A DIETARY AND CLINICAL SURVEY OF PREGNANT WOMEN WITH PARTICULAR REFERENCE TO TOXAEMIA OF PREGNANCY

By W. HOBSON, B.Sc., M.D., D.P.H., *Department of Preventive Medicine, Whatley Road, Clifton, Bristol*

(With 3 Figures in the Text)

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INTRODUCTION

It is of the greatest importance to know whether the dietary habits of the people are adequate for their needs; this is particularly important during pregnancy when the growing foetus makes extra demands upon the requirements of the pregnant woman.

The Ministry of Health has published from time to time the results of surveys of the dietary habits of families; these have been carried out by the questionnaire method indicating the total intake of the family. It is possible to assess the individual intake of each member of the family by the use of family coefficients.

The application of such methods is liable to considerable inaccuracy as Widdowson (1947) has recently shown. Thus a slight decrease in the total intake of a family may be due to starvation in one member of the family, and it is a well-known fact that a mother will often reduce her intake of food in order to give it to the other members of the family. Canadian workers have shown that in Canada, at any rate, the mother is the most poorly fed member of the family (Hunter & Pett, 1941). The questionnaire method itself is also open to inaccuracies, as the food is not weighed and only an approximate measure of the amount of food taken can be given. The only accurate way of assessing the intake of an individual is by the weighing of each and every item of food. This method is known as the 'individual method', and has been used by Widdowson *et al.*; the subject is discussed in 'A study of individual children's diets' by E. M. Widdowson (1947). 'The individual survey seems to offer the only satisfactory method of discovering trends of food consumption and dietary habits whatever the age of the subject.' 'It is probably one of the most precise methods of assessing the value of a diet' (*Ministry of Food, Manual of Nutrition*, 1947).

An additional advantage of the individual method is that it gives information not only of the average intake, but of the minimum and maximum and the deviation from the average for every article of diet and for every chemical constituent.

Unfortunately, the method is tedious and much more time-consuming than the questionnaire method, hence only a relatively small number can be investigated compared with other methods. For this reason there have been very few analyses of the diet of pregnant women by the individual method, the most important being that of McCance, Widdowson & Verdon-Roe (1938) on 120 women of varying social class. They showed increasing intakes of protein, calcium, iron and vitamin B_1 with income. Assessment of other vitamins was not made due to the lack of adequate analyses at that time. It must be remembered that 60% of the women had unemployed husbands and were on a low income level.

No important individual dietary surveys have been made since that time on pregnant women despite very pronounced changes in the diet of the people. Moreover, there are now available abundant analyses of the various foodstuffs in terms of vitamins and other chemical constituents. It is manifestly of great importance to analyse the food intakes of normal pregnant women and to compare these with the generally recommended allowances; no such data are available at present for this country. It is also of the greatest importance to correlate these figures with the clinical condition of the subjects.

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PURPOSE AND SCOPE OF THE INVESTIGATION

A survey of the diets of 111 normal pregnant women was carried out in Bristol during 1947 by the individual method (Widdowson, 1936). The subjects were primiparae attending the ante-natal clinics of the City and County of Bristol.

The weighing was supervised by twelve health visitors of the local authority. The survey estimated the total food intake over a period of 1 week; blood samples were also taken for biochemical and haematological investigations. Full records were kept of money spent on food, occupation of husband, clinical history during pregnancy and the neonatal period, including an examination for signs of deficiency disease. The health and clinical history of the infant resulting from the pregnancy were also recorded during the neonatal period, including details of birth, weight and frequency of breast feeding.

Selection of subjects. As far as possible all primiparae attending the ante-natal clinics and supervised by the twelve health visitors were included in the survey. There were, however, a few who refused to participate, so that inevitably a certain amount of selection has taken place. The fact that there was detailed supervision of the group probably meant that a higher percentage were taking vitamin tablets than would be found in a normal sample of the population. The object of the survey was explained to all the subjects and their co-operation was enlisted in making the survey as representative of normal conditions as possible. The present-day rationing system made it impossible for subjects to vary a great deal in their intake of the important foodstuffs. The subjects generally showed a considerable interest in co-operation in the experiment and the majority were quite eager to give samples of blood for purposes of the investigation. A week probably represents a fair picture of the average intake, but this point will be considered in more detail in the discussion of the results.

Stage of pregnancy. Four were under 3 months; ninety-six between 3 and 6 months; and eleven between 6 months and term.

METHOD

Each subject was given a spring-balance on which to weigh all the food taken over a period of 1 week and an exercise book in which to record the details of each meal. The weighing and recording was supervised by a health visitor who also visited the home prior to the week's experiment and explained in detail the method of weighing and recording the results. The health visitor finally completed a printed form on which all the details of the week's diet were entered; this included beverages, alcohol, sweets and method of preparation of food, particularly vegetables and recipes of any special dishes. Weekly conferences were held to check the detailed working of the scheme. No health visitor had more than two subjects in any 1 week. Prior to the start of the survey each health visitor was herself instructed in the methods of conducting the survey and carried out a similar survey on herself over a period of 1 week.

The chemical composition of the diet was analysed from food tables and figures from *The Vitamins in Medicine* (Bicknell & Prescott, 1947); *The Table of Nutritive Value of Wartime Foods* (M.R.C. 1945); Fixsen & Roscoe (1939–40); Bacharach (1940–1); McVicar & Berryman (1942); Cheldelin & Williams (1943) and from numerous other references in the recent literature.

Estimations were made of calories, protein, animal proteins, fat, carbohydrate, calcium iron, vitamins A, D, C, and B_1, riboflavin and nicotinic acid. The accuracy and significance of these estimations will be discussed under their appropriate headings.

The survey was postponed if there were any unusual features such as illness, particularly vomiting or abnormal loss of appetite.

RESULTS

(*a*) *Articles of diet*

The consumption of bread, milk, butter and margarine, potatoes, other vegetables, total meat and fish has been expressed as a frequency distribution for each item (Fig. 1) and the mean, minimum, maximum, standard deviation and coefficient of variation expressed for each item in the form of a table (Table 1). Comparison can be made with mean values for these foodstuffs found by McCance in 1938 in 120 pregnant women of low income.

It has been shown by Widdowson (1947) that as far as the staple foods are concerned the consumption from week to week shows little variation, certain seasonal foods, however, varying according to the time of year; this applies particularly to home-grown fruit. With the present-day rationing, however, the maintenance of extra quantities of milk, bread, meat, eggs and vitamin supplements ensures a relatively constant supply from week to week; generally home-grown fruit has supplied only a small proportion of the vitamin C supply which is maintained mostly by concentrated orange juice.

It is probable that a week is a very fair estimate of the average intake, and little would be gained by extending it for a longer period. The only exception perhaps would be in the case of liver which is only available every 2–4 weeks.

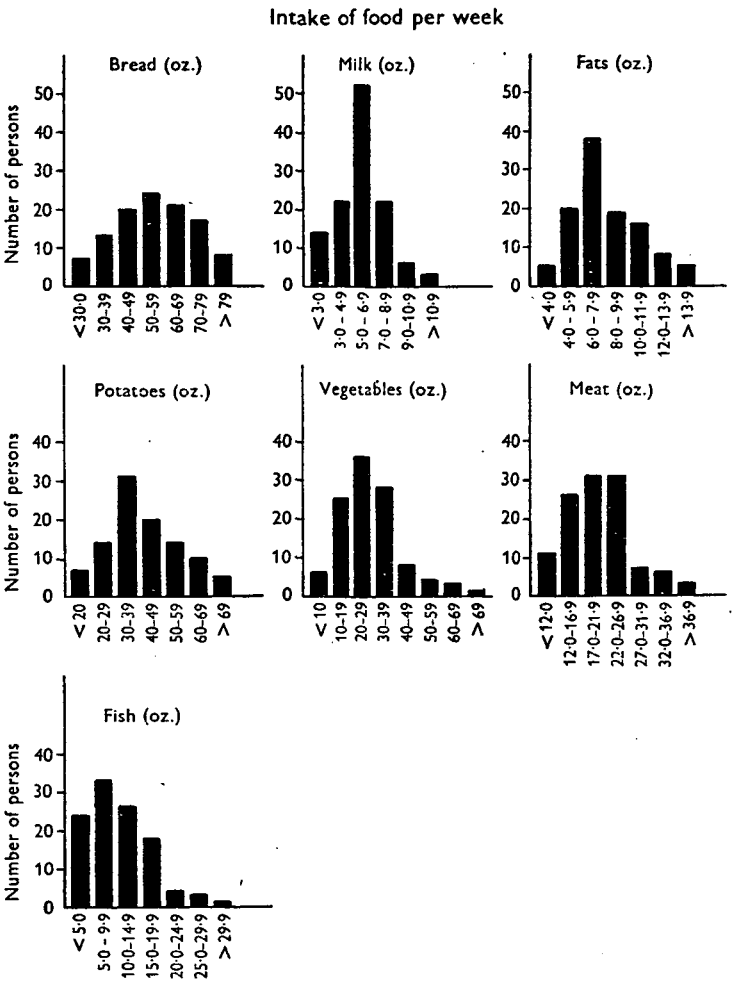

Fig. 1.

Table 1. *Ounces per week*

	Minimum	Maximum	Mean	Standard deviation	Coefficient of variation	Mean 1938*	Percentage 1947 against 1938
Bread	10·0	92·0	56·0	± 16·7	30·0	48·0	117
Milk	25·0	243·0	123·0	± 42·0	35·0	63·0	190
Butter and margarine	2·0	22·0	8·0	± 3·0	37·5	10·0	80
Potatoes	4·0	100·0	44·0	± 16·8	38·0	30·0	147
Other vegetables	3·0	74·0	26·0	± 12·0	46·0	22·0	118
Total meat and offals	7·0	43·5	20·0	± 7·0	35·0	21·0	95
Fish	0·0	32·0	10·0	± 6·7	67·0	7·0	143

* Indicates mean intake of items recorded by Widdowson & McCance (1938) in a similar group.

The last column shows the percentage change in consumption of various items compared with 1938. Thus fats and meat are decreased, but all the rest increased.

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Bread (see Fig. 1 and Table 1)

The proportions of total dietary intake of calories, iron, calcium, vitamin B_1, riboflavin and nicotinic acid provided by bread is shown in Table 2. This also shows the reductions which would occur if national flour was replaced by the white flour (70 % extraction) of pre-war days.

Table 2

	Percentage of total intake of nutrients provided by bread	Average reduction in amount of nutrient in diet if white bread replaced national bread (%)
Vitamin B_1	38	28
Iron	28	17
Nicotinic acid	23	8
Calories	23	0
Riboflavin	15	10
Calcium	10	7·5

This table shows clearly that bread is most important as a provider of vitamin B_1, iron, nicotinic acid, calories, riboflavin and calcium. National bread fortified with calcium provided 10 % of the calcium of the diet and it must be remembered that the extra amount of phytic acid in national bread causes a diminished absorption of calcium and iron due to the formation of an insoluble phytate. Taking these facts into consideration bread becomes relatively unimportant as a source of calcium in the diet of the pregnant woman.

The advantage of national bread over white bread is most marked in respect of vitamin B_1.

The mean intake of 56 oz. per week can be compared with the 77 oz. per week allowed under the rationing system, only eight individuals (7 %) exceeded this latter figure. The mean intake was 17 % greater than in McCance's group (1938).

Milk (see Fig. 1 and Table 1)

This group were taking 90 % more milk on the average than the group studied by McCance *et al.* in 1938, their mean intake being 123 oz. per week whilst the ration allowed was 190 oz. per week. Eight subjects (7 %) were drinking more than their ration. Only twenty-three (21 %) were taking more than 1 pint per day although it was available. The larger the family the more likely is milk to be diverted from the expectant mother, but even in primiparae at least 80 % were not taking their full ration; according to most authorities expectant mothers should be taking 2 pints of milk a day.

These results indicate the fallacy of assessing the adequacy of the present-day diet from a bare consideration of the amounts supplied in the ration; this takes no account of individual likes or dislikes or distribution within the family.

When one considered the proportion of total intake of chemical constituents provided by milk, it is obvious how important milk is as a food. Thus in this survey 50 % of the calcium, 42 % of the riboflavin, 33 % of the animal protein and 17 % of the vitamin B_1 were supplied by milk.

Butter and margarine (see Fig. 1 and Table 1)

Margarine was national margarine fortified with vitamins A and D. The mean intake for the group was 8·0 oz. per week compared with 10·0 oz. in 1938 (McCance *et al.* 1938); a drop of 20 %. The ration allowed was 6 oz. per week. Sixty-nine (63 %) were consuming more than their ration; this may have been due to other sources of supply, or because they took more than their ration from the family pool. In agreement with this latter suggestion Widdowson (1947) found that women ate proportionately more butter than men.

In this survey butter and margarine provided only 2 % of the vitamin A and 6 % of the vitamin D, the bulk of the vitamins being supplied by vitamin supplements. If the diet is considered without vitamin supplements, however, butter and margarine supplied 25 % of vitamin A and 55 % of vitamin D.

Potatoes (see Fig. 1 and Table 1)

Potatoes are a fairly constant source of ascorbic acid, but the content varies according to the season of the year, i.e. new or old potatoes and the method of cooking and serving. An attempt has been made to allow for this.

In this survey potatoes provided 16 % of the total ascorbic acid, 12 % of the vitamin B_1, 12·5 % of nicotinic acid and 10 % of the calories.

The mean intake was 44·0 oz. per week. This is 47 % more than a similar group were consuming pre-war (McCance *et al.* 1938).

Potatoes became rationed in November 1947, giving 4½ lb. (72 oz.) per week for a pregnant woman. Only five subjects reached this figure before rationing came into force; so the ration would appear to be sufficient to satisfy the appetites of pregnant women.

Vegetables (see Fig. 1 and Table 1)

This total includes green and yellow leafy vegetables, salads, legumes, pulses and root vegetables, fresh and tinned.

These are important sources of vitamins A, B_1 and C. Carrots are particularly rich as a source of vitamin A. The method of cooking and serving vegetables, particularly green leafy vegetables, has quite an appreciable effect upon the ascorbic acid content. An attempt was made to make an allowance for this and particular attention was paid to the method of cooking vegetables.

The mean intake was 26 oz. per week or 18% more than in a pre-war group of McCance's (1938).

Total meat (see Fig. 1 and Table 1)

The total includes all meat, rabbit, chicken, bacon, pork, ham and offals. These are most important sources of animal protein and nicotinic acid. Liver is the commonest offal and the richest source of vitamin A. It is also very rich in nicotinic acid, riboflavin, vitamin B_1 and iron.

The mean intake of 20 oz. per week was 5% lower than in a pre-war group (McCance, 1938).

Fish (see Fig. 1 and Table 1)

This included fried fish from shops, tinned fish and shell fish. Fish is an important source of animal protein, the pelagic fish are the richest source of vitamin D and shell fish are extremely rich in iron and nicotinic acid. The mean intake of 10 oz. per week was 43% higher than the pre-war group.

Summary

Compared with the group of 120 pregnant women studied by McCance (1938) this group were getting more bread, milk, potatoes, vegetables and fish but less butter and margarine and slightly less meat. In this pre-war group 60% of the women had unemployed husbands and were on very low incomes.

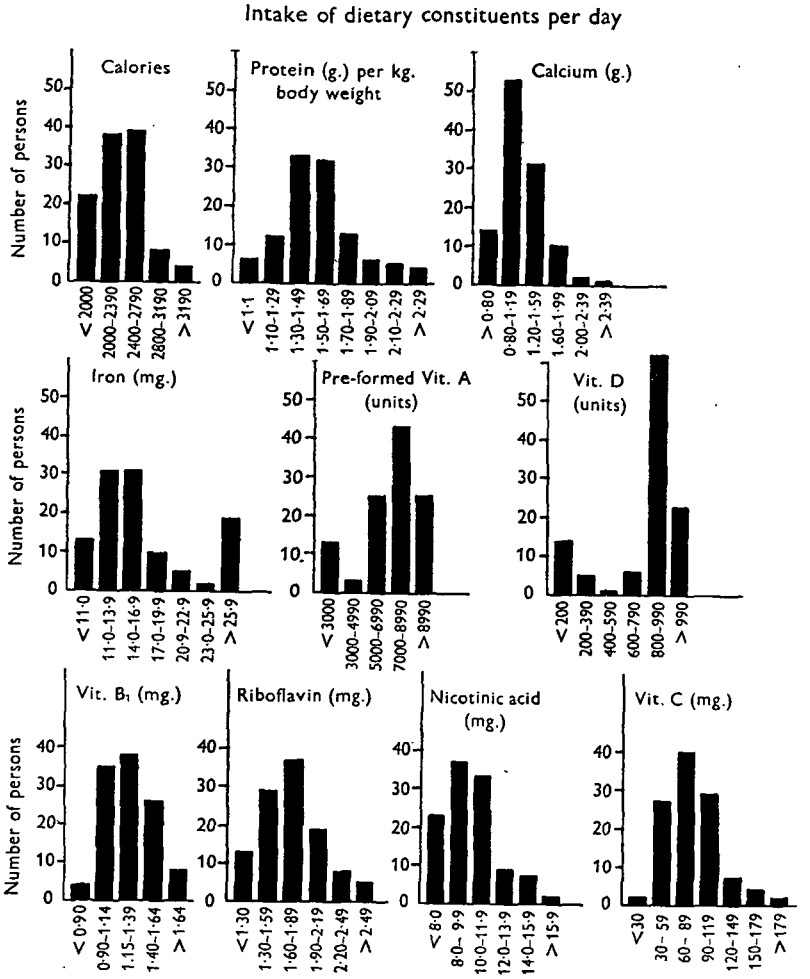

Fig. 2.

(*b*) *Nutrient principles of the diet*

The intakes of calories, protein per kilogram body weight, calcium, iron, vitamins A, D and B_1, riboflavin, nicotinic acid and vitamin C have been expressed as a frequency distribution, see Fig. 2.

The minimum, maximum, mean and standard deviation have been expressed in a table (Table 3).

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Table 3

	Minimum	Maximum	Mean	Standard deviation (σ)	Coefficient of variation	'Standard A' N.R.C. pregnant women	'Standard B' N.R.C. sedentary women (modified)*	McCance & Widdowson 1938	Percentage reaching 'Standard A'	Percentage not reaching 'Standard B'
Calories	1600	3500	2400	±430	18·0	2500	2100	2360	43	21
Total protein (g.)	55	120	90	±13·8	15·3	—	—	—	—	—
Protein in g./kg. body weight	0·9	2·5	1·5	± 0·32	21·3	1·5	1·0	1·2	53	<1
Animal protein (g.)	27	85	50	±12·3	24·6	—	—	43	—	—
Calcium (g.)	0·5	2·8	1·2	± 0·40	33·0	1·5	0·8	0·7	18	9
Iron (mg.)	8·0	300	34	Median 15		15	12	12	52	18
Iron less supplements (mg.)	8·0	24·0	14·0	± 3·5	25·0	—	—	—	44	22·5
Vitamin A (i.u.)	1320	22000	7600	Median 7300		3500	3000	—	86·5	13·5
Vitamin A less supplements and liver (i.u.)	1010	6500	3050	±910	30·0	preformed	preformed	—	22	52
Vitamin D (i.u.)	25	3220	850	Median 870		—	—	—	78	17
Vitamin D less supplements (i.u.)	25	810	110	± 9·2	8·0	800	400*	—	<1	95
Vitamin B_1 (mg.)	0·7	1·8	1·25	± 0·25	20·0	1·8	1·1	1·0	<1	23
Vitamin B_1 (mg.)/1000 non-fat calories	0·63	1·17	0·81	± 0·09	11·5	—	—	—	—	—
Riboflavin (mg.)	1·0	2·9	1·7	± 0·39	23·0	2·5	1·5	—	3	30
Nicotinic acid (mg.)	5·5	16·0	10·0	± 2·4	24·0	18·0	11·0	—	10	74
Vitamin C (mg.)	20	200	81·0	±29	35·3	100	70	—	25	40

* The modification from the N.R.C. standard for sedentary women is the addition of 400 units vitamin D.

Additional information has been added to the table for the following items: total protein, animal protein, iron (less supplements), vitamin A (less liver or supplements), vitamin D (less supplements), vitamin B_1 per 1000 non-fat calories. Where the information is available comparison has been made with the figures obtained by McCance *et al.* in 1938. The N.R.C. standards for pregnancy, here called 'Standard A', and for sedentary women (slightly modified) 'Standard B', have been given.

In the case of iron, total vitamin A and total vitamin D, the median has been given as a more accurate measure of the average intake. Concentrated sources of iron, vitamin A and vitamin D can make a considerable difference to the mean, although they may have only been taken by a few individuals. In the rest of the estimations the minimum, maximum, mean, standard deviation and coefficient of variation have been calculated.

Comparisons have been made with the standard for pregnancy proposed by the National Research Council of U.S.A.; this is the allowance recommended in the *Ministry of Food, Manual of Nutrition*, 1947. This in future will be called Standard A (see Table 3). It must be clearly understood that this allowance is an optimum allowance and is designed to provide an adequate margin of safety in all normal circumstances, and to cover considerable individual differences in requirements; these individual differences may be considerable in the case of vitamin B_1, riboflavin and nicotinic acid, as it has been shown by Najjar *et al.* (1943–4) and Ellinger (1944) that these vitamins can be synthesized in the human gut.

It is clear then that comparison with a recommended allowance must be interpreted in this light. No one single diet reaches the standard set up, and it is very difficult to do this in England under present circumstances; it must be remembered that the standard was set up in the U.S.A. and is a very high one even by their standards. This survey showed that double the quantity of milk was being consumed compared with a similar social group pre-war, and that the majority were receiving vitamin supplements. Even so, the group would have to consume far greater amounts of dairy produce, meat and offals to reach this standard. As a working standard for this country it is set far too high. The correlation of the dietary intake with clinical findings will be discussed in some detail later, but the majority of the subjects remained in a very good state of health. There were only 8 % showing a haemoglobin below 80 % and only one subject showing hypoprotinaemia, i.e. plasma protein $< 5{\cdot}5$ g./100 c.c. There were no subjects showing any stigmata of nutritional deficiency, and the majority produced healthy full-time babies. In this respect then the diets must be considered to be adequate taken on the whole.

For this reason comparison was also made with the standard set up by the N.R.C. for sedentary women with a slight modification, allowing in addition 400 units of vitamin D per day. This will in future be called standard B (see Table 3).

An attempt has been made to ascertain the relative amounts of essential nutrients provided by the different foodstuffs. It should be noted that the total vitamin contributions of many foods is quite different from what would be expected on the basis of relative vitamin contents alone, because of the wide variations in the calorie contributions of different foods. Thus bread is the chief provider of many essential nutrients, although there may be foodstuffs in the diet much richer in these particular substances. This is because bread is eaten in such large quantities compared with other foods. An excellent review of the nutritional requirements in pregnancy is given by Garry & Woods (1946).

Calories (see Fig. 2 and Table 3)

E. M. Widdowson (1947) has shown in her survey of the diets of children of all ages that there is a wide variation in the daily calorie intake of a particular age and sex group. This survey has shown a similar wide variation in the calorie intake of pregnant women, varying from 1600 to 3500 calories per day. There are always some individuals who have small appetites and are able to do as much work, and sometimes more work, than those individuals with large appetites. These differences are probably not due to differences in digestion and absorption at any rate in children (Macy, 1942), and may possibly be due to a better utilization of the foodstuff in the body. It appears that a fair estimate of a person's calorie intake is obtained by a survey covering a period of 1 week (Widdowson, 1947). If one person can be taking double the calorie intake of another of the same age and sex, it is obvious how inaccurate a picture is given by the application of man values and family coefficients to a family survey.

The mean intake of 2400 calories agrees fairly well with the intake of 2500 calories in the N.R.C. standard for pregnant women and is a little higher than the 2360 calories taken by McCance's group (1938). As a generalization the greater the calorie intake, the more likely is it to contain an adequacy of vitamins and mineral salts, and in the case of a small calorie intake it is more difficult to reach the standards recommended. We know that there are considerable individual variations in the requirements of vitamins and it may be that some individuals utilize them more efficiently. In the case of certain vitamins a smaller amount is required on a low calorie intake.

The average calorie intake was supplied by 14·5 % protein, 37·5 % fat and 48 % carbohydrate.

Protein (see Fig. 2 and Table 3).

Considerable attention has been focussed in recent years on the protein requirements of pregnancy. In the past it has been thought that a high protein intake was harmful in pregnancy and predisposed to the development of toxaemia of pregnancy and many women are still advised to take a diet low in protein. In hospitals and clinics any sign of toxaemia is an indication for the patient to go on to a low protein diet. In recent years, however, there has been considerable evidence that a low protein intake may be associated with toxaemia (Holmes, 1941; Strauss, 1935; Arnell *et al.* 1945; Dodge & Frost, 1938; Bibb, 1941).

There are certain essential amino-acids necessary for normal growth and development, and their importance is receiving increasing recognition; of particular importance in pregnancy are the relationship of methionine deficiency to liver damage and tryptophan in replacing nicotinic acid.

The mean intake of 1·5 g. protein per kg. body weight agrees well with the recommended figure of the N.R.C., only one subject (1 %) was receiving less than 1 g. protein per kg. body weight, and only one subject had a plasma protein level lower than 5·5 g./100 c.c. Arnell & Guerriero (1942) found the levels of protein intake which produced hypoproteinaemia ($< 5{\cdot}5$ g./100 c.c.) were < 1 g. per kg. body weight. The protein also contained a satisfactory proportion of animal protein, the mean intake being 50 g. per diem. This satisfactory state of affairs with regard to protein intake is almost certainly due to the satisfactory intake of milk provided by the priority supply. An interesting comparison is afforded with the group of McCance in 1938 where the mean intake of total protein per kg. body weight was 1·2 g. per day and the mean intake of animal protein was 43 g. per day; thus more protein per kg. body weight and more animal protein were being consumed than in 1938.

The significance of plasma albumen and globulin will be discussed in a later paper in relationship to protein intake and in conjunction with haematological investigations.

The seventeen cases of toxaemia which occurred bore no relationship to the intake of protein.

Calcium (see Fig. 2 and Table 3)

Calcium is an essential mineral for the building of new bone tissue, hence the requirements in pregnancy are particularly important. The mean intake of calcium was 1·2 g. compared with a mean intake of 0·7 g. in McCance's group in 1938; the increase of nearly double was due to the good intake of milk, Twenty subjects (18 %) were receiving calcium up to standard A, only ten (9 %) below standard B. Thus by comparison with standard B the diets on the whole were adequately supplied with calcium, but poor compared with standard A. The intake was almost double that of the pre-war group studied by McCance (1938). 0·1 g. is supplied by vitamin tablets and anything up to 0·2 g. can be supplied in Bristol drinking water; this latter source has not been allowed for in the estimated intake. There is a very close correlation between milk intake and calcium intake as milk supplies 50 % of the calcium, bread supplying only 10 %. Those diets which were low in calcium were low because of the poor intake of milk, usually due to the fact that the subject disliked milk. In the lowest calcium intake of 0·5 g. the subject was only taking 25 oz. of milk per week due to a dislike of milk. This was also the lowest milk intake. The baby was born prematurely (birth weight 5 lb. 8 oz.).

The next lowest intake was 0·6 g. on a milk intake of 40 oz. per week, the patient did not like milk. No gross effects were noted, although the baby was described as being pale and flabby. Both diets were defective in other essentials.

The availability of calcium will depend upon its absorption which will be decreased under the following conditions:

(1) *Phytates.* The high percentage of phytic acid in high extraction flour will render more calcium insoluble.

(2) *Oxalates.* Rhubarb and spinach interfere with absorption by formation of insoluble calcium oxalate. No diets had excessive amounts.

(3) Some workers have found that large amounts of fats in the diet can form insoluble calcium soaps. All the diets had small amounts of fat.

(4) A high phosphate content of the diet will decrease absorption.

Calcium absorption is increased in the following conditions:

(1) When associated with protein due to amino-acids causing a greater solubility of calcium phosphate.

(2) When associated with lactose which increases calcium retention.

(3) An adequate intake of vitamin D is necessary for absorption and utilization of calcium. 80 % were taking adequate intakes of vitamin D.

(4) Duckworth & Warnock (1942) have shown that in pregnancy a woman is able to absorb a greater proportion of calcium.

Thus the importance of milk as a provider of calcium during pregnancy is apparent; as 50 % of the calcium intake of this group came from milk the group as a whole probably absorbing and utilizing their calcium adequately.

Iron (see Fig. 2 and Table 3)

The frequency distribution of the iron intake shows two definite peaks, the first is made up of those

subjects whose diet was not supplemented by any medicinal source, the second peak is made up of those diets which were supplemented by medicinal iron on the advice of the clinic or doctor and which was done independently of the investigation in the course of routine ante-natal care. In all nineteen diets (17 %) were supplemented in this way. The mean and standard deviation for this series are no real measure of the distribution of iron intake, thus the few very high iron supplements make a very large difference to the mean value without conferring any advantage on the rest of the members of the group; the median has been calculated as a better measure of the average intake.

The minimum, maximum, mean, standard deviation and coefficient of variation have therefore been calculated for the diets without medicinal supplements (see Table 3).

The mean intake of iron without supplements is 14·0 mg. per day, compared with 12·0 mg. per day in the group studied by McCance (1938). Even without supplements the iron content is good, 44 % reaching standard A.

Dietary iron is supplied by bread 30 %, meat 30 % and vegetables 30 %.

Widdowson & McCance (1944) have shown that an appreciable amount of iron can be supplied from iron cooking utensils and knives. There is evidence that iron in bread is rendered insoluble by the formation of insoluble iron phytate (McCance *et al.* 1942). Moreover, iron from meat is probably absorbed adequately (Oldham *et al.* 1937, 1941) contrary to what has usually been assumed. Iron is also inadequately absorbed when there is achlorhydria.

Balfour *et al.* (1942) has shown, by the use of radioactive iron, that a pregnant woman absorbs two to ten times as much iron as does a non-pregnant woman; this technique has a great future in the study of iron metabolism.

It is obviously extremely difficult to assess the proportion of iron which is absorbed and utilized by the body, and a great deal of reserve must be placed on any estimate of deficiency or adequacy based on intake alone.

There appears to be a high proportion of the group (82 %) who had adequate iron intakes in relation to standard B; 52 % reached standard A.

The iron intake is closely associated with the intake of meat and bread, the lowest iron intakes having low intake of nicotinic acid also. Thus of six subjects with the lowest iron intake, i.e. (8–9 mg.), five of them had also the lowest nicotinic intake recorded. There is a strong correlation between the intake of iron and nicotinic acid. The correlation coefficient between the two was $+0{\cdot}70 \pm 0{\cdot}10$; the correlation coefficient is thus seven times its standard error and highly significant.

Vitamin A (see Fig. 2 and Table 3)

Vitamin A occurs as preformed vitamin A in animal tissues including vitamin supplements. In plant foodstuffs, however, it occurs in the form of carotene of which on an average only one-half is utilized. In assessing the dietary intake and requirements of an individual it is necessary to state whether the preformed vitamin A or the total combined vitamin has been calculated. Many published tables of food values do not always make this point quite clear.

In this survey the vitamin A intake has been calculated in terms of preformed vitamin A and all figures for carotene have been reduced accordingly, comparison must therefore be made with requirements of preformed vitamin A. On the N.R.C. standard these are 3500 units in pregnancy and 3000 units for a sedentary woman, the corresponding figures for a combined mixture of vitamin A and carotene are 6000 and 5000 respectively. Thus the preformed vitamin A is approximately 60 % of the combined vitamin A and carotene requirements.

For effective absorption bile is necessary in adequate amounts and it has been shown that liquid paraffin interferes with the absorption of vitamin A, for this reason inquiry was made into the use of laxatives, none used liquid paraffin habitually, there is no reason to suppose that any of the subjects suffered from a deficiency in the secretion of bile.

84 % were taking vitamin A supplements, equivalent to a daily intake of 4000 units of preformed vitamin A, so that all these subjects had a sufficient intake of vitamin A. It is worthy of note that many did not begin to take their vitamin supplements until the fourth month. The total reaching standard A was 86·5 %.

There is no doubt that liver has a very marked effect upon vitamin A intake, and only small amounts (2–3 oz. weekly) are necessary to bring the vitamin A content up to the necessary standard.

The dependence upon vitamin supplements and liver is shown by the fact that if these two sources are eliminated only 48 % were receiving sufficient vitamin A for a sedentary woman (Standard B). It must be remembered also that as far as individual intakes are concerned, those who ate liver 1 week would probably not be able to get it the next. In other words, 1 week does not give a fair picture of the intake of liver over the year, particularly at the present moment when liver is only procurable every 2–4 weeks.

Apart from liver, the best sources of dietary vitamin A are carrots and dairy produce. Margarine is now fortified with vitamin A.

The frequency distribution of the total vitamin A intakes show two peaks, the first small one is due to

the subjects not taking vitamin supplements of liver and the second large peak is due to the subjects taking the vitamin supplements of liver.

The intake of vitamin A without vitamin supplements or liver is much more constant and has been expressed as minimum, maximum, mean, standard deviation and coefficient of variation. The median of the total vitamin A intake has been given as this is probably a better measure of average intake (see Table 3).

Vitamin D (see Fig. 2 and Table 3)

The frequency distribution of vitamin D intakes shows two well-marked peaks, the first small one due to natural sources of vitamin D, the second large peak due to diets having supplements of vitamin D. Apart from vitamin supplements, the richest sources of vitamin D are fat fish, i.e. herrings, salmon, sardines, these were not taken consistently and the intake varied from one subject to the next. The intake of butter and margarine was much more consistent. Vitamin supplements provided 800 units per day. They were taken regularly by 84 % of the subjects. The median intake has been calculated for total vitamin D as this gives a better picture of the average intake. The maximum, minimum, standard deviation and coefficient of variation have been calculated for vitamin D in the diet without supplements (see Table 3), the coefficient of variation is very low showing a consistent intake from individual to individual.

One very obvious point emerges, namely that 95 % of the women would have had an intake less than 400 units per day if they had relied upon natural sources of vitamin D. This is likely to be more serious in winter and in cities when no vitamin D is being formed by the action of sunlight on the skin. This indicates the necessity of ensuring that all pregnant women take extra vitamin D.

Vitamin B_1 (see Fig. 2 and Table 3)

Vitamin B_1 is provided from a number of sources, but the chief source is from bread which supplies on the average 37 %. Bacon, ham and pork, are very rich in this vitamin and must have supplied a greater amount to the diet before the war. Milk supplies on the average 17 % of vitamin B_1.

Widdowson (1947) found in children before the war that at all age groups milk provided more vitamin B_1 than any other source; this is not true of pregnant women to-day. In the first place, milk takes up a greater percentage of the diet in children than in pregnancy, whilst bread makes up a greater percentage in adults, and secondly bread now contains more vitamin B_1 than before the war.

It has been shown that a loss of 28 % would take place in the intake of vitamin B_1 if the bread was made with white flour.

The mean intake of 1·25 mg. compares with a mean intake of 1·0 mg. in McCance's group pre-war. Only 1 (1 %) subject reached standard A (1·8 mg.), 26 (23·4 %) were below standard B (1·1 mg.).

The adequacy of vitamin B_1 intake is related to the intake of non-fat calories, therefore the ratio of vitamin B_1 intake per 1000 non-fat calories has been calculated for each subject. These have been expressed as minimum, maximum, mean standard deviation and coefficient of variation (see Table 3).

Holman (1945) states that the optimum intake should be 0·6 mg./1000 non-fat calories. All subjects had greater intakes than this. The frequency distribution was much more even and there was a lower coefficient of variation when the results were expressed as intake per 1000 non-fat calories than when expressed as gross intake. Other investigations have related vitamin B_1 intake to total calories intake, but Arnold & Elvehjem (1939) have shown that the important relationship is to non-fat calories.

Vitamin B_1 deficiency has been associated with hyperemesis gravidarium, polyneuritis of pregnancy and toxaemia of pregnancy (King & Ride, 1945). Seventeen cases of toxaemia occurred but did not appear to bear a constant relationship to the intake of vitamin B_1.

It should be noted that the vitamin B_1 requirements on the N.R.C. standard have been based on three experimental studies on human volunteers and these did not show any close agreement.

Riboflavin (see Fig. 2 and Table 3)

Riboflavin deficiency is likely to result on a diet low in milk and meat, and composed chiefly of vegetables, fruit and starchy food.

The mean intake of 1·7 mg. was a little over the 1·5 mg. of standard B, thirty-three (30 %) were below standard B, three (3 %) reached standard A.

It was obviously very difficult to achieve standard A even on maximum amounts of milk and quite a high percentage came below standard B, 42 % of the riboflavin was supplied by milk.

Brzezinski *et al.* (1947) found no correlation between the incidence of toxaemia and riboflavin excretion, but they did find a significant increase in the incidence of prematurity, ante-natal death, late vomiting of pregnancy and hypogalactia, on those subjects having a low riboflavin excretion, as in all such experiments those subjects which are low in one factor are probably low in another. The picture is further complicated by the fact that Najjar *et al.* (1944) have shown that riboflavin can be made available to the body by bacterial synthesis in the gut.

Nicotinic acid (see Fig. 2 and Table 3)

Nicotinic acid was provided chiefly by bread, meat and offals. Surprisingly enough, potatoes were relatively a fairly good source of supply of nicotinic acid,

because in some cases a large quantity was eaten they provided an average of 12·5 % of the nicotinic acid. Beer is another good source. Three pints a day could supply the total daily needs in pregnancy.

There is a very strong correlation between the iron intake and nicotinic acid intake. Correlation coefficient $+0{\cdot}70 \pm 0{\cdot}10$.

The mean intake of 10·0 mg. per day was less than 11·0 mg. recommended on standard B. 74 % failed to reach standard B and none reached standard A.

Compared with all other nutrients the diets were worse in nicotinic acid content than in any other (see Fig. 3), due to the shortage of meat and offals in the present-day diet. Of the other important constituents of meat, animal protein and riboflavin were made good by the generous milk supply and by iron from bread and vegetables.

It was noted that seventeen subjects developed toxaemia of pregnancy. The mean nicotinic acid intake of this group was lower than the mean nicotinic acid intake of the normal group. The difference was statistically significant.

Those diets which were adequate in all respects with the exception of nicotinic acid were those in which there was a high proportion of milk and little meat or bread. One must not only consider absolute deficiencies but amounts relative to other items of the diet, since it has been shown that excess of one number of the vitamin B group can lead to symptoms of deficiency of another. The diet of one subject who had the severest degree of toxaemia (eclampsia) was particularly interesting as it showed a high vitamin B_1 intake and a low nicotinic acid intake.

This is of interest in the light of the observation of Richards (1945), who has shown that large intakes of vitamin B_1 will induce signs of vitamin B_6 deficiency on a low intake of the latter.

The possibility arises that deficiency of nicotinic acid or some other factor of the B_2 complex closely associated with nicotinic acid, may be a predisposing factor in toxaemia of pregnancy. Pyridoxin or vitamin B_6 is of particular interest in this respect as it occurs in similar foods to nicotinic acid. Thus milk contains very little, but meat, offals and bread are rich sources. Experimental deficiency of vitamin B_6 in animals has produced conditions similar to those found in eclampsia (Chick, Macrae & Worden, 1940; Calder, 1944; Patton, 1944; Richards, 1945).

Deficiency of nicotinic acid can cause achlorhydria (Sinclair, 1942), and therefore may predispose to defective absorption of other nutrient principles.

Vitamin C (see Fig. 2 and Table 3)

The mean intake of vitamin C was 81 mg. per day compared with 100 mg. required on standard A and 70 mg. standard B. These standards are often considered to be on the high side and 50 mg. a day recommended by the League of Nations is probably adequate. 25 % reached standard A, 40 % failed to reach standard B, 18 % failed to reach the 50 mg. per day recommended by the League of Nations. 78 % had some form of supplementation of their diet by vitamin C, either by concentrated orange juice or some other preparation.

The best sources of vitamin C are fruits, particularly citrus fruits and vegetables. A high percentage of the vitamin C of vegetables can be destroyed in cooking; an attempt was made to make allowance for this in calculating the intake. There is probably a considerable seasonable variation in the vitamin C intake from vegetables and home-grown fruit. Most of the vitamin C, however, came from concentrated orange juice and this would tend to mask the smaller variations in the diet from other sources at any rate in the supplemented diets.

Apart from scurvy and follicular hyperkeratosis there appear to be no specific stigmata of vitamin C deficiency in pregnancy; gingivitis may be due to vitamin C deficiency but many cases may be due to hormonal influences (Sinclair, 1942). In relation to the N.R.C. standard the vitamin C intake of the group is not very satisfactory.

(c) *Clinical results*

The majority of these women forming the group were attending ante-natal clinics regularly and were seen by a doctor on an average as follows: every month in the first 6 months, fortnightly in the next 2 months and weekly in the last month, each was seen by a consultant 6 weeks before term and on further occasions if necessary. Each woman was examined once for evidence of any specific nutritional defect. In addition, they were seen on numerous occasions by health visitors and particularly frequently during the week of the nutritional survey.

At routine examinations the usual ante-natal procedures were carried out, including urine examination, measurement of systolic and diastolic blood pressure and clinical examination. Examination of the blood for *Rhesus* factors and Kahn tests were carried out in addition to special biochemical and haematological investigations.

In the examination for nutritional defects, particular attention was directed to the following: eyes, skin, particularly the skin of the face, teeth, tongue, gums, lips, oedema and neurological signs. No slit lamp examination of the eyes was made for corneal vascularization in view of its doubtful significance. The examination was carried out on the lines suggested by Sandstedd & Anderson (1947).

A diagnosis of toxaemia of pregnancy was made if the blood pressure exceeded 140/90, where it had previously been normal or where albuminuria occurred. This appears to be the usual criterion adopted by other workers (Ebbs, 1941; King & Ride, 1945).

A complete history of the pregnancy and delivery was thus available for each subject. The birth weight and subsequent history of the child are also being recorded.

In no case was any clinical condition found which could be attributed to nutritional deficiency.

The morbidity and mortality rates were as follows:

Miscarriages 2: Case 1. The mother had congenital syphilis, Kahn negative and *Rhesus* negative. Case 2. The mother had ante-partum haemorrhage. This subject was on a very poor diet, eating very little meat or bread.

Stillbirths 4: Case 1. Age 44, with mitral stenosis. This subject did not take vitamin supplements. Cases 2 and 3. These were both severe toxaemias and were placed on low protein diets for the toxaemia. Case 4. Nothing abnormal detected.

The cases of stillbirths and miscarriages were too small in number from which to draw any conclusions, but there were definite dietetic deficiencies in four out of the six cases.

Toxaemia, seventeen cases.

Many of these subjects were on quite good diets, only one of the cases was not taking vitamin tablets regularly, so that the majority had adequate intakes of vitamins A, D and C. Six had rather poor milk intakes (under 100 oz. per week). On the contrary, the rest had very satisfactory intakes of milk, some had poor riboflavin intakes as a result but many were very good. The great majority had low intakes of bread and meat resulting in poor intakes of vitamin B_1 and nicotinic acid. The intakes of these two vitamins generally run together. There was a notable difference in the two however, the nicotinic acid intake being universally low, whereas two of the diets had quite high intakes of vitamin B_1. Nicotinic acid was the only substance which was consistently low in the diets of the toxaemic women.

The nicotinic acid intakes of the two groups were as follows:

		Mean
Seventeen subjects	Group with toxaemia	8·3 mg. $\pm$ 1·34
Ninety-four subjects	Group without toxaemia	10·3 mg. $\pm$ 2·20

The difference between the two means is $2{\cdot}0 \pm 0{\cdot}64$ or five times its standard error. Thus the lowered nicotinic acid intake in the group with toxaemia is statistically significant. This receives added importance when one realizes that the group as a whole is on a low level of nicotinic acid intake. The minimum daily requirements in a normal adult are given as 10 mg. by the United States Food and Drug administration (Davidson & Anderson, 1947).

There are a number of facts relating toxaemia of pregnancy to a deficiency of vitamin B_2 complex.

Toxaemia of pregnancy occurs commonly in association with pellagra and vitamin B deficiency. Thus Ross (1938) and Siddall (1940) showed that the distribution of toxaemia in the Southern States of U.S.A. has a striking relationship to the distribution of vitamin B deficiency and pellagra. King (1945) showed a high incidence of toxaemia and eclampsia associated with a deficiency of the B group of vitamins. Dieckmann (1938) has shown that toxaemia is rare in native African and other races except where they adopt the white man's diet. It is common amongst negroes in the U.S.A. The Peoples League of Health (1942) in this country showed a significant lowering in the incidence of toxaemia in a group of women on supplemented diets; their supplements contained vitamin B_2 complex in addition to other vitamins.

Burke *et al.* (1943) found a high incidence of toxaemia on poor diets but none on their good diets. Ross (1938), Ebbs *et al.* (1941) and Dieckmann *et al.* (1944) found no significant difference in the incidence of toxaemia in groups whose diets were supplemented with calcium, phosphorus, iron, vitamin A and vitamin D. Many of the experiments which have shown no significant change in the incidence of toxaemia in supplemented diets have made no allowance for the provision of the vitamin B_2 complex in the supplemented diets.

Ross (1947), in his presidential address to the South Atlantic Association of Obstetricians and Gynaecologists, made the following remarks: 'We have rarely found toxaemia in the intelligent and adequately nourished group but it is the prime factor in the improperly nourished. In our areas such a patient would develop pellagra if exposed to the sun, and we feel may develop symptoms of pregnancy toxaemia if she becomes pregnant. The patient that we see in eclamptic convulsions has come from the same group who subsisted on a diet similar to pellagrins.'

Duncan (1947), writing of his experiences on the Yukon, found that toxaemia was almost unknown. He thought that the only plausible explanation was the diet which consisted of large quantities of meat and eggs.

There is clearly then evidence of a very close relationship between a deficiency of vitamin B_2 complex and the occurrence of toxaemia of pregnancy; this is borne out as a result of a dietary survey of those subjects who subsequently developed toxaemia. In this series the only substance which appeared to be consistently deficient in the diets of all the subjects who developed toxaemia, was nicotinic acid. It is suggested that the development of toxaemia of pregnancy may be associated with a deficiency in the diet of nicotinic acid or closely related substance, e.g. vitamin B_6, and it is hoped that this paper will stimulate further work to

determine if these vitamins have any effect in the prevention of toxaemia of pregnancy.

(d) Assessment of the diet as a whole

It became obvious that if any relationship was to be established between money spent on food and quality of dietary intake, some numerical measure of this quality had to be made; such a measure would be useful in comparing with clinical findings and data on blood examinations. Accordingly the diets were given a score made up as follows:

2 marks for all nutrient principles which reached standard A.

1 mark for all nutrient principles which reached standard B.

The marks were given in respect of nine principles, i.e. protein intake per kg. body weight, calcium, iron, vitamin A, vitamin D, vitamin B_1, riboflavin, nicotinic acid, vitamin C.

The highest score possible was 18.

The distribution of scores was as follows, minimum 2·0, maximum 16·0, mean 10·0 ± 3·4.

Range of scores

2–4	Classed as 'very poor' 8 %.
5–7	Classed as 'poor' 16 %.
8–10	Classed as 'fair' 33 %.
11–13	Classed as 'good' 31 %.
14–17	Classed as 'very good' 12 %.

Fig. 3 expresses the percentage of subjects reaching standard A (N.R.C. standard for pregnant women) and those not reaching standard B (Modified N.R.C. standard for sedentary women).

When compared with standard B it can be seen at a glance that the group are most deficient in terms of the vitamin B complex, particularly nicotinic acid, and also in terms of vitamin C.

Comparing the group with standard A it can be seen that over 20 % reached the very high standard for vitamin C so that it is obviously possible to get sufficient vitamin C. On the other hand, only a very small percentage were able to reach standard A in respect of the vitamin B group, because of the very great difficulty on present-day rations which are particularly deficient in the richest sources of vitamin B, e.g. bacon, ham and pork. These amounts are more easily attainable in the U.S.A. where bacon, ham and pork form such a large part of the diet and where there is artificial supplementation of the bread. It is important to decide two points. Is the N.R.C. standard for pregnancy set too high for this country? Or is there a real deficiency of the vitamin B complex in the present-day diet of the pregnant woman?

These questions are difficult to answer but the clinical survey of the group does throw some light on the subject. Evidence has been produced to show that the group as a whole shows no evidence of malnutrition, and the only possible defect that can be attributed to dietetic deficiency is toxaemia of pregnancy.

The average intake of the group is therefore probably adequate with the possible exception of nicotinic acid. It appears possible therefore that the N.R.C. standard for pregnancy may be set too high for this country particularly in terms of vitamin B.

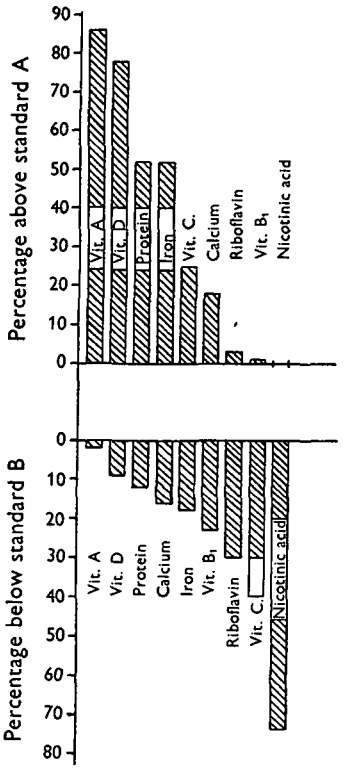

Fig. 3.

(e) Relationship of money spent on food to dietary score

Information on the amount of money spent on food was obtained from ninety subjects. The amount spent on food per week was as follows: minimum 7*s*., maximum 35*s*., mean 19*s*. 6*d*.

Group A, 22*s*. and above. Twenty-eight subjects. Mean dietary score 11·0 ± 2·6.

Group B, below 22*s*. and above 17*s*. Thirty-five subjects. Mean dietary score 10·5 ± 3·0.

Group C, 17*s*. and below. Twenty-seven subjects. Mean dietary score 8·0 ± 3·2.

Thus the average diet of the highest income group, Group A, was classed as good; whilst the average diet of the lowest income group, Group B, was classed as fair.

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The difference of mean of Group C from both Group B and Group A is significant, but the difference between means of A and B is not significant.

Thus if less than 17*s*. was spent on food the diet became poorer in quality; there was no significant difference over this figure.

The differences in the quality of the diet do not show the gross differences between the low income groups and the high income groups which were noticeable before the war (McCance, *et al.* 1938). This is without doubt due to the real increase in wages and the greater amount of money spent on food. Any differences in the quality of diet are due more to faulty food habits and ignorance than to differences in income. The amount of money spent on food is considerably more than was spent by a similar group before the war, but if the money is not spent wisely it can still produce a poor diet. It often follows that the persons spending the least money on food are also those who spend it most unwisely.

DISCUSSION

The chief purpose of this investigation was to investigate the dietary habits and food intake of a representative group of pregnant women in the period immediately following the war, and to ascertain how far this food intake met the various requirements recommended in pregnancy. The second purpose was to elicit any information from clinical investigation and history of the subject on the adequacy of the diet and correlate any clinical findings with dietary intake. Before attempting to apply these results to pregnant women in general, it is necessary to discuss the errors which are likely to occur and estimate the accuracy or otherwise of the results.

The chief sources of error likely to operate are as follows:

(1) The sample taken may not have been an accurate sample of pregnant women in general.

(2) The mere fact that a survey was being carried out on the individuals may have caused the subjects to alter their dietary habits.

(3) The period of the survey, 1 week, may not be a sufficiently long time to give an accurate measure of the food intake.

(4) The period of pregnancy may cause variations in the food intake.

(5) There may be discrepancies between the calculated amount of each nutrient principle and the amount actually taken, due to losses in cooking, variations in tables, and inaccuracies in recording the intake.

(1) The survey was limited to primiparae, because it would obviously be easier for women with no children to devote the time and attention to the survey, moreover, they were likely to be more co-operative. The women taking part in the survey were taken from the practices of twelve health visitors covering the middle-class and poorer sections of the city, and attending the city ante-natal clinics. An effort was made to include every primipara attending the ante-natal clinics covered by the survey, but inevitably there were a few who refused to co-operate or who were unable to do so because of low intelligence. The group then must represent the better type of women in the poor and middle-class sections of the community. There can be no doubt that the conditions represented here are better than those which would operate amongst multiparae, who have children to look after and do not as a rule give the same care and thought to their diet.

(2) The fact that a survey was being undertaken may have caused the subjects to alter their food habits in an effort to impress, this may have operated consciously or subconsciously. On the other hand, a small number of the subjects may have taken a reduced intake with the mistaken impression that they would thereby get something out of it, or as an unconscious protest against the rationing system. The tendency to this latter attitude has been observed on more than one occasion. On the other hand, the former attitude is probably more common; its effects were minimized by the present-day rationing system which gives a small choice in the way of foods; none of the subjects had meals in restaurants during the week's survey. Generally speaking, individual differences in intake were due to appetite and specific likes and dislikes. Thus some subjects did not like milk, bread, potatoes, meat or fish as the case may be. If there is a marked dislike for one of the important rationed food, e.g. milk or bread, it is very difficult to make good the specific deficiencies by means of other foods.

The fact that 84 % were taking vitamin supplements is an indication that the group were much more conscientious in taking their supplements than pregnant women in general.

(3) The pre-war studies of Widdowson & McCance (1942) have shown that although a week is probably the shortest time for which a dietary survey should be made 'the results of 1 week are probably fairly representative of the person's usual food intake'. Post-war conditions have modified this to some extent, and it is probable that with the strict rationing system the results of 1 week's survey are even more representative of the person's usual intake. The one exception is in the case of liver and other offals which become available every 2–4 weeks, this may make a difference to the vitamin A intake. The seasonal variation in the intake of vitamin C is not such an important factor in the diets of pregnant women, as it is largely swamped by the high and constant intake from concentrated orange juice, the

same remarks apply to vitamins A and D in fortified margarine and vitamin supplements.

(4) The period of pregnancy may make a difference to the appetite of the subject. In the early stages of pregnancy morning sickness may affect the appetite and cause a decrease in the food intake; as the demands of the growing foetus become greater the daily intake of food should increase. In addition, marked idiosyncrasies may develop over certain foods. Some subjects showed an increased desire for fruit to the exclusion of many important foodstuffs, and there appeared to be a widespread and mistaken idea that a diet with plenty of fruit in it was a good diet; usually such a diet was a very poor one, as the appetite was satisfied by such things as apples and grapes at the expense of other important foodstuffs.

Every endeavour was made to limit the survey to the stages of pregnancy between 3 and 6 months. Of the 111 subjects, ninety-six were between 3 and 6 months, eleven between 6 months and term, and four under 3 months.

We know very little of the changes which take place in the dietary intake during pregnancy as no work appears to have been done on this.

These results probably relate adequately to the second trimester of pregnancy.

It should be remembered that the allowances recommended by the N.R.C. of America are for the third trimester of pregnancy.

(5) The record of intake and analysis of results in terms of essential nutrients may not agree with the actual amounts taken in the diet. There may be, for example, errors in weighing and recording, losses due to cooking, variations in the values given by different authorities for certain vitamins, difficulties with made-up dishes due to differences in composition, additions from various sources such as calcium from drinking water and iron from utensils.

McCance & Widdowson (1942) have made a comparison of the chemical composition of mixed diets, as determined by direct analysis with that obtained by calculation from food tables, and they have found a very close relationship in the case of calories, protein, fat and phosphorus. On the other hand, calcium was too low because of the use of hard tap water for cooking and iron was too low because of the iron from cooking utensils and knives; the deficiencies were in the region of 10 %.

It is well known that there are losses in cooking vegetables particularly due to vitamin C and vitamin B_1; these are likely to be small compared with the total supplies of these vitamins from concentrated orange juice and from bread.

Allowances were always made for losses in cooking of vegetables.

The accuracy of the estimations of vitamins A and D is probably fairly high as most of the supply came from constant and easily estimated sources such as vitamin tablets, butter, margarine, pelagic fish.

Greater errors are likely to occur in the estimations of the vitamin B complex. It is well known that there are variations in the figures given for some foodstuffs. However, average figures were taken for each foodstuff and the same figures used for every estimation. The chief value of these estimations lies not in their absolute value but in their comparative values; moreover the same foods are used in each diet.

The greatest difficulty arises with the made-up foods, such as cakes, puddings, soups and stews. Wherever possible recipes were obtained for these items, but it was not always possible to do this and in such cases average figures had to be taken. There is no doubt that these can form a source of error. These errors are not of course limited to individual dietary surveys; they are a source of error in any survey which uses food tables for an estimation of essential nutrients. The individual laboratory analysis of all diets for each nutrient principle would eliminate some of these errors but would be a prohibitive procedure in all but the smallest survey. It would be well-nigh impossible to take representative samples of foodstuffs from a small household for analysis under present-day conditions. Summing up, one can say that the group as a whole were taking a diet above average for their class. The protein, calories, calcium, iron, vitamins A, D and C are fairly accurate in absolute amounts, although there may be some discrepancies in the estimations of vitamin B complex, but in any case their greatest value lies in the comparison of one diet with another. If in the future more accurate figures become available for the various foodstuffs, a correction figure applied to these results will give a more accurate picture of the absolute value.

Despite what has been said on the errors in this method, the fact still remains that relative to the questionnaire and other methods it is certainly more accurate, and in the words of the Ministry of Food 'It is probably one of the most precise methods of assessing the value of a diet'. There does not appear to be any more accurate method available.

Many attempts have been made to assess the dietetic needs of the body in pregnancy in terms of essential nutrients. The energy requirements were the first to receive consideration. It has been shown in this paper that there can be wide individual variations in calorie intake compatible with health. Widdowson (1947) found a similar variation in children's intakes. The determination of the requirements of protein and mineral salts has been estimated as a result of balance experiments, and it has been shown that there are extraordinary variations in the intake of these substances compatible with good health. Moreover, the absorption of many of these

essentials depends upon a variety of factors such as the type of foodstuffs in which they occur or the presence of achlorhydria.

The optimum requirements are those amounts which will maintain a group of individuals in perfect health over a long period of time with a reasonable margin for safety which will cover all eventualities and provide for individual differences of requirements within the group. One of the most important things about optimum requirements is that a given individual can be taking an intake of a particular substance at a much lower level than the optimum requirement and still be in perfect health. Another individual on the same intake may show a clinically recognizable deficiency state. There are, in addition, many degrees of ill health and lack of efficiency between those two extremes which are not measurable. It follows that the ascertainment of the optimum requirement, even for mineral salts, is of considerable difficulty and has resulted in much controversy; requirements based on individual experiments are not always applicable to a group.

It has been stated that the daily intake on a freely chosen diet of a particular nutrient is no measure of the requirement, as we have no appetite for essential nutrients. This may be perfectly true, but if the clinical conditions of a large group are assessed as a whole and correlated with the dietary intake, we can eventually arrive at a figure for the group which is necessary for health. Naturally such figures can only be based on a large number of such surveys on differing economic and racial groups.

When we come to the question of vitamin requirements there is even greater difficulty in arguing from experiments on individuals. Not only are there individual variations in intake, absorption, storage and excretion but vitamins are destroyed and synthesized. Moreover, the significance of blood levels of the various vitamins is open to considerable criticism, as we do not know whether it is necessary to live in a state of vitamin saturation. On the contrary, we know that perfect health is often compatible with levels of vitamin in the body considerably below saturation point. Again, each individual utilizes and responds to vitamins in a different way to another. The general dietary habits of the group as a whole are also important in view of the fact that bacterial synthesis in the gut can provide the vitamin requirements, and alterations in the type of diet can alter the type and degree of synthesis which goes on.

In assessing optimum requirements, therefore, we can obtain useful information from the clinical assessment of a group as a whole, and its correlation with average intakes in relation to the average food habits of the group. If these surveys are carried out on widely different groups and under different conditions we shall gain considerable information as to their optimum requirements.

In speaking of optimum requirements we assume that it is possible to have an excess of a particular nutrient; additional evidence is forthcoming that this may indeed be so. Thus an upset in the balance of calcium and phosphorus or the balance of the vitamin B group may be harmful. Our knowledge of these ratios is still in its infancy.

In setting up recommended allowances we must, as far as possible, set up a figure which provides the optimum requirements taken in conjunction with the general dietary habits of the healthy members of the community. At the present moment the recommended allowances are no more than intelligent guesses based on experiments on individuals. There are, in fact, very few group surveys and very little precise information on which to form an estimate of the optimum requirements. Any comparison with recommended allowances must therefore be interpreted in the light of these remarks, and it must not be assumed that because one particular individual is below the standard she is likely to show any symptom of deficiency, but what does become of significance is that the members of the group with the lowest intake of a particular nutrient are more likely to show signs of ill health than those on a high intake. In other words, levels of intake assume greater significance when a comparison is made within a group and with the results of clinical examination of the group. It must be realized also that it is possible for a deficiency to arise due to defective absorption although there is an adequate amount in the diet.

The N.R.C. recommended allowances for pregnant women have been criticized as being far too high a standard for this country. This survey bears this out. Although the group as a whole must be considered adequately nourished, not one of the subjects was able to reach this standard. This level is almost impossible to reach on present-day standards and as a practical standard it can have little value. The standard set up for sedentary women with certain modifications would appear to be much more related to the level which is likely to be obtainable in this country. Even so, only 16 % of the subjects reached this standard, the chief deficiency being in nicotinic acid. On this scale the recommended level of vitamin C (70 mg.) is considerably higher than that recommended by the League of Nations Committee (50 mg.).

The best diet that can be achieved on modern rationing is as follows. Amounts per week: milk, 180 oz.; cheese, 2 oz.; bacon, 1 oz.; sugar, 8 oz.; fats, 7 oz.; meat, 14 oz.; liver, 2 oz.; sausage, 2 oz.; bread, 77 oz.; potatoes, 72 oz.; vegetables, 28 oz.; fruit, 28 oz.; white fish, 7 oz.; herrings, 7 oz.; +points goods and the occasional egg, +vitamin supplements A, D and C. This would provide the following nutrient principles: calories, 2500; protein, 100 g.; 1·5 g. per kg. body weight. Calcium, 1·5 g.; iron,

15·0 mg.; vitamin A, 8000 units; vitamin D, 1100 units; vitamin C, 90 mg.; vitamin B_1, 1·5 mg.; riboflavin, 2·2 mg.; nicotinic acid, 14·0 mg. This is probably adequate in all respects. It could be bought for about 15*s.* to-day. Unfortunately it leaves little room for individual likes and dislikes; the full amounts of all foods must be taken. Vegetables and fruit cannot make good any deficit in the other items. Fat fish and offals are the only foods which could make up for deficiencies and which are unrationed. Offals are very difficult to get and it is usually necessary to queue for them. The herring is the one important food which can be bought off the ration and is easily available; it is rich in animal protein, calcium, iron, riboflavin, nicotinic acid and the richest source of vitamin D.

In the light of these observations the author feels that the following is a reasonable practical allowance for pregnant women. Such an allowance is possible on present-day rationing and, if provided, would be well above the average found in the group studied in this survey. It provides an allowance of nicotinic acid above the maximum found in the toxaemic group. Calories, 2500; protein, 1·5 g. per kg. body weight; calcium, 1·5 g.; iron, 15 mg.; vitamin A, 3500 units (pre-formed); vitamin D, 800 units; vitamin B_1, 1·5 mg.; riboflavin, 2·0 mg.; nicotinic acid, 14 mg.; vitamin C, 50 mg.

It will be necessary to supplement the diet in order to get sufficient vitamin D and desirable to provide extra orange juice.

The pregnant woman should have more natural foods in order to give a greater scope for individual likes and dislikes; at present her diet is adequate only if she takes all the items. There is always the danger of her extra rations being divided amongst the family, this is more likely in a large family.

If women do not take their full ration of bread, which is quite a lot to take, they will be getting less nicotinic acid and vitamin B_1. The Ministry of Food should endeavour to make available a greater amount of meat or offal in the ration of pregnant women, and endeavour to make available a full 2 pints of milk a day. The diet could be markedly improved by judicious advice and education; a tendency to eat large amounts of fruit was often responsible for a badly balanced diet at the expense of the other important protective foods.

The outstanding feature of the whole survey was the enthusiasm shown by the mothers for the experiment. Unfortunately it was not possible to use the results of the survey to correct and educate these women in their dietary habits, but if the survey had been carried out as part of the nutritional programme of a Public Health Department much valuable work could have been done in this respect. It shows also that enthusiasm is not enough, it must be supplemented by careful survey and skilled advice. Doctors generally are too busy to spend their time on detailed investigations over food habits and are often content to inquire about the intake of vitamin tablets and advise plenty of milk and fruit without inquiring whether the diet is adequately balanced. There is a tendency on the part of many women to think that the taking of vitamin tablets ensures a diet adequate in all respects; this is far from the truth.

An important function of Medical Officers of Health in future will be to conduct surveys on the health conditions of their area in order to ascertain what necessary action can be taken to improve health conditions. Much of that action will be in the form of health education and instruction. There can be no more important field than nutritional surveys in pregnancy as it has been abundantly shown how health in pregnancy is related to nutrition. Such surveys should form a routine part of the work of every public health department so that the Medical Officer of Health is constantly aware of the dietary habits of the differing social and economic groups of his area. At the same time much health education can be carried on in remedying the defects. A week's dietary survey would be a very fine start for all primiparae. She would immediately become interested in the question of nutrition and the person conducting the survey can show her where her diet is inadequate. Only in this way can women become aware of the requirements of pregnancy. Only by such methods can we eliminate the regrettable tendencies of some women of to-day who consider a diet adequate if it contains vitaminized margarine and vitamin tablets. The knowledge gained in a first pregnancy would be a good help in future pregnancies. We are far behind the U.S.A. in this respect and much of our education in nutritional matters is left to the proprietary firms. There is ample scope in all large authorities for the appointment of a trained dietitian to take charge of the detailed day to day organization of education in nutrition by posters, lectures, talks on the results of surveys and practical ways of remedying any deficiencies. A part of her work should consist in organizing nutritional surveys within the area in conjunction with the health visitors. This survey has shown very clearly that ignorance is now more important than poverty as a cause of a poor quality diet, it is even more essential therefore to increase our efforts in nutrition education. At present education in nutritional matters is far too haphazard.

There is accumulating evidence from the large-scale supplementing of diets (Peoples League of Health, Birthday Trust) that many hitherto resistant causes of maternal and infant mortality can be diminished by better nutrition. The suggestions made here are a practical way of bringing this about. This is a step forward in the direction of a policy that ensures that women will eventually get their essential

nutrients, not in the form of vitamin pills but in actual food. The need for education and guidance is even greater at the present time with rationing at a critical level and new food cuts being imposed. Unfortunately, at the present time an adequate diet in pregnancy can only be achieved by the use of supplements. The maintenance of adequate milk priorities for the pregnant woman and the continuance of the use of national flour have never been more important.

SUMMARY

An individual dietary survey of 111 primiparae was carried out in Bristol during 1947. Compared with a group studied by McCance in 1938, these women were getting twice as much milk, more bread, potatoes, vegetables and fish; they were getting less meat, butter and margarine. 84 % were taking supplements of vitamins A and D.

Compared with the N.R.C. standard for pregnant women the diets were very poor, not one reaching the standard. It is felt that the N.R.C. standard for pregnant women is set too high. Compared with the standard for sedentary women there were deficiencies in vitamins B and C, the most marked being in nicotinic acid (74 % of diets). As a group they appeared to be well nourished, only 8 % had a Hb below 80 % and only one a plasma protein below 5·5 g./100 c.c.; there were no stigmata usually attributable to nutritional deficiencies. The only complication of note was toxaemia, which occurred in 15 % of cases. The only deficiency in the diet common to all cases of toxaemia was in nicotinic acid. The mean intake of nicotinic acid was 2·0 mg. lower in the toxaemic group than the mean intake of nicotinic acid in the normal subjects. This difference was statistically significant. Evidence is presented which suggests that deficiency of nicotinic acid or vitamin B_6 may be a predisposing factor in the production of toxaemia of pregnancy. The main cause of defective nutrition appears to be ignorance and not lack of money, this is an additional reason for the promotion of an intensive nutritional education programme.

The appointment of dietitians to ante-natal clinics is stressed as an important step in promoting education in nutritional matters during pregnancy.

The use and abuse of recommended allowances in pregnancy is discussed and the following diet is suggested as a reasonable practical allowance for pregnant women: calories, 2500; protein, 1·5 g. per kg. body weight; calcium, 1·5 g.; iron, 15 mg.; vitamin A, 3500 units (pre-formed); vitamin D, 800 units; vitamin B_1, 1·5 mg.; riboflavin, 2·0 mg.; nicotinic acid, 14 mg.; vitamin C, 50 mg.

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