceding sections have dealt with average food consumption per head of the population, but clearly this is a case where a mere statistical average has little meaning. From the standpoints both of public health and of agricultural marketing, it is more important to know how many families fall below the average and what is the variation in consumption at different income levels.

The family budgets and dietary surveys were first arranged in groups according to the income per head of the family, the total family income from all sources being divided by the number of persons, irrespective of age and sex, supported by that income. The average food expenditure in each income group and the average amount and value of each food purchased per head per week were then ascertained. The results are given in full in Appendix VI, Tables I–III.

The next step in the enquiry was to estimate the proportions of the entire population falling into the several income groups.

There is no completely satisfactory means of classifying the population by income groups. In default of accurate information, which could only be obtained by a census of family incomes, it has been necessary to make indirect estimates based on a large number of calculations. The data and methods used in arriving at these estimates are described briefly in Appendix V.

Income per head depends on the size of the family and the combined incomes of all members of the family. It has been inferred from a random sample of the 1931 Census that roughly half the families in the country contain more than one earner. The earnings of other members of the family and supplementary incomes, such as unemployment benefit, pensions, public assistance and investments,

have to be taken into account and the total related to the number of persons to be maintained.

Table IV below shows the final approximate estimates of the distribution of the National Income, based on the computations described in Appendix V. The population has been classified into six groups, consisting of 10 per cent. at the top and the bottom, and four intermediate groups of 20 per cent.

TABLE IV.

CLASSIFICATION OF THE POPULATION BY INCOME GROUPS AND AVERAGE FOOD EXPENDITURE PER HEAD IN EACH GROUP.

Group	Income per head per week	Estimated average expenditure on food	Estimated population of group.	
			Numbers	Percentage
I	Up to 10s.	4s.	4,500,000	10
II	10s. to 15s.	6s.	9,000,000	20
III	15s. to 20s.	8s.	9,000,000	20
IV	20s. to 30s.	10s.	9,000,000	20
V	30s. to 45s.	12s.	9,000,000	20
VI	Over 45s.	14s.	4,500,000	10
Average	30s.	9s.	—	—

Here also the figure given for income per head is the income of the family divided by the number of persons supported. Thus, a man and wife with £2 10*s.* a week with no children or dependants would fall in group IV ; with one child into group III ; with two or three children into group II, and with four or more children into group I. The poorest 10 per cent. of the population consist in the main of families in which there is a disproportionate number of children or other dependants per earner. It is estimated that half the persons in group I are children under 14 and that between 20 and 25 per cent. of the children in the country are in the lowest income group.

Included in the table is a column showing average food expenditure per head per week. It is obvious, of course, that as income falls the percentage spent on food, which is a prime necessity of life, will increase. The average expenditure on food represents a proportion rising from below 20 per cent. in group VI to nearly 50 per

cent. in groups I, II and III. Among the poorest some observers have found expenditure on food exceeding 70 per cent. of total income (10, 18), but food prices were then higher than they have been in the past few years. A study of family budgets in a number of countries shows that food accounts on the average for between 45 and 60 per cent. of the total expenditure of working-class families (2).

It is of interest to compare the results obtained here with estimates of income distribution in working-class families given in recent surveys of the economic condition of the people in particular areas. Thus the percentage of the population living below the poverty line computed from data given in the surveys of London (42), Merseyside (20) and Southampton (15), is estimated to be approximately as follows :—

London, 1929–30 . .	8 per cent.
Liverpool, 1929 . . .	13 ,, ,,
Merseyside, 1929–30 . .	14 ,, ,,
Southampton, 1931 . .	16 ,, ,,

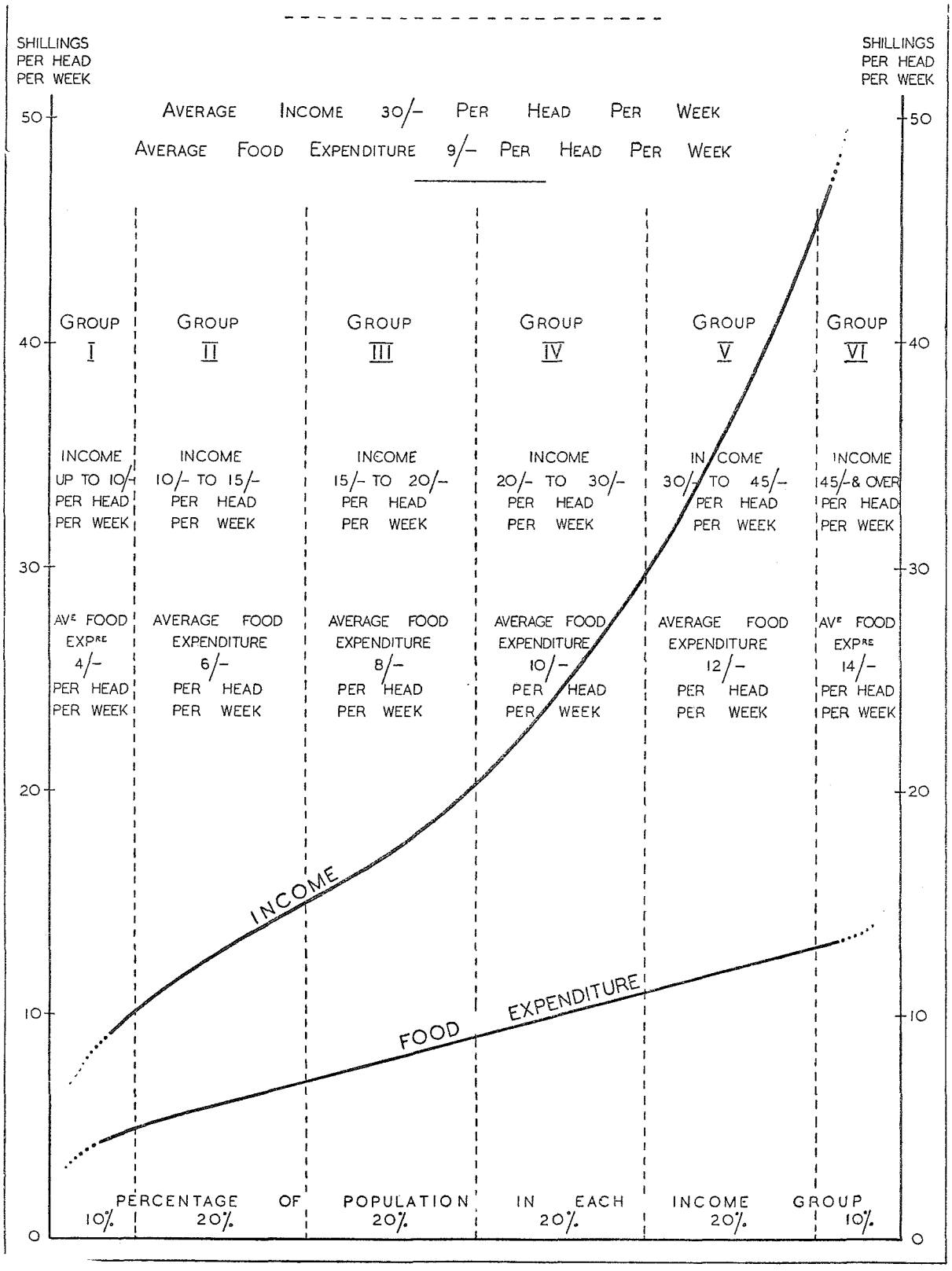
Data regarding the dispersion of working-class family incomes in these surveys indicate that in Southampton the upper limit of income of the poorer half of the population was 15s. per head per week, in Merseyside 18s. 6d., and in London 21s. In the present enquiry, the corresponding figure based on income data for the whole population is 20s. The comparison suggests, therefore, that as regards the lower groups the classification of the population given in the above table is unlikely to involve serious error and can be accepted as a reasonable working hypothesis.

VI. CONSUMPTION OF PARTICULAR FOODS AT DIFFERENT INCOME LEVELS.

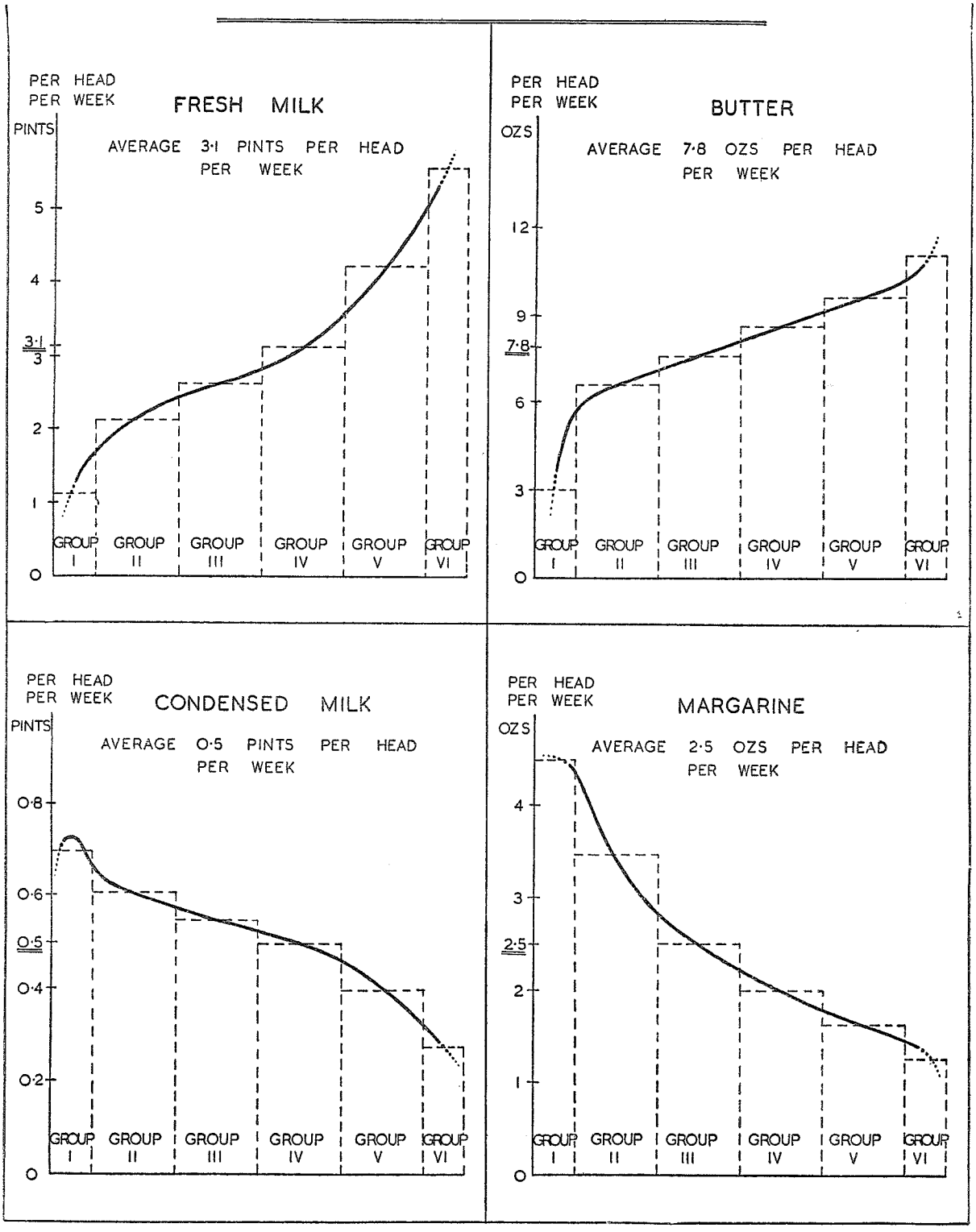
The next stage of the enquiry was to compare the average consumption of each food as shown in the budgets, weighted by the proportions of the population in each group, with the national consumption per head given in Table I. p. 15. Owing to the relatively small number of budgets available no exact correspondence could be expected, but for most foods a fair measure of agreement was obtained. Certain discrepancies were to be expected. For example, the national averages are based upon food supplies at the point of origin, whereas the budget data give weights of food as purchased from the shops. Some allowance has therefore to be made for wastage in distribution. Secondly, for some foods the budget data, having been collected over short periods of a week or month, were affected by seasonal factors. This was particularly noticeable in the case of eggs. Thirdly, the national averages do not show separate quantities and values for complex foodstuffs, such as cakes, jams and confectionery, as the family budgets do. These, and other sources of discrepancy are discussed in Appendix VI, where three tables are included, the first giving quantities of food consumed as shown in 1,152 family budgets, and the other two estimated consumption and expenditure in the six income groups of the entire population.

The variation in consumption of the principal foods in the different income groups is also shown in the following graphs, which bring out clearly the resemblances and differences. It should be observed that the scales adopted are designed to yield a direct comparison to the eye of the relative variation in each group from the national average consumption. Thus the average quantity of fresh milk consumed is about six times that of condensed and dried milk; and consequently the scale for the latter is about six times as large as that of the former. Similarly the scale for margarine is approximately three times that for butter. The graphs do not yield direct comparison to the eye of the absolute average quantities of each food consumed, but these are indicated in the figures given in the scales.

ESTIMATED INCOME & FOOD EXPENDITURE BY GROUPS OF THE POPULATION



ESTIMATED CONSUMPTION PER HEAD OF CERTAIN FOODSTUFFS BY INCOME GROUPS



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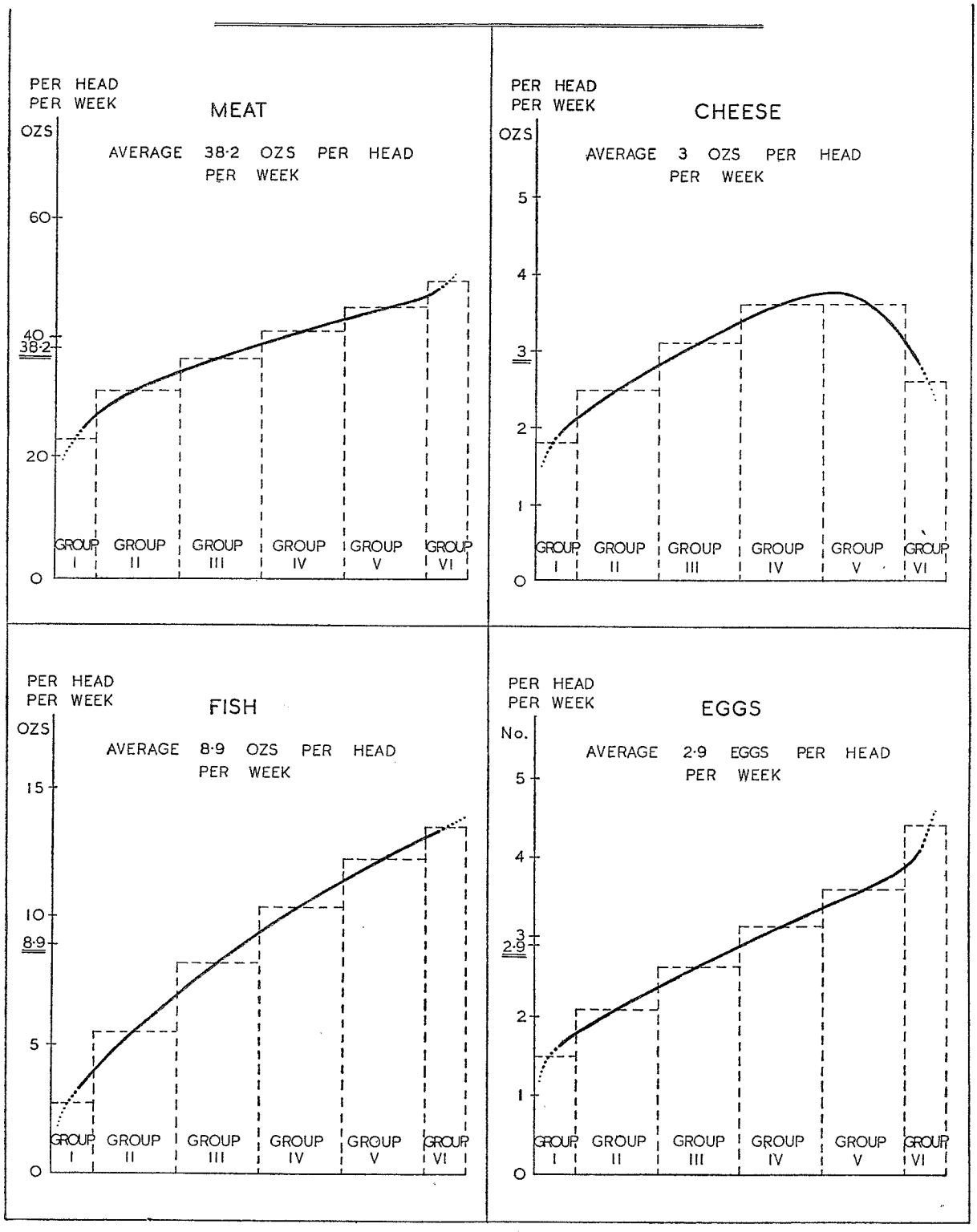

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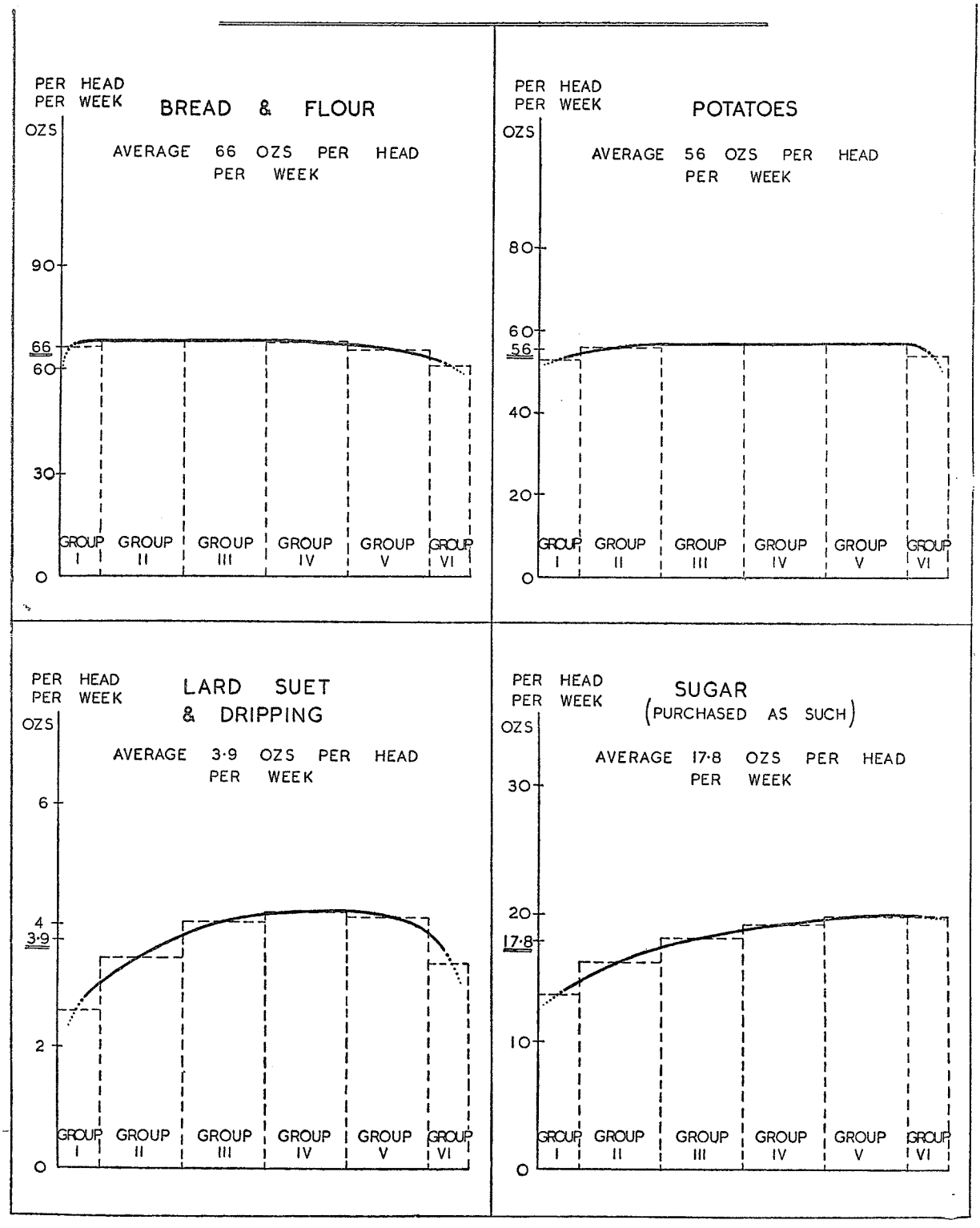
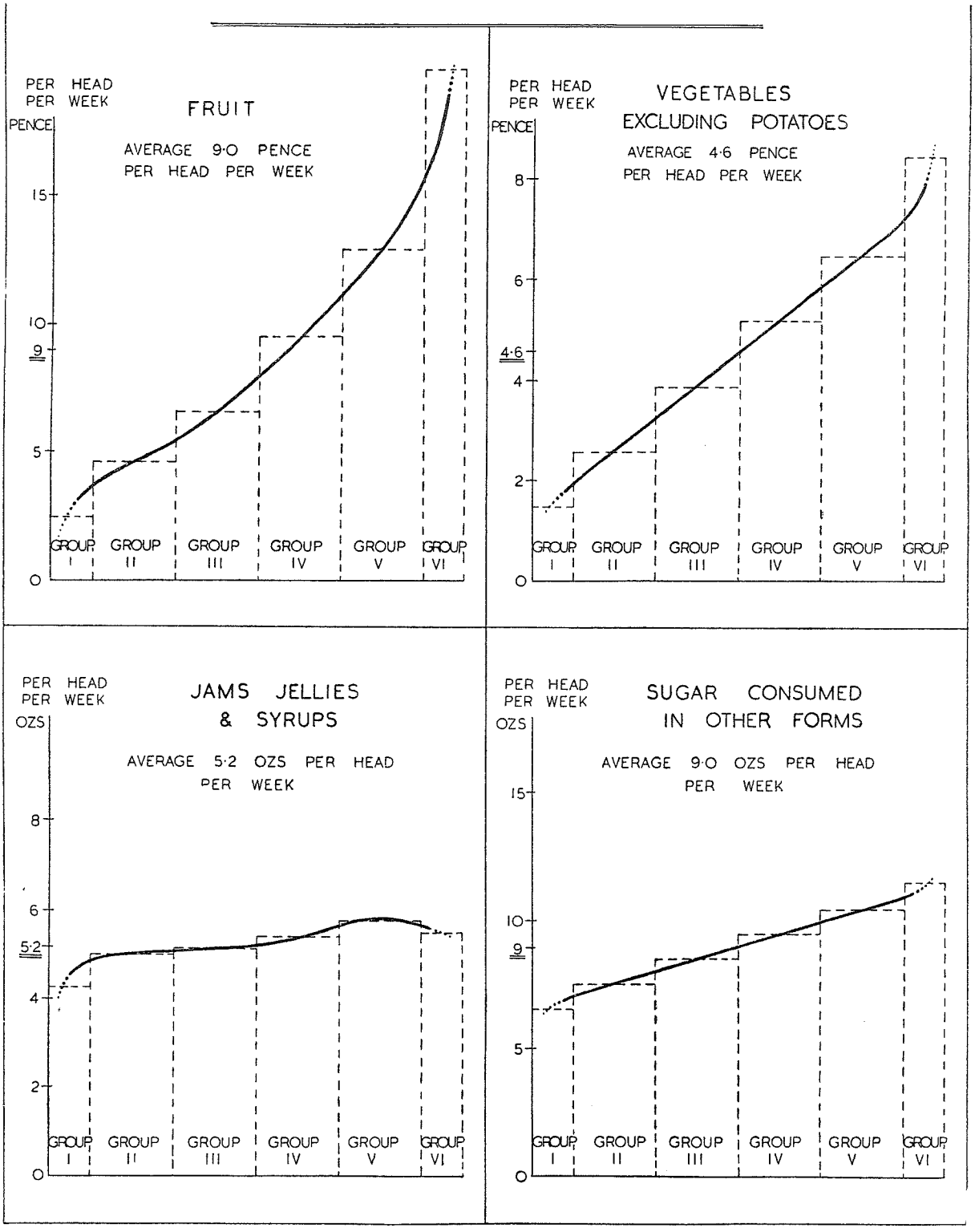


ESTIMATED CONSUMPTION PER HEAD OF CERTAIN FOODSTUFFS BY INCOME GROUPS



The consumption of potatoes and flour is remarkably uniform in all the groups except I and VI, the lowest and the highest, in both of which it is slightly lower than in the four middle groups, which comprise 80 per cent. of the population. In the highest income group there is evidence that more expensive foods are substituted for potatoes and bread. The inclusion of cakes and biscuits brings the curve for flour considerably above what it would have been for bread alone in the highest groups. The curves for the expensive foodstuffs, e.g., milk and eggs, rise steeply in group VI. In the lowest group there is no indication of any substitution, nor indeed is there any cheaper food which could be substituted for potatoes and bread. It looks as if either the purchasing power of this group is so low that the consumption of even the cheapest foodstuffs is limited, or, what is more probable, the appetite in the lowest income group is below the average. One of the first signs of sub-optimal nutrition is diminished appetite.

Cheese and the fats—lard, suet and dripping—reach their highest consumption in the middle groups. The falling off in the consumption of lard, suet and dripping in the two upper groups may be due to the substitution of butter for cooking purposes, and the falling off in the consumption of cheese in the two upper groups to the substitution of other foodstuffs, the consumption of which is higher in these.

The graphs for margarine and butter show that as income rises there is a change over from margarine, which is cheaper, to butter. When butter, margarine, lard, suet and dripping are grouped together, it is found that the total fat consumption rises steadily from 10·2 ounces in group I, to 15·8 ounces in group VI.

The consumption of all the other foodstuffs shown in the graphs rises with income. Thus in the case of liquid milk the average consumption for the whole population is taken at 3·1 pints per head per week. This figure, which is based on the estimated number and yield of cows, is 10 per cent. in excess of the estimate made by the Milk Marketing Board, which is only 2·8 pints per head per week. In the lowest group the average consumption is 1·1 pints and in the highest 5·5 pints. The small consumption of liquid milk in the lower groups is partly compensated for by a greater consumption of condensed and dried milk. Taking all kinds of milk in terms of the equivalent of liquid milk, consumption per head per week is as follows: group I, 1·8; group II, 2·7; group III, 3·1; group IV, 3·6; groups V and VI combined, 5 pints.

All kinds of fruits were considered together and the same

procedure was followed in the case of vegetables. The graphs show not the actual quantities purchased, but the expenditure on these commodities. Fruit shows the steepest gradient, expenditure rising from 2½d. per head per week in group I to 20d. in group VI.

When all the foodstuffs are considered together, it is seen that in group I, comprising 4½ million people, total food consumption is low and includes mainly cheap suppliers of energy and therefore cheap satisfiers of hunger, e.g., potatoes, bread, margarine. The consumption of more expensive foodstuffs, e.g., liquid milk, eggs, fruit, vegetables, meat, rises progressively with income, the increase being superimposed upon a relatively constant quantity of bread and potatoes.

EXTENT TO WHICH CONSUMPTION CAN BE INCREASED.

In view of the desirability of increasing consumption it is of interest to estimate the additional amounts of the various foodstuffs which would be required to raise consumption of the lower groups to that of the higher. Table V shows the increase in consumption needed to bring that of the lowest group up to that of the second, the lowest two up to that of the third, the lowest three up to that of the fourth and so on.

Group VI represents a level at which price fluctuations have little effect on consumption. This, therefore, may be taken to represent roughly saturation point for the staple foods. It gives an indication of the highest level to which consumption could be raised under the present food habits of this country.

TABLE V.

INCREASE IN TOTAL CONSUMPTION NEEDED TO BRING ALL LOWER GROUPS TO LEVEL OF EACH SUCCESSIVE HIGHER GROUP.

	Group I to Group II	Groups I and II to Group III	Groups I-III to Group IV	Groups I-IV to Group V	All Groups to VI
	per cent.	per cent.	per cent.	per cent.	per cent.
Milk . . .	3	8	16	42	80
Butter . . .	4	8	15	24	41
Eggs . . .	2	7	18	27	55
Fruit* . . .	2	9	25	53	124
Vegetables* (excluding potatoes) .	2	9	25	47	87
Meat . . .	2	7	12	18	29
Margarine . .	–4	–16	–26	–37	–48

* Based on expenditure : increase in quantity would not necessarily be the same figure.

VII. ADEQUACY OF DIETS FOR HEALTH.

The adequacy of the average diets of each group was estimated by comparing the amounts of the various constituents present with the amounts considered necessary for maintaining perfect health.

ANALYSIS OF THE DIETS.

The average diets of each group were analysed and the results have been summarised in Table VII. The analytical data were taken mainly from five sources:—Plimmer (38) for protein, fat, carbohydrate and calories; Sherman (41), for calcium and phosphorus; Peterson and Elvehjem (37) for iron; and (Faber and Norgaard) Fridericia (16) for vitamins. In the few cases where information could not be obtained from these sources, conversion figures compiled at Glasgow University or the Rowett Research Institute have been used.

Conversion is made in the conventional way directly from the figures of quantities of foods purchased at the shop, and in this conversion allowance is made for the inedible portions. Since no reliable data are available from which to estimate the average wastage of edible constituents either in preparation in the kitchen or at the table, no allowance has been made for this. The wastage, however, is likely to be greatest amongst those who can best afford it. Particular foodstuffs by their different natures will have different proportions of wastage in preparation. Thus, fruit and vegetables with peel will lose some of the edible portion in being peeled, while milk, which needs no preparation, will not lose any significent proportion.

The percentages of total mineral intake provided by different foodstuffs in each of the six groups have been summarised and are shown in Table VIII. No reliable published data on mineral waste have been found, but from unpublished figures available it is clear that loss of calcium is negligible (probably less than 1 per cent.), while loss of phosphorus and of iron may vary from 5 to 25 per cent. A great part of the vitamin intake is derived from fruit and

vegetables. Without complete information as to the relative quantities of different fruits and vegetables bought, it is impossible to do more than make very rough estimates of the vitamin supply per unit cost of either of these two commodities in each group and hence the figures (given in italics in Table VII) should be considered only as a rough conjecture. There is little doubt, however, that the trend of each is substantially correct.

STANDARDS OF REQUIREMENTS.

Human requirements for the maintenance of perfect health have not yet been defined with any degree of accuracy. Intensive laboratory researches and dietary surveys have been made by Sherman and his co-workers, and from these a set of standards has been compiled by Stiebeling, of the Government Bureau of Home Economics, U.S.A. The quantities of constituents in the average diets of each group have been compared with the set of standards compiled by Stiebeling (44). These standards are based on the relative requirements of children, adolescents and adults, male and female, as shown in Table VI and weighted according to the distribution of these individual units in the total population.

TABLE VI.

QUANTITIES OF NUTRIENTS REQUIRED FOR INDIVIDUALS PER DAY.

(Stiebeling).

Individuals by age, sex, and activity groups.	Dietary Allowance in :—						
	Energy value.	Protein.	Calcium.	Phosphorus.	Iron.	Vitamin A.	Vitamin C.
	Calories	Grams	Grams	Grams	Grams	Sherman Units	
Child under 4 years	1,200	45	1.00	1.00	0.006–0.009	3,000	75
Boy, 4-6 ; girl, 4-7 years	1,500	55	1.00	1.00	0.008–0.011	3,000	80
Boy, 7-8 ; girl, 8-10 years	2,100	65	1.00	1.00	0.011–0.015	3,500	85
Boy, 9-10 ; girl, 11-13 years	2,400	75	1.00	1.20	0.012–0.015	3,500	90
Moderately active woman ; boy 11-12 years ; girl over 13 years	2,500	75	1.00	1.20	0.013–0.015	4,000	95
Very active woman ; active boy, 13-15 years	3,000	75	0.88	1.32	0.015	4,000	100
Active boy over 15 years	3,000-4,000	75	0.88	1.32	0.015	4,000	100
Moderately active man	3,000	67	0.68	1.32	0.015	4,000	100
Very active man	4,500	67	0.68	1.32	0.015	4,000	100
Average per head of the population	2,810	68	0.9	1.23	0.013–0.014	3,800	95

The requirements have been tested against the age and sex distribution of the United Kingdom population and no significant difference has been found, so that it has been possible to compare the Stiebeling standards directly with the average diets of each income group. Though the age and sex distributions will vary to some extent between the groups, it is believed that these variations will not seriously affect the results.

Fat requirements are not given in Stiebeling's table, but in view of the relatively high wastage of fat which is known to occur, and on the basis of standards suggested for children by authorities such as Holt and Fales (19), 98 gms. ($3\frac{1}{2}$ ozs.) is probably not unreasonably high. The vitamin requirement for health is taken as twice that which will prevent the occurrence of obvious deficiency disease. An ample supply is necessary, since it is known that there are minor degrees of ill-health caused by deficiencies of vitamins not great enough to show obvious symptoms. For mineral elements, the standards are based on the minimum requirements for the maintenance of a positive balance in laboratory studies, plus 50 per cent. allowance for additional requirements of everyday life and maintenance of health.

It is probable that further research may show that for some constituents the margin of safety is unnecessarily generous. Observations made at Aberdeen (12) suggest that this is so for iron. On account of this the weighted average requirement for iron has been reduced from 13–14 (Table VI) to 11·5 milligrammes. Iron presents special difficulty on account of the wide differences in the requirements of women of child-bearing age, other adults and children. The requirement of the first is possibly over 20 milligrammes, while that for other adults may be less than half.

COMPARISON OF THE DIETS WITH THE STANDARDS.

For purposes of comparison, the degrees of adequacy of the different constituents have been calculated for each of the six groups as a percentage of the above standards, and these are shown in graph form on page 35.

Assuming the validity of the standards, it will be seen from these graphs, calculated from the figures in Table VII, that the average diet of group I is inadequate for perfect health in all the constituents considered; group II is adequate only in total proteins and total fat; group III is adequate in energy value, protein and fat, but below

TABLE VII.

COMPOSITION OF THE DIET (PER DAY) BY INCOME GROUPS OF THE POPULATION.

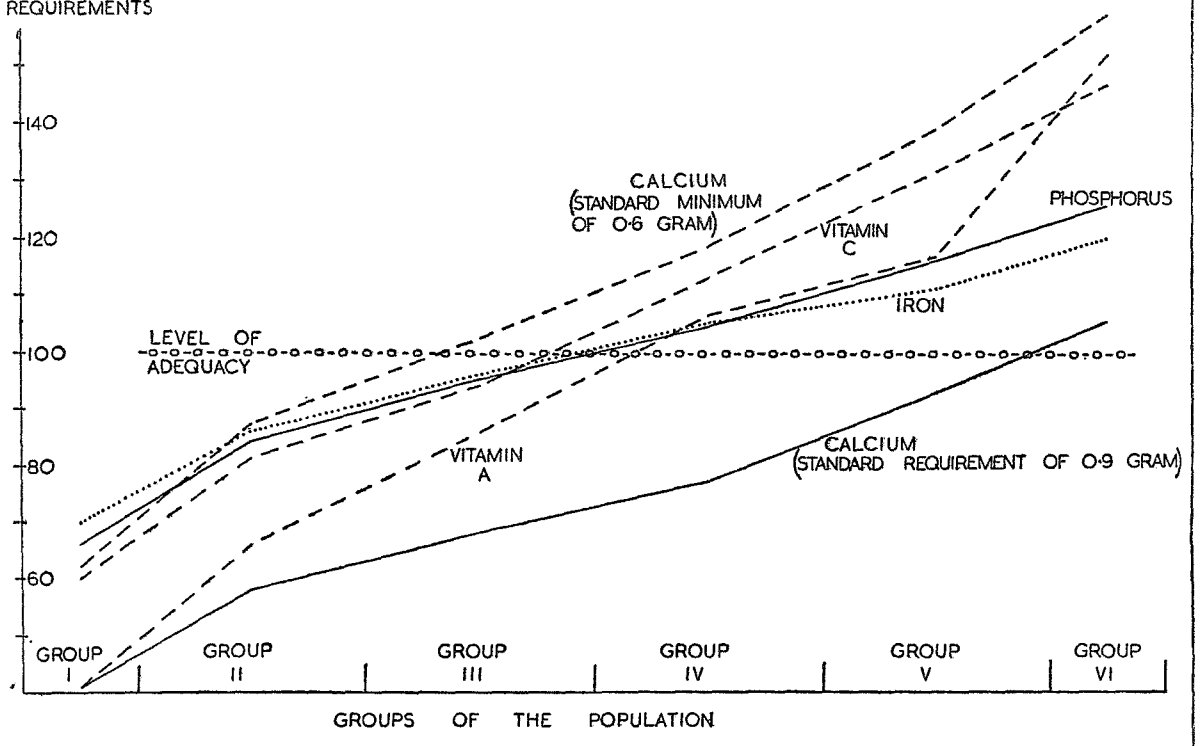
—	Group I.		Group II.		Group III.		Group IV.		Group V.		Group VI.		Standard Requirements per Unit of Population.	
Protein:	grams.	per cent.	grams.	per cent.	grams.	per cent.	grams.	per cent.	grams.	per cent.	grams.	per cent.	grams.	
Plant .	40.9	64.5	43–5	57.2	44.0	52.6	43.8	49.0	42.8	45.3	40.5	41	—	
Animal .	22.5	35.5	32.5	42.8	39.6	47.4	45.6	51.0	51.6	54.7	57.8	8	—	
Total	63.4	100.0	76.0	100.0	83.6	100.0	89.4	100.0	94.4	100.0	98.3	100.0	68	
Fat:														
Plant .	20.9	29.2	17.9	18.1	14.5	13.2	13.3	11.0	12.2	9.4	11.1	7.9	—	
Animal .	50.7	70.8	80.9	81.9	95.1	86.8	107.3	89.0	118.3	90.6	130.4	92.1	—	
Total	71.6	100.0	98.8	100.0	109.6	100.0	120.6	100.0	130.5	100.0	141.5	100.0	98	
Carbohydrate	348	—	381	—	395	—	403	—	406	—	396	—	—	
Minerals:														
Calcium .	0.37	—	0.52	—	0.61	—	0.71	—	0.83	—	0.95	—	0.6*	0.9†
Phosphorus	0.81	—	1.04	—	1.17	—	1.28	—	1.42	—	1.54	—	1.23	
Iron .	0.008	—	0.0099	—	0.011	—	0.012	—	0.0127	—	0.0137	—	0.0115	
	Sherman Units.	International Units.	Sherman Units.	International Units.	Sherman Units.	International Units.	Sherman Units.	International Units.	Sherman Units.	International Units.	Sherman Units.	International Units.	Sherman Units.	International Units.
Vitamin A .	*1,548*	*774*	*2,500*	*1,250*	*3,248*	*1,624*	*4,030*	*2,015*	*4,420*	*2,210*	*5,750*	*2,875*	*3,800*	*1,900*
,, *C* .	*57*	*838*	*78*	*1,134*	*90*	*1,314*	*108*	*1,577*	*126*	*1,832*	*158*	*2,323*	*95*	*1,400*
Calories .	2,317		2,768		2,962		3,119		3,249		3,326		2,810	

* Minimum for positive balance.

† Minimum plus 50% for safety margin.

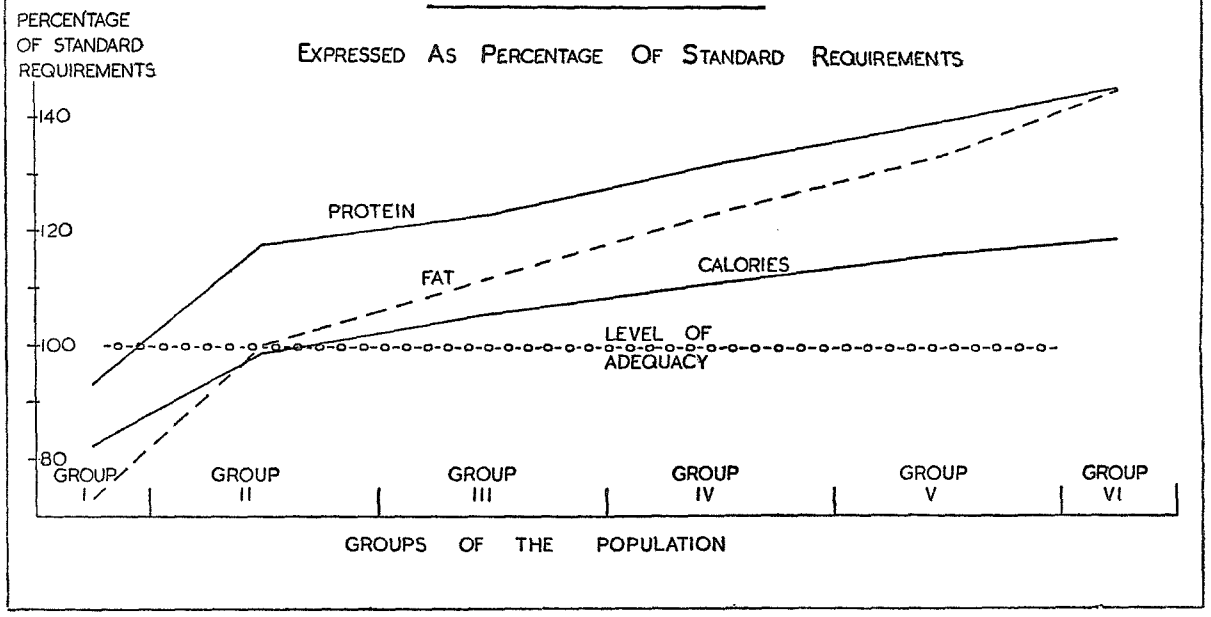
AVERAGE INTAKE OF MINERALS & VITAMINS

EXPRESSED AS PERCENTAGE OF STANDARD REQUIREMENTS



AVERAGE INTAKE OF CALORIES PROTEIN & FAT

EXPRESSED AS PERCENTAGE OF STANDARD REQUIREMENTS



standard in minerals and vitamins; group IV is adequate in iron, phosphorus and vitamins, but probably below standard in calcium; group V has an ample margin of safety in everything with the possible exception of calcium; in group VI the standard requirements are exceeded in every case.

It will be noted that calcium has been calculated on two bases: (1) minimum requirement for maintenance of a positive balance, and (2) the same plus a 50 per cent. safety allowance. The true position for the calcium curve lies probably between these two. No allowance has been made for the calcium intake from drinking-water. In some areas this may amount to from 5 to 10 per cent. of the total intake. Taking this into account, group IV diet is probably adequate.

The quality of the protein is important, especially for children, and it will be seen from Table VII that the percentages of protein and fat of animal origin, which are of higher biological value than those of plant origin, increase from group to group. Hence, not only does the intake of the several constituents increase with expenditure on food but the quality of the diet also improves. This improvement is not only in protein and fat but also in mineral elements.

The percentages of total iron, phosphorus and calcium intakes derived from different foodstuffs in the six income groups are shown in Table VIII. As a source of easily assimilable calcium and phosphorus, milk ranks above all other foodstuffs. The percentage of total phosphorus from milk rises from 16·5 in group I to 29·8 in group VI, while the percentage of calcium rises from 44·4 in group I to 58·6 in group VI, and in all groups over 60 per cent. of the calcium intake is derived from milk and cheese. Another point of interest is the high percentage of iron derived from bread and flour and potatoes.

It should be kept in view that the standards with which the above comparisons are made are those compiled for the maintenance of *perfect* health, which is a standard very different from the average health of the community. The fact that the average diets of the lower income groups are inadequate according to these standards does not mean that these people are starving or even suffering from such a degree of ill-health as is recognised in the term disease. These diets may be sufficient to maintain life and a certain degree of activity, and yet be inadequate for the maintenance of the fullest degree of health which a perfectly adequate diet would make possible.

TABLE VIII.

PERCENTAGE OF MINERAL INTAKES FROM DIFFERENT FOODSTUFFS IN SIX INCOME GROUPS.

Fe.

Group	Total **Iron** Intake per day mg.	Milk and cheese			Total	Bread and flour	Meat	Potatoes	Legumes and vegetables excluding potatoes	Fruit	Eggs	Fish	Syrup and jam	Total	% of total Fe from these foodstuffs
		Liquid milk	Condensed milk	Cheese											
I	8.0	1.4	0.5	1.2	3.1	30.9	24.3	18.8	7.3	6.7	3.7	1.2	0.5	93.4	96.5
II	9.9	2.0	0.3	1.3	3.6	25.9	26.6	16.2	8.4	9.3	4.2	1.9	0.6	93.1	96.7
III	11.0	2.3	0.3	1.6	4.2	23.3	28.2	14.8	8.6	10.3	4.7	2.3	0.5	92.7	96.9
IV	12.0	2.6	0.2	1.7	4.5	21.6	28.7	13.5	9.0	11.2	5.2	2.8	0.5	92.5	97.0
V	12.7	3.3	0.2	1.6	5.1	20.8	29.2	12.8	9.6	10.3	5.6	2.5	0.6	91.4	96.5
VI	13.7	4.1	0.1	1.0	5.2	18.4	29.6	11.2	10.5	12.5	6.4	3.2	0.4	92.2	97.4

P.

Group	Total **Phos-phorus** Intake per day g.	Milk and cheese			Total	Bread and flour	Meat	Potatoes	Legumes and vegetables excluding potatoes	Eggs	Fruit	Fish	Syrup and jam	Total	% of total P from these foodstuffs
		Liquid milk	Condensed milk	Cheese											
I	0.81	10.9	5.6	5.8	22.3	30.6	17.3	13.0	5.5	2.6	2.5	2.3	0.18	73.98	96.3
II	1.04	16.1	3.9	6.3	26.3	24.6	18.2	10.7	6.1	3.0	3.4	3.7	0.14	69.84	96.1
III	1.17	17.8	3.1	7.0	27.9	21.9	19.1	9.7	6.3	3.2	3.7	4.9	0.12	68.92	96.8
IV	1.28	19.2	2.2	7.3	28.7	20.2	19.4	8.8	6.6	3.7	3.6	5.6	0.11	68.01	96.7
V	1.42	23.6	1.8	6.6	32.0	18.6	18.8	7.9	6.9	3.7	3.0	5.9	0.10	64.90	96.9
VI	1.54	28.8	1.0	4.5	34.3	16.4	19.0	7.0	7.6	4.3	2.8	6.1	0.09	63.29	97.6

Ca.

Group	Total **Calcium** Intake per day g.	Milk and cheese			Total	Bread and flour	Legumes and vegetables excluding potatoes	Potatoes	Fruit	Eggs	Meat	Syrup and jam	Total	% of total Ca from these foodstuffs
		Liquid milk	Condensed milk	Cheese										
I	0.37	29.2	15.2	17.5	61.9	14.7	7.2	6.7	2.8	2.2	2.1	0.5	36.2	98.1
II	0.52	39.2	9.3	17.0	65.5	10.6	8.3	5.0	3.6	2.2	1.9	0.4	32.0	97.5
III	0.61	41.0	7.2	18.1	66.3	9.0	9.3	4.3	4.0	2.3	1.9	0.3	31.1	97.4
IV	0.71	42.5	6.0	18.1	66.6	7.9	10.6	3.7	3.8	2.4	1.9	0.3	30.6	97.2
V	0.83	49.1	3.9	15.4	68.4	6.8	11.5	3.2	3.3	2.3	1.7	0.3	29.1	97.5
VI	0.95	56.5	2.1	9.8	68.4	5.8	12.9	2.7	3.6	2.6	1.6	0.2	29.4	97.8

VIII. NUTRITION AT DIFFERENT INCOME LEVELS.

The examination of the diets of the different groups recorded in the preceding section shows that, on the standards taken, in the lower income groups the average diet is inadequate for perfect health. As income rises the average diet improves, but a diet completely adequate for health according to modern standards is reached only at an income level above that of 50 per cent. of the population.

As income level falls other factors affecting health change as well as diet. These are referred to later (page 45). Ignoring for the time being these other factors, one could predict from the nature of the diet of the different income level groups that there would be a good deal of ill health due to faulty diet, the incidence and degree being greater at the lower levels.

Owing to the requirement for new tissue formation in growth, children need a diet richer in first-class protein, in minerals and probably also in vitamins, than do adults. The evil effects of poor diet are, therefore, accentuated in children.

NUTRITION OF CHILDREN.

Owing to the difference in the nature of the diets, a comparison of the health of children of the lower income groups with that of children of the higher income groups, should show a slower rate of growth and a greater incidence of deficiency diseases in the former.

Rate of Growth in Children.

It is well known that stature is largely determined by heredity. The extent to which a child will attain the limit set by heredity is, however, affected by diet. Certain deficiencies of the diet lead to a diminution in the rate of growth, with the result that the adult does not attain the full stature made possible by his inherited capacity for growth. Height and weight of children are therefore sometimes taken as an indication of the state of nutrition. On account of hereditary factors, figures applying to small groups are of little

value. When applied to large groups of the same race, however, comparable figures for height and weight do give an indication of the relative adequacy of the diets of the groups.

Differences in the height of children and adolescents of different classes are depicted in the accompanying graph. Table IX shows the numbers of observations on which the averages are based. Further details are given in Appendix VII.

TABLE IX.

	Dates at which measurements were taken.	*No. of observations.*
1. Public School . . .	1935	307
2. Christ's Hospital School .	1926–29	16,031
3. Employed Males . . .	1929–32	2,061
4. Council School, Boys . .	1927	12,605
5. Council School, Boys . .	1932–34	36,949

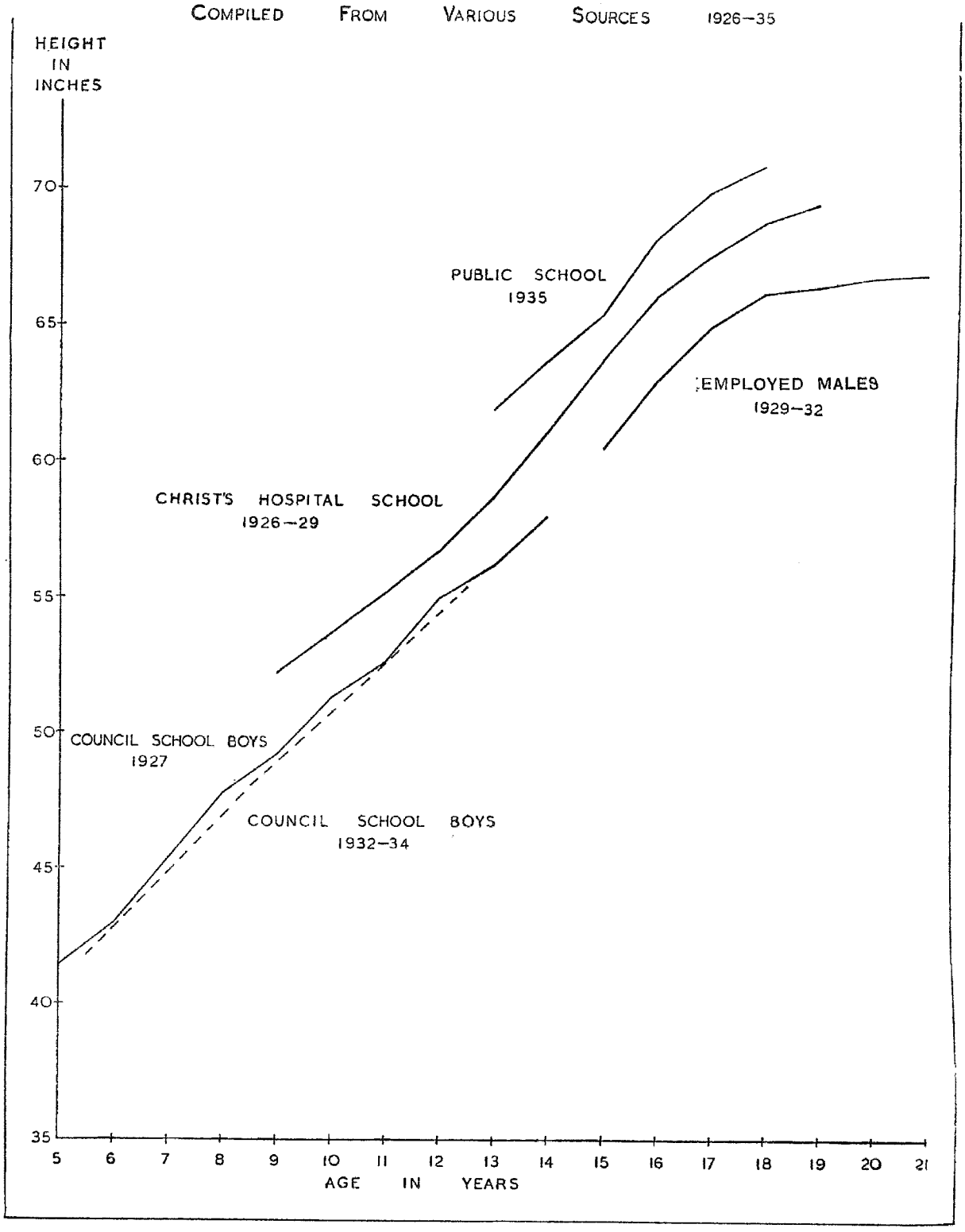
The children attending elementary council schools and the employed males may be taken as belonging mainly to groups I to IV; those attending Christ's Hospital School (17) to groups III to VI. Those attending the public school belong almost entirely to group VI, where every constituent essential to health is present in abundance in the diet.

It is seen that there is a marked difference in the heights of boys drawn from different classes. Thus, at thirteen years of age the boys at Christ's Hospital School are on an average 2·4 inches taller than those of the Council Schools. At seventeen they are 3·8 inches taller than "Employed Males," who may be taken as belonging to the same class as the boys in the council schools. The most striking feature of the graph, however, is the average height of the boys of the public school drawn from group VI, the highest income group. Further figures are needed for other public schools of the same class to show whether the heights recorded here are true averages for boys in this class of school.

The British Association anthropometric data of 1883 (6) showed that the average height of boys of thirteen and a half years in an industrial school was 2·6 inches below that of artisan boys of the same age, and 5·8 inches below that of boys of the professional class. It appears that in the last fifty years, though the average

HEIGHTS OF MALES BY SOCIAL GROUPS

COMPILED FROM VARIOUS SOURCES 1926–35



height for all classes has risen, there has been no marked change in the order of differences between the classes.

These differences in height are in accordance with what would be expected from an examination of the diets in common use in these classes. In the lower income groups the diet is relatively deficient in the constituents required for growth. Too high a proportion of the diet consists of carbohydrate rich foods, which contain very little bone and flesh forming material.

Of course tall and short individuals are found in all the groups. We are, however, considering here average diets and average heights. In each group some diets are better than the average and some worse. The better diets in the lower groups support a faster rate of growth. On the other hand no diet, however good, would enable an individual to exceed the limits of growth set by heredity. Short stature in the wealthier groups is in most cases inherited.

Incidence of deficiency Disease in Children.

Owing to the varying standards of health assumed by different observers, those who accept the average as normal and regard as ill-health only what is markedly below the average, find little malnutrition or disease arising from it. On the other hand, those who adopt the physiological or ideal standard, as defined on page 12, recognise a great deal of preventable ill-health. There are no universally accepted standards of health based on agreed systems of measurements and clinical signs. Unfortunately there are too few observations on any reasonable standard. In the absence of sufficient comparable data, all that can be done is to give illustrative examples of observations of ill-health due to faulty diet.

It will be sufficient for the present purpose to consider three diseases: rickets, bad teeth and anæmia. It is known that diet is an important factor in the etiology of these.

Rickets.—Figures for the incidence of rickets given by different observers vary very widely owing to differences in the standard adopted and in the method of diagnosis. If the diagnosis be made on clinical examination only, the number found will usually be less than if a radiological examination be made, and in clinical diagnosis the number will depend on whether only obvious gross deformities are considered, or minor degrees of imperfect development are included. For this reason the figures given by different observers for the incidence of this disease are not comparable. Thus, for example,

the incidence of rickets in L.C.C. schools was estimated at 0·3 per cent. in 1933 (25). On the other hand, in 1931 a special examination of 1,638 unselected school children showed that 87·5 per cent. had one or more signs of rickets (5).

With such imperfect data it is impossible to make any accurate estimate of the incidence of this disease in the country generally, and still less of differences in incidence in different social classes. There is, however, no doubt that though minor degrees of rickets are still prevalent and probably more prevalent in the poorer classes, the incidence of gross rickets with marked bony deformities, which are obvious even to the lay observer, has markedly decreased in recent years. The deficiencies in the diet to which this condition is due are now well known, and this knowledge has been applied to the reduction of the preventable disease.

Bad Teeth.—It is now generally believed that there is a close correlation between dietary deficiency and dental caries. Though there is still some difference of opinion as to the relative importance of the dietary factors involved, there is no longer any doubt that the diets of the lower income groups, which are markedly deficient in minerals and vitamins, are not such as to promote the growth of sound healthy teeth. Whatever other causes of dental caries there may be, one would expect to find poorly developed teeth and a high incidence of caries in children reared on such diets.

About 80 per cent. of the deciduous teeth of British children are imperfectly developed (hypoplastic) (31). Since this defect may be established before birth, it may in part be due to dietary deficiency in pregnancy. But the fact that the incisors, which are in the most advanced state of development at birth, are usually better calcified than the later developed molars, suggests that the dietary deficiency may be even greater in early childhood than before birth.

Nutritional Anæmia.—Records of the incidence of nutritional anæmia would give a good indication of the adequacy of the diet. Unfortunately the incidence of anæmias and the extent to which they are due to causes other than diet, cannot be stated with any degree of confidence. Reports of School Medical Officers based merely on the appearance of the child show incidences of from 0·25 to 3·76 per cent. in the children examined, but an examination based merely on appearance would not show minor degrees of anæmia such as could be caused by lesser degrees of malnutrition.

The hæmoglobin content of the blood is the only true standard. In a special investigation in which the hæmoglobin of the blood was determined in two groups of children: (*a*) in a routine medical inspection group, and (*b*) in a group selected because of poverty to be given a supplement of milk, 75 per cent. of the children in (*a*), and only 51·5 per cent. in (*b*) showed a hæmoglobin value over 70 (21). For a perfectly healthy child the value should be at least 90.

There are available the results of one investigation in which children of pre-school age of the poorest class are compared with children of the same age of the well-to-do class. Of the former, 23 per cent. were definitely anæmic, and of the latter, none (43).

It is possible that a minor degree of anæmia, indicating a minor degree of ill-health in children, is more common than is generally supposed. An extensive enquiry to show the relative frequency of anæmia in the children of groups I and II compared with that in groups V and VI would throw much needed light on the relative state of health of the children of families at different economic levels.

We have considered three characteristic signs of malnutrition in children, rickets, bad teeth and anæmia. These are fairly widespread in the lower income groups, the only groups in which extensive observations have been made. In these groups growth is slower than in the high income groups. It is interesting to note that these diseases and stunted growth are attributable to lack of those dietary factors, viz., first class protein, minerals and vitamins which are the constituents of the diets shown to be deficient in the lower groups (pages 33–36).

Incidence of infective Disease in Children.

There is evidence to show that these same deficiences affect resistance to some infectious diseases, such as pulmonary and intestinal disorders in young children. Children with rickets show a higher incidence of complications and a higher death-rate from some common diseases, such as whooping-cough, measles, and diphtheria than do those in the same environment without rickets (27). A recent observation seems to indicate that non-pulmonary tuberculosis is less frequent in children who drink relatively large quantities of milk than in those who consume little milk (8).

NUTRITION OF ADULTS.

It has been established in nutritional studies that the constitution of the adult is affected by the state of nutrition in childhood. The rate of growth and the health of children have been shown to be below the optimum. The result of this should be traceable in poor physique in adult life. There is much evidence of the effect of malnutrition in selected groups of male adults, e.g., in certain occupations and in army recruits. There are, however, few comparable data on adults at different income levels. The state of nutrition of the adult is therefore not referred to at length. It will be sufficient to choose two diseases as illustrative examples, one infectious and one non-infectious, in which diet is an important factor.

The most significant infectious disease illustrating the influence of nutrition on susceptibility to infection, is tuberculosis. Infection is very widespread and in the great majority of cases it is the resistance of the individual which determines the extent to which the disease develops. Striking evidence of the influence of diet on resistance is afforded by the experience of Germany during the recent war. In the highly industrialised parts of the country where the food shortage was most acute the tuberculosis mortality showed an enormous increase. In Saxony it was almost doubled. This increase was accompanied by an increased virulence in the type of the disease (3, 1).

The Registrar-General's Report of 1927 shows that the mortality rate from tuberculosis amongst occupied males was nearly three times as high for unskilled labour as for the higher ranks of business and professional life (40). It is probable that the most effective line of attack on tuberculosis is by the improvement of diet.

For the health and physique of the rising generation the health of women is more important than that of men. One of the common results of malnutrition is anæmia, though, of course, anæmia may arise from other causes. It is much more common in women than in children and men. Its frequency in women is attributed to the extra demands for iron in women of the child-bearing age. In an investigation in Aberdeen in 1933, it was found that of about 1,000 women of the class of groups I, II and III, 50 per cent. were anæmic, 15 per cent. being classed as " severely anæmic " (12). In 1935 in the examination of 368 London mothers of low economic status, it

was found that less than 30 per cent. had a normal hæmoglobin level (26).

There are no comparable figures showing the incidence of anæmia in the higher income groups. Further, causes other than poor diet predispose to it. All that can be said, therefore, is that some degree of anæmia is common in the lower income groups, that it is, at least in part, preventable, and that diet is an important factor in its prevention.

INFLUENCE OF FACTORS OTHER THAN DIET.

In considering the different types of ill-health referred to above, it has been difficult to assess the relative importance of diet and other factors. As income level falls, housing and other environmental conditions change. The importance of these for health is now fully recognised. Even apart from the known deleterious effect on health, the social evils of slums are so great that any suggestion that improvement of housing is of less importance than other social reforms is to be deprecated. The advantages to be obtained by better housing, as has been shown by M'Gonigle (30), are limited by inadequacy of diet, and the maximum advantage can only be obtained by improvements in both.

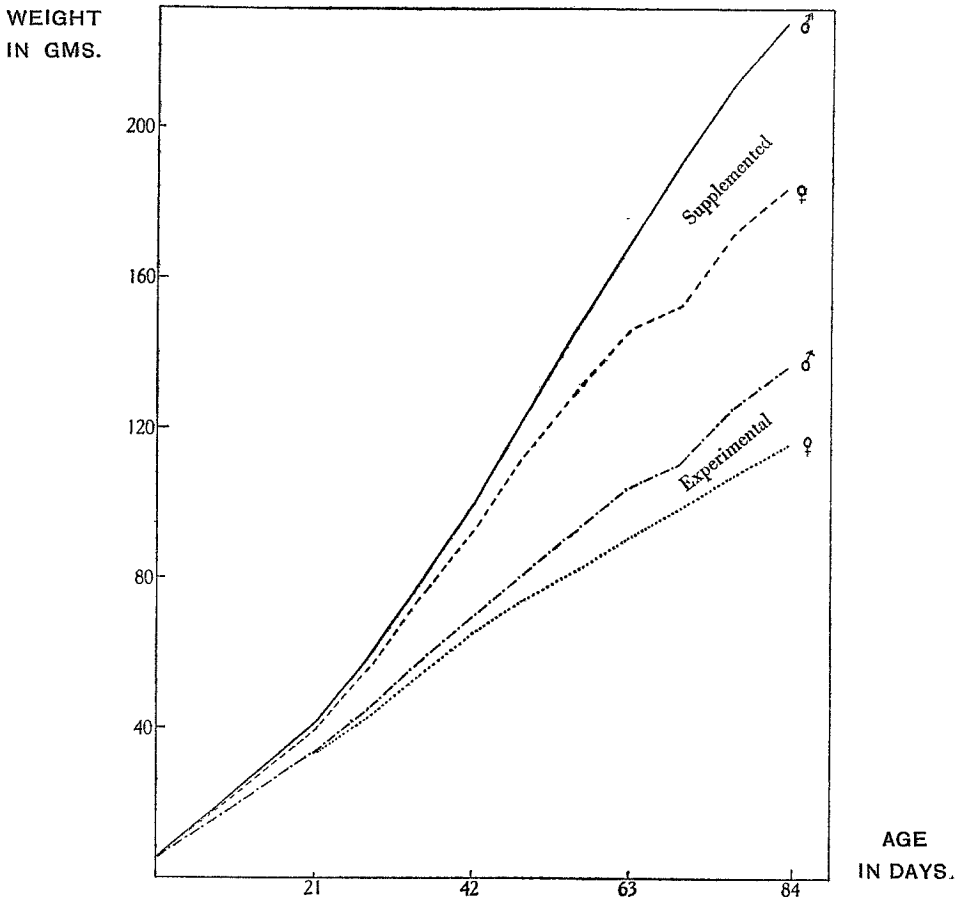
Hereditary differences also profoundly affect growth and susceptibility to some diseases. No individual can pass the limits set by inheritance. The most that can be done by diet or other environmental factors is to enable the individual to attain his full inherited capacity for growth and health.

Feeding Tests with other Factors controlled.

The effect of diet can, however, be studied by feeding experiments with animals under conditions where diet is the only varying factor. Hundreds of such experiments have been made on closely related animals with, as far as possible, the same inherited characteristics and kept under the same environmental conditions. McCarrison, who has made a life study of nutritional problems, especially those relating to India, took several groups of rats and fed each group on a diet in common use by one or other of the various tribes in India. These rats were all kept under the same environmental conditions. He found that the physique and incidence of disease in each of the groups corresponded to an astonishing degree with those found in the tribes whose diets were copied and that there was a similar

corresponding incidence even in the case of diseases which, at that time, were not usually thought to be connected with faulty diet (28).

A similar experiment with modifications to suit this country has since been conducted in Scotland (36). The rats in one group were fed on a diet somewhat similar to that of income group I in the present survey. Other closely related rats were fed on the same diet supplemented by an abundance of milk and as much green food as they cared to eat. These additions made good all the deficiencies of the average group I diet, making it as adequate for the maintenance of health as the diet of group VI. The following graph shows the relative rates of growth of the young animals of the two groups.



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Not only were the rates of growth markedly divergent, but the death rates of the two groups differed correspondingly. The mortality to 140 days of age on the supplemented diet was 11·6 per cent., while for those on the experimental diet the rate was 54·3 per cent. This heavy death rate was due mainly to epidemic infections to which both groups were equally exposed.

Such experiments with rats, of course, do not carry the same weight as observations on human beings. The dietary requirements of man and rats are not identical. Observations, however, have been made on two tribes, the Masai and the Kikuyu, living in Africa under the same climatic and housing conditions, but with very different diets (35). The diet of the Masai is rich in first-class proteins, minerals and most vitamins, though faulty in some other respects; the diet of the Kikuyu is rich in carbohydrates but relatively poor in most other constituents. The latter corresponds, roughly, to the average diet of groups I and II of our own population, A medical survey of the two tribes showed that the males in the tribe with the former diet were, on an average, five inches taller than the males of the latter tribe. There was also a striking difference in the incidence of disease in the two tribes. Bony deformities, somewhat similar to those found in children who suffer from rickets, carious teeth and pulmonary and intestinal diseases were more than twice as prevalent in the tribe on the diet poor in proteins, minerals and vitamins. These observations, though they do not refer to the people of this country, give confidence in accepting as substantially correct the general picture given here.

Effect of Improvement of Diet on Rate of Growth and Health.

Tests have also been carried out with children in this country. As far as they go these confirm the results obtained on animals and native tribes.

In 1926 observations were made on the effect of supplementing the diet of boys in an industrial school. The diet without the supplement was assumed to be adequate for health. It was found that the addition of milk increased the rate of growth for the period of the test, the increase per twelve months in boys on the diet alone being 1·84 inches, while in those receiving extra milk it was 2·63 inches (11).

These results, however, cannot be applied to children under home conditions. In 1927, therefore, a series of tests was carried out in

Scotland in which about 1,500 children in the ordinary elementary schools in the seven largest towns were given additional milk at school for a period of seven months. Periodic measurements of the children showed that the rate of growth in those getting the additional milk was about 20 per cent. greater than in those not getting additional milk. The increased rate of growth was accompanied by a noticeable improvement in health and vigour (33, 34). This experiment was twice repeated by different observers who obtained substantially the same results on numbers up to 20,000 children (22, 23).

Tests with even more striking results have been obtained in other countries, where the average diet is inferior to that in this country. Tsurumi has shown that in elementary schools in Tokyo the addition of 200 c.c. (about $\frac{1}{3}$ pint) of milk to the diet for six months caused a marked acceleration in the rate of growth, the gain in weight being 86 per cent., and in height, 16 per cent. more than in the controls. It was reported that the children who received milk " had improved complexions and glossy skins," and that " they became more cheerful, attended school more regularly, and were more successful in athletic contests than the corresponding control children " (45). Turbott and Rolland, in New Zealand, found that a supplement of $\frac{1}{2}$ to 1 pint of milk daily given to Maori children caused an increase in rate of growth such that they gained twice as much in height, and $2\frac{1}{2}$ times as much in weight as the controls (46).

The results of these tests on animals under experimental conditions and children under ordinary conditions of everyday life, suggest that, to whatever extent heredity and environment account for differences in health and physique of different classes, it would be possible to effect a considerable improvement in the health of the children of lower income groups by improving the diet.

IX. SUMMARY AND CONCLUSION.

The food position of the country has been investigated to show the average consumption of the main foodstuffs at different income levels. The standard of food requirements and the standard of health adopted are not the present average but the optimum, i.e., the physiological standard, which, though ideal, is attainable in practice with a national food supply sufficient to provide a diet adequate for health for any member of the community. The main findings may be summarized as follows :—

I. Of an estimated national income of £3,750 millions, about £1,075 millions are spent on food. This is equivalent to 9s. per head per week.

II. The consumption of bread and potatoes is practically uniform throughout the different income level groups. Consumption of milk, eggs, fruit, vegetables, meat and fish rises with income. Thus, in the poorest group the average consumption of milk, including tinned milk, is equivalent to 1·8 pints per head per week ; in the wealthiest group 5·5 pints. The poorest group consume 1·5 eggs per head per week ; the wealthiest 4·5. The poorest spend 2·4d. on fruit ; the wealthiest 1s. 8d.

III. An examination of the composition of the diets of the different groups shows that the degree of adequacy for health increases as income rises. The average diet of the poorest group, comprising 4½ million people, is, by the standard adopted, deficient in every constituent examined. The second group, comprising 9 million people, is adequate in protein, fat and carbohydrates, but deficient in all the vitamins and minerals considered. The third group, comprising another 9 million, is deficient in several of the important vitamins and minerals. Complete adequacy is almost reached in group IV, and in the still wealthier groups the diet has a surplus of all constituents considered.

IV. A review of the state of health of the people of the different groups suggests that, as income increases, disease and death-rate decrease, children grow more quickly, adult stature is greater and general health and physique improve.

V. The results of tests on children show that improvement of the diet in the lower groups is accompanied by improvement in health and increased rate of growth, which approximates to that of children in the higher income groups.

VI. To make the diet of the poorer groups the same as that of the first group whose diet is adequate for full health, i.e., group IV, would involve increases in consumption of a number of the more expensive foodstuffs, viz., milk, eggs, butter, fruit, vegetables and meat, varying from 12 to 25 per cent.

If these findings be accepted as sufficiently accurate to form a working hypothesis, they raise important economic and political problems. Consideration of these is outwith the scope of the investigation. It may be pointed out here, however, that one of the main difficulties in dealing with these problems is that they are not within the sphere of any single Department of State. This new knowledge of nutrition, which shows that there can be an enormous improvement in the health and physique of the nation, coming at the same time as the greatly increased powers of producing food, has created an entirely new situation which demands economic statesmanship. The prominence given to this new social problem at the last Assembly of the League of Nations shows that it is occupying the attention of all civilized countries. It is gratifying that the lead in this movement was taken by the British Empire.

FOOD HEALTH AND INCOME

Appendices

APPENDIX I.

THE BASIS OF CALCULATION: PER "HEAD" AND PER "MAN VALUE" UNITS.

The data on consumption and requirements were arranged on a per head instead of a per "man value" basis. The man value of any individual is the ratio of that individual's normal calorie requirement to the calorie requirement of the average moderately active man taken as unity. Thus the man value of the average moderately active woman, whose calorie requirement is commonly estimated as four-fifths that of the average moderately active man, may be taken as 0·8. The man values of children are smaller or larger than unity according to age and according to the particular scale of man value adopted. There are at least thirty-eight such scales.

The object of this investigation is to present an economic survey of the food habits of the country, and consequently the cost of supplying fully health-maintaining diets to individuals of both sexes and all ages is necessarily one of the most important bases of the investigation. The use of any man value scale based on calorie requirements would have led to an underestimation of the cost of feeding children, since foods rich in first-class protein, vitamins or minerals, of which the requirements are greater for growing children than for adults, are the more expensive. Stiebeling (44) has drawn up tables showing the relative cost of food for different individuals in terms of the cost of the diet of the moderatively active man. Thus the cost of feeding a boy 11–12 years old is only 11 per cent. less than the cost of feeding a moderatively active man an adequate diet, while for an active boy over 15 years old it is 17 per cent. more. The cost of feeding an infant alone is clearly less than that of an adult, but on the other hand the nutritional requirements of the nursing mother are much greater. The difference between the cost of feeding an infant compared with an adult is partly counterbalanced by the extra cost of giving the mother a fully adequate diet, which would enable her to breast-feed her infant.

APPENDIX II.

FAMILY BUDGETS EXAMINED.

Twelve surveys comprising 2,640 family budgets were examined, ranging from very poor families spending less than 2s. per head weekly on food, up to families with an income of £2,000 per annum spending 15s. or more per head weekly on food. Rather more than half of these budgets had to be rejected when compiling Table I, Appendix VI. They were used, however, to a more limited extent as an indication of the food habits of the country. None of those rejected differed materially from the budgets used in the information they supplied, the rejection being solely on the grounds either of insufficiency of data on family income, or total food expenditure, or of relating to years prior to 1932. In all 1,152 budgets were used. The total number examined in each survey, the final number used, the areas covered by the surveys and the years in which the enquiries were made :—

NUMBER OF FAMILY BUDGETS EXAMINED AND AREA COVERED BY ENQUIRIES.

Total Number of Budgets.	*Number Used.*	*Area to which Budgets refer.*	*Year.*
700	538	England and Wales (Women's Co-operative Guild).	1935
105	102	Newcastle	1933–34
50	49	Manchester and District	1933
85	82	Stockton-on-Tees	1932
300	243	Merseyside	1932
200	138	Great Britain (Middle-class) ..	1932
100	—	Peterhead and Aberdeen	1932
60	—	London	1931
100	—	Reading and Cardiff	1928
180	—	St. Andrews	1927
600	—	Scotland (larger eastern towns) ..	1926–27
160	—	England and Wales (Middle-class)	1926
2,640	1,152		

Grateful acknowledgment is due to those responsible for collecting the budgets; for their kindness in permitting the original data to be used, and particularly to the Women's Co-operative Guild for carrying out a special enquiry on our behalf.

APPENDIX III.

QUANTITIES OF FOOD SUPPLIES, HOME PRODUCED AND IMPORTED, OF THE UNITED KINGDOM, 1909–13, 1924–28 AND 1934.

	Average of 1909–13.			Average of 1924–28.			1934.		
	Home Produced.	Imported.	Total.	Home Produced.	Imported.	Total.	Home Produced.	Imported.	Total.
	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.	Th. met. tons.
Beef and veal	820	491	1,311	579	683	1,262	614	646	1,260
Mutton and lamb	331	266	597	205	273	478	255	338	593
Bacon and ham	100	272	372	75	447	522	104	438	542
Other pigmeat	304	41	345	234	51	285	271	66	337
Meat offals	60	—	60	94	8	102	107	68	175
Poultry and game	41	14	55	47	27	74	78	24	102
Rabbits	—	18	18	—	9	9	16	26	42
Total Meat	1,656	1,102	2,758	1,234	1,498	2,732	1,445	1,606	3,051
Eggs	129	129	258	156	156	312	279	170	449
Fish	715	133	848	638	214	852	742	173	915
Milk, fresh*	4,500	—	4,500	4,465	—	4,465	3,930	8	3,938
,, condensed	—	55	55	32	121	153	137	107	244
Butter	114	207	321	44	282	326	57	485	542
Cheese	30	117	147	42	149	191	75	150	225
Lard	—†	90	90	—†	120	120	48†	142	190
Margarine	60	59	119	184	64	248	166	—	166
Wheat flour	840	3,485	4,325	711	3,348	4,059	660	3,560	4,220
Other cereals	170	370	540	92	238	330	93	196	289
Apples	127	163	290	194	323	517	400	267	667
Bananas	—	150	150	—	309	309	—	256	256
Other fruit and nuts	214	617	831	198	840	1,038	300	1,246	1,546
Potatoes	3,988	262	4,250	3,563	415	3,978	4,600‡	108	4,708
Other vegetables	800	432	1,232	1,123	474	1,597	1,540	580	2,120
Sugar	—	1,621	1,621	106	1,671	1,777	490	1,505	1,995
Cocoa	—	36	36	—	54	54	—	72	72

* Including cream.

† Vegetable lard only. Animal lard included in Other Pigmeat.

‡ Includes cottage produce.

APPENDIX IV.

FOOD SUPPLIES OF THE UNITED KINGDOM CONVERTED INTO PROTEIN, FAT, CARBOHYDRATE, AND CALORIES.

	Average 1909–1913				Average 1924–1928				1934			
	Protein	Fat	Carbo-hydrate	Calories	Protein	Fat	Carbo-hydrate	Calories	Protein	Fat	Carbo-hydrate	Calories
	Th. met. tons	Th. met. tons	Th. met. tons	Thousand million	Th. met. tons	Th. met. tons	Th. met. tons	Thousand million	Th. met. tons	Th. met. tons	Th. met. tons	Thousand million
Meat	356	799	—	8,890	341	793	—	8,774	397	886	—	9,867
Poultry and eggs	49	37	—	547	51	39	—	571	69	53	—	775
Fish	91	17	—	531	90	18	—	536	98	18	—	569
Dairy produce	198	588	258	7,338	217	641	289	8,036	216	884	279	10,251
Cottage produce from animal sources	14	5	—	103	4	3	—	44	*	*	—	*
Total from animal sources	708	1,446	258	17,409	703	1,494	289	17,961	780	1,841	279	21,462
Cereals	531	53	3,557	17,254	497	51	3,281	15,964	514	50	3,374	16,404
Fruit	9	14	222	1,077	15	19	302	1,476	19	25	383	1,876
Vegetables	120	10	1,031	4,812	125	11	1,008	4,751	139	12	1,208	5,633
Sugar	—	—	1,562	6,404	—	—	1,724	7,068	—	—	1,941	7,958
Cocoa	5	18	10	229	8	27	14	341	10	36	18	450
Margarine	1	98	—	915	3	209	—	1,956	2	140	—	1,310
Cottage produce from vegetable sources	46	2	551	2,466	52	7	510	2,370	*	*	*	*
Total from vegetable sources	712	195	6,933	33,157	700	324	6,839	33,926	684	263	6,924	33,631
Grand total	1,420	1,641	7,191	50,566	1,403	1,818	7,128	51,887	1,464	2,104	7,203	55,093

* Included under individual commodities.

APPENDIX V.

DISTRIBUTION OF THE POPULATION BY INCOME GROUPS.

The analysis of the family budget data was carried out on the basis of per head consumption, in groups of families which were defined by the average income per head in the family, i.e., the total family income from all sources divided by the number of persons, irrespective of age and sex, supported by that income. It was then necessary to make some estimate of the proportions of the population falling into these several income groups. The earnings of the head of the family are no sure guide; the earnings of other members, together with supplementary income—unemployment benefit, pensions of various kinds, public assistance, investments—have to be brought into the account, and the total related to the number of persons to be maintained. An average per head income of say, 60s. per week may be reached in many ways—by a skilled worker at £6 per week with only a wife to support; or by a worker and his wife both in employment with earnings of 75s. and 45s. per week respectively; or by a man earning £1,100 a year with a wife and four children and a domestic servant; or by a variety of other combinations of earners and non-earners.

The method adopted in estimating the approximate proportions in the different income groups may be very briefly described as follows:—

(i) Tables were constructed separating married men, single men and women, and male and female juveniles into groups according to their estimated weekly incomes on the following basis:—

35s. and under per week.
35s. to 45s. per week.
45s. to 55s. ,, ,,
55s. to 65s. ,, ,,
65s. to 75s. ,, ,,
75s. to 85s. ,, ,,
Over 85s. ,, ,,

For this purpose the occupation tables in the 1931 Census Report were used, together with such published information as could be traced regarding wages and earnings in different occupations and different areas. Those returned as out of work in the 1931 Census were classified separately. A number of independent estimates of this nature were made by different authorities, and as the results showed a satisfactory degree of agreement it was felt that any of them might be accepted as a reasonable approximation to the facts.

(ii) Tables were constructed showing the estimated proportionate distribution of families according to the numbers in the family, and the numbers of earners or recipients of income from other sources. In addition to one table covering all private families, separate distribution tables were made for those families which included a married couple, and those in which no married couple occurred. "One-person" families, and families of which the head was "retired" were excluded from these subsidiary tables.

These tables were derived from figures given in the Report on Housing and from the General Tables in the 1931 Census. The former volume includes tables showing the numbers of private families of different sizes; and an analysis of private families according to constitution of family (married couples, adult males, adult females and children) for families of each size from 1 to 15 persons in two boroughs (Camberwell and Sheffield). The General Tables give, in addition to population by ages and marital condition, information regarding the number and (partially) the sexes, ages and marital condition of persons living in hotels, boarding houses, schools and institutions of various kinds; and a comparison of the Census and resident populations.

(iii) By courtesy of the Registrar General a random sample of 23,000 returns of private families was taken from the original records of the 1931 Census and frequency distribution tables, by size of family and numbers of earners, were constructed for seven different groups—those in which the head of the family fell into the following classes:—

(*a*) agricultural workers.
(*b*) unskilled labourers.
(*c*) other manual workers.
(*d*) unemployed.
(*e*) no earner.
(*f*) remainder.
(*g*) all families.

These figures included as earners only the occupied, retired and out of work, whereas the tables referred to under (ii) above included as " earners " all persons dependent upon social and investment income. Allowing for this difference, the table showing distribution of all families was found to be in sufficient agreement with the similar table constructed from the Census publications to warrant acceptance of the latter. Moreover, the Census sample revealed differences between the various occupations in such matters as average size of family and proportion of non-earners to earners, small enough to justify the application of the frequency distribution tables to all families, irrespective of the income or occupation of the head of the family.

(iv) The estimated number of private families including a married couple (roughly 8,000,000) agreed fairly closely with the number of married men in the country (8,500,000), the disparity being accounted for by families including more than one married couple, and by married occupants of hotels, boarding houses and institutions. The married men in the various income groups were consequently allotted families of earners and dependants in accordance with the frequency distribution tables for " married couple " families. Subsidiary earners (varying from an old age pensioner at 10s. and a juvenile at perhaps less, to an adult male earning many times that sum) were distributed among the families upon a simple mathematical basis in accordance with the estimated numbers in the various income groups, after deducting married men. Aggregating the incomes and dividing by the numbers in family give the numbers both of families and of persons in the following " per head " income groups :—

Up to 10s. per head per week.
10s. to 15s. ,, ,, ,,
15s. to 20s. ,, ,, ,,
Over 20s. ,, ,, ,,

(v) Similar tables were constructed for families without a married couple, the appropriate frequency distribution table being used, and the earners again being distributed proportionately throughout all families. A rough estimate was made of the probable distribution among the income groups of persons living alone, and separate estimates were also made for married couple families in which the head was " retired "—on the ground that such families have fewer dependants than married couples still in occupations.

(vi) The addition of the numbers in the different per head income

groups (up to 20s.) accounted for practically one half of the population in private families. The provisional figures arrived at were as follows :—

TABLE I.

	No. of Families.	*No. of Persons.*	*Proportion per cent.*
Up to 10s. per head per week	701,000	2,935,000	7·7
10s. to 15s. ,, ,, ,,	1,649,000	6,826,000	18·0
15s. to 20s. ,, ,, ,,	2,026,000	8,356,000	21·9
Over 20s. ,, ,, ,,	5,854,000	19,923,000	52·4
Total	10,230,000	38,040,000	100·0

Beyond 20s. per head per week the first analysis did not go, but income tax statistics indicate that roughly 10 per cent. of the incomes in the country are in excess of £250 per annum, and if the ratio of dependants to earners in that group is taken at about 1·1 (as compared with rather less than 1·0 for the country as a whole) then 10 per cent. of the population may be taken as having a per head income of 45s. per week and upwards. The 42 per cent. of the population between 20s. and 45s. per head per week were then divided into two equal groups, at 20s. to 30s. and at 30s. to 45s. Further analysis of the available material suggests that the two 5s. ranges between 20s. and 30s. may, however, embrace as much as 27 per cent. of the total population (17 per cent. between 20s. and 25s., and 10 per cent. between 25s. and 30s.) while the next three sub-divisions, from 30s. to 45s., may comprise only 15 per cent.

Estimates were also made on the same bases of the numbers of children of and below school age falling into the respective groups. From these estimates it appears that children comprise 49 per cent. of the persons in group I, 35 per cent. of those in group II, 25 per cent. of those in group III, 14 per cent. of those in group IV, and about 12½ per cent. of those in groups V and VI.

(vii) The analysis described above related only to private families in England and Wales. The figures are very rough, and, moreover, take no account of reduced incomes owing to sickness and short-time employment, nor, on the other hand, of casual earnings, overtime and soldiers' disability pensions and allowances. In view of these factors, and in view also of the probability that the proportions in the lower groups in Scotland are larger than those in England and Wales, it was considered reasonable to round up the proportions in

the two lowest groups to 10 and 20 per cent. respectively and to apply them to the whole of Great Britain. Finally, the results were assumed to apply to the inhabitants (staff, residents and inmates) of hotels, boarding houses and institutions as well as private families.

The figures finally adopted for the purposes of this report are as follows :—

TABLE II.

Group.	*Income per head per week.*	*Estimated average expenditure on food per week.*	*Estimated population.*	
			Numbers.	*Percentage.*
I	Up to 10s.	4s.	4,500,000	10
II	10s. to 15s.	6s.	9,000,000	20
III	15s. to 20s.	8s.	9,000,000	20
IV	20s. to 30s. (*a*)	10s.	9,000,000	20
V	30s. to 45s. (*a*)	12s.	9,000,000	20
VI	Over 45s.	14s.	4,500,000	10
Average	30s.	9s.	—	—

(*a*) Further analysis suggests that the upper limit of group IV and the lower limit of group V should be somewhat below 30s., but the average expenditure upon food and the consumption of individual foods in these two groups would not be materially affected by this alteration.

Included in the table is a column showing average food expenditure per head per week. This has been computed from the analysis of family budgets, and represents an average outlay on food amounting to rather over 45 per cent. of income for the lower three groups, the proportion falling sharply above the third group. Expenditure upon food includes the value, at retail prices, of meals taken at restaurants, etc., but excludes the cost of service of such meals.

The foregoing description of the various steps taken in arriving at a rough estimate of the proportions of the population falling within certain per head income groups gives a very summary and imperfect indication of the mass of calculations involved and the many considerations which had to be taken into account. Comparison with particulars of persons below the poverty line given in recent social surveys in London, Merseyside and Southampton and with data regarding the dispersion of family incomes in these surveys, suggests that, at any rate as regards the two lowest groups, the results are probably not seriously in error. But more information is needed in respect of earnings and the constitution of families before the population can be divided into per head income groups with a satisfactory degree of precision.

APPENDIX VI.

COMPARISON OF ESTIMATED FOOD CONSUMPTION IN INCOME GROUPS WITH FIGURES OBTAINED FROM FAMILY BUDGETS.

If all the statistics were perfect, the average consumption of each food found by calculating an average of the consumption per head in the various income groups, weighted by the proportions of the population within those groups, should agree with the national average consumption figure obtained by dividing total supply by total population. Such precise agreement cannot, of course, be expected, partly because of the margin of error inherent in the estimates themselves, partly because the two sets of figures—the aggregate national supply, and the consumption in households as derived from family budgets—relate to somewhat different totals.

At all stages it has been necessary to make estimates from insufficient or barely sufficient data, and the figures used have throughout been approximations, sometimes reasonably close, sometimes subject to a fairly wide margin of error. The figures of total supplies, which are the most satisfactory of the data, are themselves merely estimates which, though believed to be reasonably accurate, cannot be accepted as precise beyond dispute. An indication of the error which may be involved is given by the impossibility of reconciling the official estimates of milk consumed in liquid form with corresponding figures derived from the published statements of the Milk Marketing Boards.

What applies to the estimates of total quantities applies with even more force to the two separate factors which should, theoretically, also give us figures of total supplies. As we have seen, the number of family budgets used was something less than 1,200. They included an undue proportion of families in the industrial north, of families with small incomes and relatively large numbers of dependants. Moreover they were not distributed seasonally throughout the year, but tended to be concentrated in

the spring and early summer months. Family budgets for " black-coated " workers were few; those for the middle classes were poorly represented and for the rich completely lacking. There is good reason to believe that the average proportion of the income spent in providing food is fairly accurately shown by the family budget figures for the various income groups—at any rate by those in the lower income groups—but the actual quantities and values of the different items in the family dietary would no doubt be somewhat altered if a collection of family budgets thoroughly representative of the whole country were available.

The estimates of the proportions of the population falling within each income group on a per head basis are similarly the result of work done with inadequate material, and a margin of error of as much as 10 or 15 per cent. in any one group would not be surprising.

Apart from these possibilities of error, however, there are a number of points of difference between the estimated national supply and the quantities consumed in family households. In the first place, the national supply figures are " gross " ; they cover the total quantity of each food available at the first point of sale—the farm, factory or port. Between that point and the purchase by the housewife there is a considerable loss of weight. The total supply of fish and meat includes a large proportion which is not passed on to the consumer, but is wasted or is sold for industrial purposes. Other commodities also are subject to a similar, although smaller, degree of wastage, e.g., milk, eggs, fruit and vegetables. Secondly, not all the food consumed in the country is included in the " family food bill " ; some part of it is eaten in institutions, residential hotels, and other " non-family " establishments, while a considerable proportion is served in restaurants, eating-houses and canteens. It has been assumed that the average consumption per head in institutions and hotels is the same as the average for the whole country.

Consumption of food in restaurants, etc., is additional to the food provided by the housewife, and yet must be included in the average per head consumption of the families concerned. It is assumed that food bought and eaten away from the home constitutes a very small addition to the food consumption of the poorest groups, is unimportant for most foods even in the fourth group, but increases rapidly in the fifth and sixth groups. Mr. Feavearyear, in his estimates of national expenditure, assumed that 10 per cent. of the

nation's food is sold through hotels, restaurants and eating-houses. It is probable that this is an over-estimate; but even if the proportion be taken at only 5 per cent., and this be divided equally between the fifth and sixth groups, it means an addition of $12\frac{1}{2}$ per cent. and 25 per cent. respectively to the per head consumption in these groups. For some foods of course, the increase will be much larger than for others.

Since it is the upper groups (V and VI) which are mainly affected by the "meals out" problem, and since in any case the family budget data for these groups were scanty, it is the average consumption in the upper groups that has needed most adjustment to secure agreement between the national average and the weighted average of the groups. The proportion of the income spent on food in the lower groups being fairly well established, no material alteration in the average consumption of any one food can be made in these groups without a corresponding alteration in the opposite direction in some other food: otherwise the food expenditure of the groups would be altered.

One further preliminary point should be made clear. Since the income groups are on a per head basis, any one group will contain a heterogeneous collection of occupations, wages, earners and non-earners. Even in the wealthier groups there will be a small proportion of working-class families—skilled workers with only one dependant, or families with several earners each in receipt of good wages. Of no group can it be said that its needs or tastes are noticeably different from those of the groups immediately above and below it. This would be equally true if the income groups were to be made much narrower—with one or two shilling ranges instead of the wider ranges selected. Hence it follows that any curve showing variation in average consumption per head at different income levels should be a smooth curve.

The procedure adopted was as follows:—The family budget figures were first entered on a diagram and a smooth curve drawn as closely as possible to the points plotted. The curve was continued in groups V and VI, its course being determined by the trend of consumption as shown by the middle-class budgets. The group averages were then read off from the diagrams, and the weighted average of all groups compared with the national averages. Reasonable approximation was regarded as satisfactory, but if a serious disparity appeared, which could not be explained by a

necessary difference between the national and the weighted budget averages, the disparity was removed either by slight amendments throughout the groups, or by further adjustment in the two upper groups; for the lower groups could not be substantially altered without affecting the proportion of income spent on food. The result is a compromise, but one which is believed to be not far from the truth. Such errors as are contained in the picture are likely to be mainly in groups V and VI, and would merely involve transfers between these two groups.

In the following tables (p. 65 *et seq.*) are shown the actual budget data and the figures finally adopted.

Most of the differences between the figures in Tables I and II are due to the smoothing of the curves described above. In a few cases, however, more important alterations have been made. These are described below.

(i) *Meat.*—The national supply figures for meat include the whole of the dressed carcase weight. While the butcher manages to pass on to the consumer considerable quantities of bone and surplus fat, there is a proportion varying between 5 per cent. for mutton and 15 or 20 per cent. for beef, which is not sold to the consumer. Moreover some edible fat (lard, dripping, suet) is included in the carcase weight, but may be bought separately by the consumer. But even allowing for these factors and for meals in restaurants, etc., the family budget averages were quite inadequate to account for the whole of the meat supply, and it was found necessary to raise consumption throughout the groups, the increases ranging from 6 ounces per head per week in group I to 20 ounces in group VI—the latter, of course, including the allowance for meals out.

(ii) *Eggs.*—The national supply of eggs was insufficient to provide the quantities shown in family budgets. As the latter were obtained mainly in the season when eggs are plentiful, a reduction throughout the groups was necessary.

(iii) *Cheese, Sugar.*—Here the converse occurred, and it was found necessary to raise all figures slightly.

(iv) *Condensed Milk.*—The budget figures were increased throughout by an allowance to represent the condensed milk used in confectionery.

(v) *Fish.*—Much the same considerations apply here as to meat.

TABLE I. (Appendix VI).

QUANTITIES OF FOOD CONSUMED PER HEAD PER WEEK AT DIFFERENT INCOME LEVELS IN 1,152 FAMILY BUDGETS.

	Group I	Group II	Group III	Group IV	Group V*	Group VI*	Weighted Average of Groups
Proportion of the population	10%	20%	20%	20%	20%	10%	
Number of budgets	411	152	233	156	136	64	—
Beef and veal ozs.	9.5	11.5	11.7	11.3	10.2	9.5	10.8
Mutton and lamb ,,	2.1	3.1	4.3	6.2	6.8	9.7	5.3
Bacon and ham ,,	2.6	4.1	4.6	5.7	5.7	6.6	4.9
Other meat (*a*) ,,	2.8	2.9	4.2	5.4	3.6	3.5	3.8
Total meat (*b*) ,,	17.0	21.6	24.8	28.6	26.3	29.3	24.8
Bread and flour (excl. biscuits and cakes) (*g*) ,,	64.5	62.0	63.3	64.7	54.6	47.7	60.1
Milk—fresh pints	1.1	2.1	2.6	2.9	4.5	5.4	3.1
,, condensed (*c*) ,,	0.6	0.4	0.4	0.3	0.2	0.1	0.3
Eggs No.	1.9	2.8	3.7	4.8	4.7	5.2	3.9
Butter ozs.	2.7	5.7	7.4	8.8	8.9	9.7	7.4
Cheese ,,	1.5	2.1	2.8	3.2	2.9	2.5	2.6
Margarine ,,	4.9	2.9	2.2	1.9	2.5	1.4	2.5
Tea ,,	2.2	2.5	2.5	2.8	2.5	2.1	2.5
Potatoes (*f*) ,,	51.2	50.8	55.5	57.4	42.8	39.4	50.4
Lard, suet and dripping ,,	2.5	3.4	4.5	4.7	3.5(*e*)	3.2(*e*)	3.8
Fish (*d*) ,,	2.4	2.6	3.9	5.4	5.9	8.1	4.6
Sugar purchased as such ,,	13.5	15.9	18.1	20.1	19.0	18.1	17.8
Jams, jellies and syrups	4.3	5.5	5.7	5.8	6.5	5.6	5.7

(*a*) Sausage, corned beef and pork only.
(*b*) i.e., the total of the four items above.
(*c*) In terms of liquid milk equivalent.
(*d*) Excludes fried and tinned.
(*e*) For the two middle class groups, lard only.
(*f*) Excludes purchased "chipped" potatoes.
(*g*) In terms of flour.

* Group V has been calculated as a straight average of one working class group with income of 30s. to 40s. per head, and two middle class groups with family incomes of £200–£300 and £300–£400 (30s. and 40s. per head per week respectively).

Group VI has been calculated as a straight average of four middle class groups with family incomes of £400–£500, £500–£600, £600–£700, £700–£800 per annum.

TABLE II. (Appendix VI).

ESTIMATED QUANTITIES OF FOOD CONSUMED PER HEAD PER WEEK AT DIFFERENT INCOME LEVELS IN THE UNITED KINGDOM.

	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Weighted Average of Groups.	National Average.
Proportion of the population	10%	20%	20%	20%	20%	10%	—	—
Average food expenditure per week	4s.	6s.	8s.	10s.	12s.	14s.	9s.	—
Beef and veal ozs.	10.5	14.5	17.2	18.9	19.5	18.9	17.0	20.0 (*a*)
Mutton and lamb ,,	3.1	5.6	7.2	9.4	11.6	13.9	8.4	9.0 (*a*)
Bacon and ham ,,	4.3	6.3	6.8	7.3	7.8	9.4	7.0	7.8 (*a*)
Other meat ,,	5.2	5.2	5.9	5.9	5.9	7.2	5.8	7.2 (*a*)
Total meat ,,	23.1	31.6	37.1	41.5	44.8	49.4	38.2	44.3 (*a*)
Bread and flour (including biscuits and cakes) (*b*) ,,	66.0	68.0	68.0	67.0	65.0	60.0	66.0	61.0
Milk, fresh pints.	1.1	2.1	2.6	3.1	4.2	5.5	3.1	2.8
,, condensed (*c*) ,,	0.7	0.6	0.55	0.5	0.4	0.3	0.5	0.5
Eggs No.	1.5	2.1	2.6	3.2	3.6	4.5	2.9	2.9
Butter ozs.	3.0	6.5	7.5	8.5	9.5	11.0	7.8	7.8
Cheese ,,	1.8	2.5	3.1	3.6	3.6	2.6	3.0	3.2
Margarine ,,	4.5	3.5	2.5	2.0	1.6	1.3	2.5	2.4
Tea ,,	2.2	2.7	2.9	3.0	2.9	2.7	2.8	2.8
Potatoes ,,	53.0	56.0	57.0	57.0	57.0	54.0	56.0	64.0 (*d*)
Lard, suet and dripping ,,	2.7	3.6	4.2	4.4	4.3	3.5	3.9	2.7 (*e*)
Fish ,,	2.7	5.5	8.2	10.4	12.2	13.5	8.9	13.2 (*a*)
Sugar purchased as such ,,	13.5	16.0	18.0	19.0	19.5	19.5	17.8	27.7 (*g*)
Jams, jellies, syrup, etc.	4.3	5.3	5.2	5.4	5.8	5.5	5.2	(*h*)
Sugar consumed in other forms	6.5	7.5	8.5	9.5	10.5	11.5	9.0	(*i*)
Fruit (*k*)	14.0	21.7	25.8	27.9	30.5	39.3	26.5	35.1 (*j*)
Vegetables (excluding potatoes) (*k*)	16.0	20.0	27.2	30.6	32.3	34.0	27.0	30.2 (*f*)

(*a*) Includes wastage in distribution.

(*b*) In terms of flour: 130 bread = 100 flour.

(*c*) In terms of liquid milk equivalent. Allowance has been made for consumption of condensed milk in complex foodstuffs.

(*d*) Includes allotment production.

(*e*) Lard only.

(*f*) Includes shop wastage estimated at 10 per cent.

(*g*) Includes industrial consumption estimated at 40 per cent.

(*h*) Included in fruit and sugar.

(*i*) Included in sugar above.

(*j*) Includes fruit used industrially estimated at 25 per cent.

(*k*) Group quantities for fruit and vegetables have been estimated from expenditure after allowing for quality variations, but the figures are subject to a wide margin of error.

TABLE III. (Appendix VI).

ESTIMATED EXPENDITURE PER HEAD PER WEEK ON FOOD AT DIFFERENT INCOME LEVELS IN THE UNITED KINGDOM.

——	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Weighted Average of Groups.	National Average
Proportion of population	10%	20%	20%	20%	20%	10%	—	—
Average food expenditure per week	4s.	6s.	8s.	10s.	12s.	14s.	9s.	—
Expenditure on—	pence	pence	pence	pence	pence	pence	pence	pence
Beef and veal	4.7	7.1	9.8	12.0	14.5	15.4	10.7	10.4
Mutton and lamb	1.7	3.1	5.0	7.1	9.2	11.0	6.1	5.9
Bacon and ham	2.9	4.4	5.1	5.9	6.7	8.0	5.5	7.3
Other meat	4.1	5.1	6.0	6.8	8.0	10.0	6.6	5.5
Total meat	13.4	19.7	25.9	31.8	38.4	44.4	28.9	29.1
Bread and Flour (including cakes and biscuits)	9.0	11.0	12.4	13.8	15.3	17.5	13.2	8.1 (*a*)
Milk, fresh	3.4	6.4	8.5	10.2	13.2	17.8	9.8	8.7
,, condensed	1.4	1.2	1.1	1.0	0.8	0.6	1.0	1.0
Eggs	1.7	2.3	3.1	4.0	4.9	7.6	3.8	4.3
Butter	2.1	4.7	5.6	6.8	8.0	10.1	6.2	5.4
Cheese	1.0	1.4	1.7	2.0	2.4	2.1	1.8	2.3
Margarine	1.6	1.3	1.0	0.8	0.7	0.6	1.0	0.8
Tea	2.5	3.6	4.1	4.6	5.0	4.8	4.2	3.8
Potatoes	2.5	2.9	3.0	3.0	3.1	3.0	3.0	3.6 (*b*)
Lard, suet and dripping	1.2	1.7	2.0	2.2	2.2	1.9	1.9	1.1 (*c*)
All fish	1.0	2.4	4.1	5.8	7.6	9.3	5.0	5.1
Sugar purchased as such	1.9	2.4	2.7	2.8	3.1	3.2	2.7	4.8 (*d*)
Jams, jellies and syrups	1.3	1.5	1.7	1.9	2.2	2.4	1.8	—
Vegetables (excluding potatoes)	1.5	2.6	3.9	5.2	6.5	8.5	4.6	3.9
Fruit	2.4	4.6	6.6	9.5	13.0	20.0	9.0	11.7 (*e*)
Miscellaneous (*f*)	0.1	2.3	8.6	14.6	17.6	14.2	10.1	12.0
Total	48.0	72.0	96.0	120.0	144.0	168.0	108.0	105.7

(*a*) Excludes cakes and biscuits.
(*b*) Includes estimate for allotment output.
(*c*) Lard only.
(*d*) Includes sugar used for manufacture.
(*e*) Includes fruit used for manufacture.
(*f*) Miscellaneous, includes such items as coffee, cocoa, condiments, sauces, etc., and, for the groups, is the difference between the enumerated items and the total group food expenditure.

The budget figures show little consumption of fried fish, and it would seem probable that fried fish purchases may sometimes be regarded by the housewife as falling outside normal household expenditure.

All groups have been raised in the same proportion and sufficiently to give an average approximating to the national average, less an allowance for wastage.

Other differences are accounted for by the necessity of obtaining a smooth curve. The figures shown in the budget data for the poorest groups have seldom been reduced and have more often been increased. Apart from eggs, only margarine has been given a lower figure than that indicated by the budgets in group I, and this slight decrease has been balanced by an increase in butter. Only jams are reduced in group II; and only jams and lard in group III. On the other hand, in each of the groups there are several increases.

The adjustments, however, are not such as to alter materially the average composition of the diets of the different income groups, as calculated from the budgets and dietary surveys. In general the changes made to bring the results into harmony with the estimates of total food supplies have tended to raise the level of consumption throughout.

In Table III corresponding figures are given for expenditure per head per week in each income group. This provides a useful check on the figures of quantities in Table II. The price per unit in each group can be roughly estimated. The figures in each group added together must then correspond with the total expenditure on food in the group and the weighted averages of expenditure on each food in all groups must add up to the average expenditure on all food for the whole population. The chief causes of discrepancy between the national and weighted averages, which is not serious, are referred to in the footnotes to Table III.

APPENDIX VII.

AVERAGE HEIGHTS OF MALES AT DIFFERENT AGES TABULATED ACCORDING TO THE SOURCES FROM WHICH THEY HAVE BEEN TAKEN.

Age.	Public School.*	Cathcart (9).			Christ's Hospital School (17).	Council School, Boys, 1927 (4).	Age.	Council School, Boys, 1932–34.†	B.A. Anthropometric Committee, 1883 (6).				
		Students.	Employed.	Unemployed.					All Classes.	Professional.	Commercial.	Labouring.	Artisan.
5	—	—	—	—	—	41.4	5½	41.8	41.0	—	—	42.4	39.7
6	—	—	—	—	—	43.0	6½	—	44.0	—	46.5	44.6	41.9
7	—	—	—	—	—	45.4	7½	—	46.0	—	47.5	45.8	44.6
8	—	—	—	—	—	47.8	8½	48.1	47.1	—	47.6	47.1	46.5
9	—	—	—	—	52.2	49.2	9½	—	49.7	50.8	50.0	49.1	48.9
10	—	—	—	—	53.7	51.3	10½	—	51.8	53.7	52.0	50.9	50.7
11	—	—	—	—	55.2	52.7	11½	—	53.5	55.2	53.8	52.3	52.7
12	—	—	—	—	56.7	55.0	12½	55.4	55.0	57.3	55.3	53.7	53.7
13	61.9	—	—	—	58.6	56.2	13½	—	56.9	59.1	57.4	55.3	55.8
14	63.7	—	—	—	61.1	58.0	14½	—	59.3	61.3	59.5	57.9	58.6
15	65.3	—	60.4	59.6	63.7	—	15½	—	62.2	63.6	62.2	61.8	61.4
16	68.1	—	62.9	64.3	66.0	—	16½	—	64.3	66.2	64.6	63.6	62.9
17	69.8	68.5	64.9	62.8	67.7	—	17½	—	66.2	67.8	66.6	65.9	64.7
18	70.8	68.1	66.1	64.4	68.7	—	18½	—	67.0	68.3	67.4	66.5	65.6
19	—	68.4	66.3	65.8	69.4	—	19½	—	67.3	68.6	67.6	66.9	66.2
20	—	68.6	66.7	65.9	—	—	20½	—	67.5	69.1	67.6	66.9	66.5
21	—	68.6	66.8	66.2	—	—	21½	—	67.6	68.2	67.8	67.2	66.6

* Grateful acknowledgement is due to the headmaster of the Public School for allowing measurements to be made, and especially to one of his science masters, who carried out the work on our behalf.

† Data collected from School Medical Officers' Reports, 1932-34, and averaged at the Rowett Research Institute.

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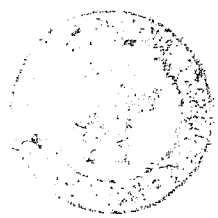

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