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# Diet in pregnancy

## 1. Dietary survey technique and the nutritive value of diets taken by primigravidae

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Despite extensive investigation it remains uncertain whether the diet taken by a pregnant woman exerts an important influence upon the clinical course and outcome of her pregnancy. Diametrically opposed results have been obtained from combined dietary and clinical surveys. For example, Burke, Beal, Kirkwood & Stuart (1943) found striking correlations between their dietary and clinical findings in a study of 'middle-class' American women, whereas McGanity, Cannon, Bridgforth, Martin, Densen, Newbill, McClellan, Christie, Peterson & Darby (1954) found none in a study of women of 'low to moderate' income in another area of the United States. It is difficult, from the published material, to decide which of these two findings is more likely to be 'true'. There is certainly no obvious reason to believe that both are wholly credible, and that two apparently similar populations behaved in completely different ways.

When, in 1949, it was decided to study the diets and clinical histories of pregnant women in Aberdeen, much thought was given to the questions of how to select a group of patients and how to determine the nutritive value of the diets they were taking. In principle, it was thought that the subjects should be as nearly as possible representative of a clearly defined population, and that food intakes should be determined by methods of proved accuracy. These principles are not readily combined in practice. Accurate weighing and measuring of food, which must for practical reasons

be undertaken in the field by the subjects themselves, calls for care, patience and not a little skill; therefore any sample which includes careless and unintelligent as well as conscientious and co-operative subjects will yield a corresponding number of inaccurate and incomplete records.

Preliminary investigations were made to find out, first, whether a survey technique not involving direct measurement can yield reliable quantitative dietary records; and second, whether the results of a survey lasting 1 week only can yield results broadly representative of the diets habitually taken during a longer period of pregnancy.

For the reasons given below, it was finally decided to study the diets of primigravidae by weighing (Leitch & Aitken, 1949–50) and to accept as inevitable that some subjects would not co-operate adequately. This paper describes and discusses the methods used and presents the findings as they relate to the social class of the subjects studied. Subsequent papers will amplify the dietary findings and will relate them to the clinical phenomena of pregnancy and childbearing. A preliminary account of some of the material was presented at a meeting of The Nutrition Society (Scottish Group) (Thomson, 1957).

## PRELIMINARY INVESTIGATIONS

*Weighed-diet surveys* v. *'recall' surveys.* It would seem axiomatic that, for the scientific determination of quantities, actual measurement must be used. Nevertheless, many workers have been quite content to estimate intake of food by the use of procedures in which no objective measurement is involved, the subjects merely being asked to record or to describe from memory their dietary habits and to assess the quantities without measurement. More or less elaborate methods of 'checking' may be used. Such procedures have been warmly defended by their users, for example, by Burke (1947*a*, *b*), but do not appear to have been tested under adequately controlled conditions. It seemed worth comparing directly the results of recall methods with those obtained by weighing and measuring.

The first trial in Aberdeen has already been briefly reported (Morrison, Russell & Stevenson, 1949). The food supplied to eight scientists living in a residential club was, unknown to them, carefully measured during 24 h, at the end of which they were individually asked to recall, in detail, what had been eaten. The questioning was undertaken by an experienced dietitian and food samples were provided so that subjects could demonstrate quantities, which were recorded in terms of household measures. The nutritive values were calculated from the measured quantities and from the recall estimations; the two sets of values were then compared. In brief, it was found that very few of these subjects, intelligent and accustomed in their daily work to quantitative procedures, could give an accurate account of what and how much they had eaten during the previous 24 h. A comparison of the weighed and the recall values showed agreement within pairs which was little better than could be achieved by pairing at random. Furthermore, the recall procedure resulted in underestimation on the average.

It might be argued that the scientists were less reliable as subjects than housewives would be in a trial of this kind; they did not choose and prepare the food and some

possibly scarcely noticed what they were eating. The next trial was therefore made on twenty pregnant women living at home, who were already co-operating satisfactorily in a weighed-diet survey (see below). In the middle of the survey week they were visited by the dietitian supervising them, and were asked to say from memory what had been eaten and recorded during the previous 24 h. The subjects seldom professed to remember the exact quantities measured and recorded, but illustrated amounts by the use of household measures and food samples. The recall record was fully analysed before the record of weighings for the same day was analysed. Finally, the weighed and the recall values were compared. It can fairly be assumed that the weighed record was reasonably complete and accurate; errors in the recall record therefore arose from defects of memory or from lack of precision due to the use of household measures to estimate quantities. The latter error was eliminated, so far as possible, by making a third analysis based on the foods listed on recall, but substituting quantities which the week's weighed record showed to be usual for each subject. The mean results for energy intake were as follows (those for nutrients were similar):

| | |
|---|---|
| Recall record (household measures) | 2140 Cal. |
| Recall record (weighed quantities) | 2435 Cal. |
| Weighed record | 2574 Cal. |

Thus, the recall record with quantities estimated from the household measures gave a mean result 17 % too low, and even after the quantities had been corrected the mean result was still 5 % low. Further analysis showed that in five out of the twenty records the recall (household measures) method gave a result at least 30 % too low, and that the size of the error tended to increase with the true calorie intake, that is, the subject with more to remember generally omitted more items on recall. In four pairs of records, the agreement was within 100 Cal. (less than 5 % error), but detailed inspection showed that it was to some extent fortuitous. Only one subject provided on recall a schedule which agreed exactly, so far as items were concerned, with what she had recorded at the time of weighing; in two other instances, there were several variations of detail though the final calorie values agreed closely; in the fourth instance, a complete meal was reported on recall which bore no resemblance to the meal actually taken, and investigation showed that the 'fictitious' meal had in fact been taken 2 days earlier.

These findings confirmed that the memory, being fallible, does not yield an accurate record of previous food habits, and that even aids to memory, such as demonstration food servings and household measures, do not permit a reliable estimation of food quantities. Furthermore, there is no reason to suppose that the errors involved are random in their effects. In our hands and those of Morrison *et al.* (1949) underestimation occurred on the average; but Bransby, Daubney & King (1948–9) found that the use of household measures led to overestimation. It was concluded that for reasonable accuracy the dietary survey of pregnant women must rely upon direct measurement.

*Generalization from the record of a survey lasting 1 week.* Owing to alterations in dietary habits at weekends, and for other reasons, it was considered that a diet survey

should cover at least 1 week. A longer period is certainly desirable, but is seldom acceptable to the subjects in view of the labour involved.

There is no doubt that, although under ordinary living conditions they are fairly stable, food habits are not exactly repeated from week to week (Yudkin, 1951). The question arises whether the weekly variation in the diet of a given subject is less than the variation between subjects. Extensive investigation of this question is obviously

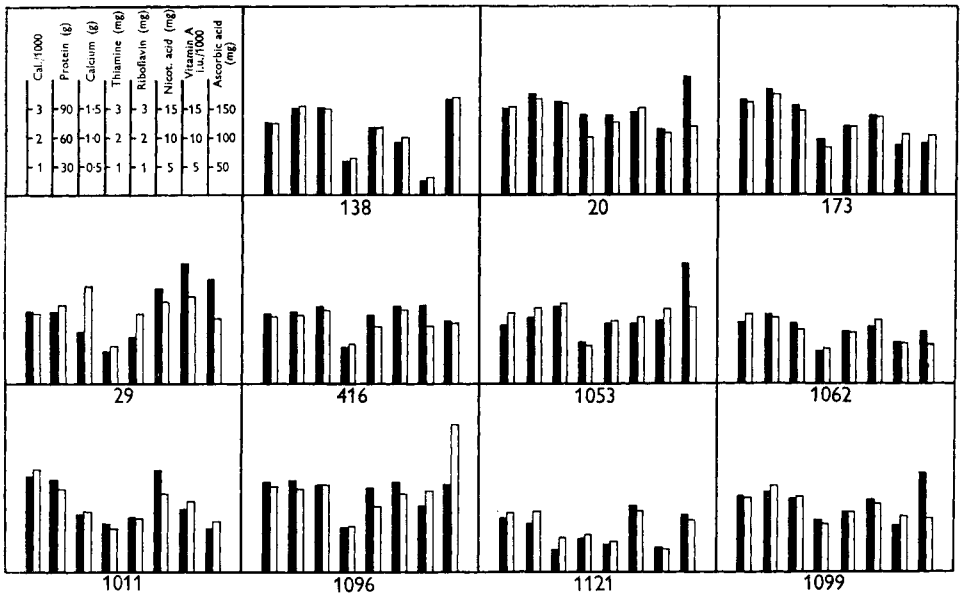


Fig. 1. Comparison of results for eleven subjects of pairs of diet surveys, the second survey being undertaken about 6 weeks after the first. The black columns show results in the first survey, the white columns the results in the second survey. The columns are identified and the scales shown in the top left-hand corner. Numbers below each set identify the subjects.

difficult. In the present survey, eleven subjects, all thought to have co-operated reliably in a 1-week weighing-inventory survey, were asked to undertake a second, similar, survey about 6 weeks later. Fig. 1 summarizes the results. It is immediately apparent that the 'profiles' of each pair of histograms are, in general, closely similar. Therefore, the diet of an individual appeared to retain its main nutritional characteristic in two widely separated weeks. If the two surveys are compared, the mean intakes of nutrients are shown to have changed but little (Table 1).

The problem was tackled also through ranking. If the values for any given nutrient are ranked in order of magnitude, and the order is similar when the first and the second surveys are compared, it is reasonable to believe that values for groups are likely to be reliable; group means are, of course, more stable than the results for individuals. The rank correlation coefficients of values for the 1st week against those for the 2nd week were as follows: calories, 0·90; protein 0·87; calcium, 0·69; vitamin A, 0·82; thiamine, 0·90; riboflavin, 0·54; nicotinic acid, 0·91; ascorbic acid, 0·68. These correlations are statistically significant ($P < 0{\cdot}02$) except that for riboflavin.

It can therefore be concluded that the relative position of the subjects in terms of intake of a given nutrient remained substantially unchanged over about 6 weeks. Those with high intakes tended to remain high, and those with low intakes low. Comparisons between groups based on the results of 1 week's survey are therefore unlikely to be seriously impaired by the results being uncharacteristic of the individuals in any given group. The same conclusion has been reached by Widdowson (1947) from a study of the diets of children.

Table 1. *Mean values for the daily intake of nutrients obtained in duplicate surveys of the eleven subjects shown in Fig. 1*

| | First survey | Second survey |
|---|---|---|
| Calories (Cal.) | 2628 | 2691 |
| Protein (g) | 83·7 | 84·0 |
| Fat (g) | 111 | 115 |
| Carbohydrate (g) | 346 | 352 |
| Calcium (g) | 1·22 | 1·16 |
| Vitamin A (i.u.) | 9892 | 8979 |
| Thiamine* (mg) | 1·54 | 1·47 |
| Riboflavin (mg) | 2·12 | 2·09 |
| Nicotinic acid (mg) | 13·9 | 12·5 |
| Ascorbic acid* (mg) | 140 | 121 |

* Not corrected for cooking losses.

## EXPERIMENTAL

### *Sampling procedure*

The study of a sample representing all pregnant women in a given population involves theoretical as well as practical difficulties. The diets of pregnant women, if they behave like family diets in general, deteriorate in nutritive value as the number of children in the family increases (Ministry of Agriculture, Fisheries and Food, 1956). But the clinical phenomena of pregnancy and childbearing do not show parallel deterioration: it is a commonplace of obstetrical experience, illustrated by the behaviour in relation to parity of National stillbirth statistics, that complications are more common in a first pregnancy than in the next two or three. Therefore, in a combined dietary and clinical survey, the data for different parity groups should not be treated together. Again, the co-operation by subjects in a dietary survey is likely to be more satisfactory with primiparae than with multiparae, who are more preoccupied with domestic responsibilities and less willing to accept the additional task of keeping special records.

For these reasons, the survey was restricted to women expecting their first babies. This decision also simplified the problem of sampling, since a higher proportion of primigravidae than of multigravidae arranged to have their confinement in institutions. In Aberdeen, primigravidae account for about one-third of all pregnant women and about 90% of them book for confinement in the Maternity Hospital. At the time of the survey these received antenatal medical supervision in one central clinic. Of the remainder, most were confined in one nursing home and were looked after privately by their family doctors or obstetrical specialists. About 2% of primigravidae were confined in their own homes under the domiciliary midwifery scheme. It was thought

that this last group could safely be ignored from the point of view of the survey. The first part of the survey was completed during 1950–1. Every sixth married primigravida giving an address in the city and attending the central antenatal clinic was selected at the time of booking. A random sample of the private nursing-home patients (mostly in the well-to-do classes) could not be arranged, but a high proportion of them was included with the permission of their family doctors.

After 2 years, a review of the data indicated that it would be desirable to increase the number from the poorer social classes, who took diets of inferior nutritive value and who also had inferior clinical records. During the years 1952–3, therefore, every booked hospital primigravida resident in the city with a husband in a semi-skilled or unskilled occupation (Registrar-General's Social Classes IV and V (General Register Office, 1951)) was selected for survey.

### *Timing of surveys*

Authoritative pronouncements on nutritional requirements during pregnancy suggest that additional needs are felt mainly during the later months ((U.S.A.) National Research Council: Food and Nutrition Board, 1953; British Medical Association: Committee on Nutrition, 1950). Dietary habits in early pregnancy may be altered by nausea or vomiting, and investigation may be complicated by the fact that many primigravidae remain in paid employment until about the 6th month. During the final month or two, pregnant women are liable to abnormalities which may prevent or interfere with investigation of diet. It was therefore decided, so far as possible, to make surveys in the 7th month of pregnancy.

### *Procedure*

During the course of the survey, there were several changes of dietetic staff. The original team of dietitians made a pilot survey during which the procedure described below was evolved. Dietitians joining the staff subsequently received training before beginning work.

Each subject was interviewed by a dietitian soon after booking at the antenatal clinic or at the private nursing home. A short diet history was taken but no dietary advice was given at this stage; patients asking for advice were told that after they had completed the survey they would be informed of any dietetic faults and advised accordingly. This was found to be a satisfactory means of arousing interest and improving co-operation. At the end of the interview the dietitian asked the subject to undertake a weighed survey at home.

On the 1st day of the survey week, the dietitian called at the subject's home by appointment, bringing with her a specially printed notebook, a sheet of instructions and two spring balances (one weighing up to 16 oz. in $\frac{1}{8}$ oz. divisions, the other weighing up to 14 lb. in 1 oz. divisions). The procedure was explained and demonstrated. Next day the dietitian called again and went over the 1st day's record, drawing attention to defects and giving such further advice as might be necessary.

At the end of the last day, a rapid review was made of all entries in the notebook, in the presence of the subject. Apparent errors were discussed and omissions were

corrected if possible. Back at headquarters, the notebook was again scrutinized for probable omissions or errors, such as, for example, a fried dish not including fat or an apparently excessive amount of fat; minor adjustments were made if feasible, e.g. by entering the quantities recorded by the same subject on another occasion or by assuming an average helping or meal. Difficulties of this kind were especially common in connexion with the records of meals taken away from home; but it was considered better to accept such difficulties than to ask patients to take all meals at home during the survey week.

During the pilot survey and the early months of the main survey, subjects were asked to record as much detail as possible: to weigh each ingredient separately before cooking; to weigh the pot with contents before and after cooking; and finally to weigh their own servings. In this manner, the weight of the serving could be related to its composition in terms of raw ingredients. Such intensive procedures are extremely laborious and the instructions were simplified after enough information had been collected to permit the construction of tables of food analysis incorporating data based on local recipes. Local firms co-operated by supplying information on the composition of prepared foods commonly purchased ready to eat. In subsequent surveys, subjects were asked to weigh food as served, and to record full details of the recipes used in the preparation of mixed dishes.

Inevitably, records were more carefully compiled by some subjects than by others. The final record was classified as 'reliable' if the notebook entries seemed to be acceptable as a *bona fide* complete and accurate record, requiring no adjustments or only very minor ones, or as 'doubtful' if many errors or omissions had to be dealt with on an arbitrary basis.

For reasons given below, the analyses of nutritive values derived from doubtful records were discarded in the end.

### *Calculation of nutritive values*

The detailed entries in the notebooks were tabulated on calculation sheets in which food items and quantities were listed in a standardized manner. Nutritive values were calculated throughout from a specially prepared table, derived from the tables of McCance & Widdowson (1946), the Medical Research Council: Accessory Food Factors Committee's (1945) *Nutritive Value of Wartime Foods*, and unpublished tables kindly provided by the Chief Scientific Adviser (Food) to the Ministry of Agriculture, Fisheries and Food. The last-mentioned were the sole source of values for riboflavin and nicotinic acid. Calorie values were calculated from the protein, fat and carbohydrate (monosaccharide) content of each diet, with the factors 4, 9 and 3·75 Cal./g, respectively. Carbohydrate values expressed as starch in certain tables were brought into line with those of McCance & Widdowson, expressed as glucose, by multiplying by 1·12.

The tables of McCance & Widdowson (1946) give extensive information, based on analyses, for cooked dishes, but the recipes cited frequently do not conform to practice in Aberdeen. It was therefore considered best to base all initial analyses on the nutritive value of 'edible portions of food as purchased'. Subsequently, the

values for ascorbic acid and for thiamine were corrected for cooking losses according to the procedure described by the Medical Research Council: Accessory Food Factors Committee (1945). That is, the total supply of thiamine was reduced by 15%; ascorbic acid from cooked green vegetables was reduced by 75% and from other cooked vegetables by 50%.

## RESULTS

### *Sampling*

The sampling procedure provided groups representative of each social class, but the aggregate was not representative of the total population of primigravidae from which the samples were derived, mainly because, in the second part of the survey, a very large group in Social Classes IV and V was deliberately selected.

Social classification was based upon husband's occupation. In presenting the results the Registrar-General's classification (General Register Office, 1951) has been modified as follows, in order to increase the numbers in the highest social category.

Class A: Registrar-General's Classes I and II (professional, managerial and generally well-to-do) and 'white-collar' occupations from Class III.

Class B: Registrar-General's Class III (skilled occupations, mainly manual) less 'white-collar' occupations.

Class C: Registrar-General's Classes IV and V (semi-skilled and unskilled manual occupations).

Table 2. *Social-class distribution of the subjects by husband's occupation, and result of diet survey*

| | Social class | | |
|---|---|---|---|
| Result of diet survey | A (non-manual) | B (skilled manual) | C (semi-skilled and unskilled manual) |
| | Number of subjects | | |
| 'Reliable' | 101 | 109 | 279 |
| 'Doubtful' | 4 | 27 | 134 |
| No data | 4 | 9 | 46 |
| Total | 109 | 145 | 459 |
| | Percentages | | |
| 'Reliable' | 92·7 | 75·2 | 60·8 |
| 'Doubtful' | 3·7 | 18·6 | 29·2 |
| No data | 3·7 | 6·2 | 10·0 |
| Total | 100·0 | 100·0 | 100·0 |

Of 729 subjects sampled, sixteen were rejected on medical grounds (nine twin pregnancies and seven pregnancies complicated by serious maternal disease, e.g. diabetes); in these, dietary habits as well as clinical patterns were likely to be exceptional. Table 2 shows the social-class distribution of the remaining 713 subjects, and the type of result obtained. The percentage of apparently reliable data fell from 93 in class A to 61 in class C. The attempt to make a weighed-diet survey failed altogether in 4% of class A subjects and in 10% of class C subjects. Table 3 summarizes the

reasons for failure in the fifty-nine subjects who failed to yield even doubtful data. Outright refusal to co-operate was uncommon, but several subjects excused themselves sooner or later on various grounds. In a similar number, the attempt had to be abandoned owing to illness or termination of pregnancy before the survey was complete. A few subjects kept records so badly that they were not even worth classifying as of doubtful value.

Table 3. *Reasons for failure of survey of the 'no data' subjects of Table 2*

| Reason | Social class A | B | C |
|---|---|---|---|
| Co-operation refused: | | | |
| Domestic difficulties | — | — | 3 |
| No specific reason | 2 | 4 | 12 |
| Records worthless | — | — | 5 |
| Late booking or failure to attend at clinic | — | 1 | 11 |
| Illness or premature delivery | 2 | 4 | 15 |
| Total | 4 | 9 | 46 |

It has been determined that the original samples closely resembled the social groups from which they were drawn in terms of age, height, general physical health and clinical outcome of pregnancy. The subjects yielding reliable dietary data were, on an average, slightly older, taller and healthier than the average of the original samples. Intelligence-test results available for some of the subjects (Scott, Illsley & Thomson, 1954) indicate that they were also more intelligent. Analyses of the clinical data showed that in social group C the reliable subjects experienced less prematurity and perinatal mortality than doubtful and no data subjects. Such clinical differences were much less evident in groups A and B.

### *Nutritive value of diets in each social class*

Table 4 summarizes the data for reliable subjects in each social class. It is evident (*a*) that the mean nutritive values diminish with falling social status, and (*b*) that in all social classes the variability between individuals, indicated by the quartiles and the standard deviations, is large. There is considerable overlap between classes. For example, 25% of subjects in class A had calcium intakes of less than 0·94 g daily and 25% of subjects in class C had intakes of more than 1·04 g.

Nutritive values for subjects yielding doubtful dietary-survey data were also calculated. The means obtained in each class were close to the means for reliable subjects, but the standard deviations were greater, usually to a statistically significant degree. It is impossible to decide the extent to which these results are real or are the result of the assumptions which had to be made in analysing the doubtful data. Many of the assumptions had to be based on experience with similar reliable subjects, which would tend to produce resemblance between means; at the same time errors of estimation might be increased, which would doubtless tend to increase variability. Our general impression, supported by the findings discussed under Sampling, is that the doubtful subjects were, on an average, socially, intellectually and clinically inferior to reliable

Table 4. *Mean values, medians, quartiles and standard deviations for daily intake of nutrients by each social class, for 'reliable' survey groups*

(Numbers of subjects are shown in Table 2)

| Social class | | Calories (Cal.) | Protein (g) | Animal protein (g) | Fat (g) | Carbo-hydrate (g) | Calcium (g) | Vitamin A (i.u.) | Thiamine (mg) | Riboflavin (mg) | Nicotinic acid (mg) | Ascorbic acid (mg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | Mean | 2633 | 80·4 | 46·7 | 111·6 | 348·8 | 1·19 | 9,858 | 1·22 | 2·05 | 12·0 | 79 |
| | Median | 2522 | 77·8 | 45·2 | 106·8 | 338·2 | 1·14 | 9,227 | 1·18 | 1·95 | 11·4 | 74 |
| | Q1 | 2301 | 66·6 | 36·9 | 93·5 | 306·6 | 0·94 | 7,102 | 1·05 | 1·64 | 10·0 | 55 |
| | Q3 | 2928 | 90·7 | 54·5 | 120·4 | 397·1 | 1·40 | 11,675 | 1·33 | 2·41 | 13·4 | 103 |
| | S.D. | 482 | 17·2 | 13·3 | 25·3 | 70·2 | 0·35 | 4,334 | 0·27 | 0·53 | 2·8 | 35 |
| B | Mean | 2521 | 78·4 | 44·3 | 108·3 | 328·7 | 1·06 | 8,085 | 1·18 | 1·89 | 11·4 | 65 |
| | Median | 2484 | 77·9 | 43·4 | 105·7 | 329·5 | 1·05 | 7,832 | 1·16 | 1·88 | 11·2 | 62 |
| | Q1 | 2181 | 69·1 | 36·1 | 91·1 | 281·8 | 0·84 | 5,208 | 1·00 | 1·58 | 9·7 | 44 |
| | Q3 | 2844 | 87·8 | 51·9 | 121·2 | 372·0 | 1·28 | 10,341 | 1·36 | 2·19 | 13·0 | 87 |
| | S.D. | 487 | 15·1 | 11·2 | 24·4 | 69·9 | 0·32 | 3,822 | 0·24 | 0·46 | 2·4 | 30 |
| C | Mean | 2354 | 71·8 | 40·4 | 99·9 | 311·5 | 0·88 | 7,545 | 1·16 | 1·74 | 11·6 | 61 |
| | Median | 2310 | 71·8 | 41·4 | 98·4 | 310·2 | 0·87 | 7,416 | 1·16 | 1·72 | 11·4 | 59 |
| | Q1 | 2022 | 62·2 | 33·0 | 83·0 | 255·4 | 0·68 | 5,081 | 1·00 | 1·44 | 9·6 | 39 |
| | Q3 | 2675 | 79·8 | 52·0 | 111·7 | 359·3 | 1·04 | 9,538 | 1·30 | 1·97 | 13·1 | 77 |
| | S.D. | 513 | 15·7 | 11·1 | 24·2 | 75·5 | 0·29 | 3,523 | 0·26 | 0·47 | 2·8 | 29 |

subjects, and that their diets also tended to be somewhat inferior. If this impression is correct, the agreement between the means for reliable and doubtful subjects in each class is artificial, and the slope of the social gradients shown in Table 4 is underestimated owing to progressively more frequent omission of subjects with inferior diets at the lower end of the social scale.

### *Nutritive values in relation to requirements*

The primary object of this survey was to obtain data with which the clinical course of pregnancy could be compared. This comparison will be made in a subsequent paper. Meanwhile, it is of interest to compare the diets of reliable subjects with the conventional recommended allowances for pregnant women. The standards most commonly used in Britain are those proposed by the British Medical Association: Committee on Nutrition (1950). Table 5 shows the percentage of reliable subjects in each social class whose intake of each nutrient was less than the allowance recommended. It is apparent that a high proportion of diets was below standard in one or more respects.

Table 5. *Percentage of 'reliable' subjects in each social class whose diets failed to attain the allowances recommended by the British Medical Association: Committee on Nutrition* (1950) *for women in the second half of pregnancy*

| | Social class | | |
|---|---|---|---|
| Standard | A | B | C |
| Calories, 2750 Cal. | 64 | 72 | 82 |
| Protein, 96 g* | 83 | 85 | 92 |
| Calcium, 1·5 g | 83 | 91 | 96 |
| Vitamin A, 6000 i.u. | 18 | 29 | 36 |
| Thiamine, 1·1 mg | 34 | 43 | 47 |
| Riboflavin, 1·6 mg | 22 | 28 | 39 |
| Nicotinic acid, 11 mg | 43 | 48 | 45 |
| Ascorbic acid, 40 mg | 9 | 18 | 27 |

* The allowance recommended is 14% of calories in the form of protein. The standard of 96 g is based on this proportion and the conversion factor 4 Cal./g.

## DISCUSSION

### *Dietary survey technique*

Although the weighing-inventory method is applied routinely on a National scale in Britain to family food surveys, it has not been widely used in studies of diets taken by individuals living under ordinary home conditions. I could trace only three reports on the diets of pregnant women assessed by this method (McCance, Widdowson & Verdon-Roe, 1938; Roscoe & McKay, 1946; Hobson, 1948); in none were formal sampling methods used, and the failures, if any, are mentioned only in passing.

Precise evaluation of the chemical composition of diets eaten by experimental subjects is possible only under laboratory conditions and is difficult even then. Data obtained in the field, even under the most favourable circumstances, are unavoidably less accurate. The less exacting the field technique, the greater the inaccuracy. Measure-

ments made in the field should yield data of sufficient accuracy for many purposes, but can be obtained only with the co-operation of reasonably intelligent subjects, so that in most random samples a proportion of failures is to be expected. Some sort of result may be obtained from most subjects, with methods that avoid measurement; but large numbers of inaccurate estimates are no substitute at all for a few accurate measurements. The means obtained from simplified survey procedures may be misleading because the errors of estimation are not necessarily random, and estimates of variance may be grossly misleading. The daily calorie intakes recorded in this survey ranged from little more than the probable basal energy expenditure to about 4000 Cal.; the reality of such extremes becomes credible only if the method of assessment is unlikely to have resulted in serious under- or over-estimation.

There is, at present, no completely satisfactory field technique that can be applied on a large scale, and it is doubtful whether one will ever be devised. Judging by the results of this study, there is no substitute for measurements, but if measurement must be left to inexpert subjects failures have to be expected; and such failures are not random. There seems to be no escape from the dilemma, but in practice it is preferable to accept measurements made with an approach to accuracy by a proportion of the subjects in a given sample than unmeasured 'quantities' derived from every person in a sample.

### *Analysis of food records*

Direct chemical analysis of duplicate servings being almost impossible in a field survey, reliance must be placed on tables of food composition. These should give results approximately correct for raw foods, less so for cooked foods in which recipes and losses vary widely. It was for this reason that it was decided to base primary analyses on nutritive values of foods as purchased, and on local recipes for mixed dishes translated into the nutritive value of raw ingredients. Under these conditions, the values for nutrients not subject to serious loss during preparation and cooking should be fairly reliable. Corrections for cooking losses (here applied to thiamine and ascorbic acid only) are unavoidably crude and values for nutrients subject to such losses may be considerably in error.

### *The social-class gradient in the nutritive value of diets*

It was noted above that the bias introduced by the loss of a high proportion of subjects, especially in social class C, probably caused the social gradients shown in Table 4 to be less steep than they are in reality.

The meaning of the social-class gradient in mean nutritive values is not easy to determine. The gradient in calorie intakes may to some extent reflect differences of body size and activity; the subjects in class C were smaller and lighter on average than those in the higher classes and also had fewer domestic responsibilities and lower standards of housewifery. The housing of Aberdeen primigravidae has been described by Thompson (1954). Since the amounts of nutrients in any given diet are intercorrelated, a reduction of calorie intake will automatically tend to be accompanied by a reduction of the intake of most nutrients.

These problems will be considered in further papers. Meanwhile, it can be said

that diets in social class C are not the same as in social class A, only smaller in amount. Apart from nutritive values, the eating habits and meal patterns show distinct differences between classes.

Perhaps the most striking feature of Table 4 is the great variability of intake of any given nutrient in any given social class. If the degree of variation represents mainly true variations between the nutritive values of diets taken habitually in the later part of pregnancy, then there should be plenty of scope for demonstrating correlations, if such exist, between the clinical outcome of pregnancy and the nutritive value of the maternal diet.

*Intakes in relation to requirements*

Table 5 indicates that a high proportion of subjects, even in social class A, was taking nutrients in amounts less than those recommended by the British Medical Association: Committee on Nutrition (1950). It would, of course, be wrong to conclude that the percentages shown in the table indicate the proportions of truly 'deficient' diets. The physiological significance of the standards remains to a large extent speculative, but they, nevertheless, have validity as targets which, in broad socio-medical terms, are safe and desirable (Thomson, 1955, 1956); the values in Table 5 show that relatively few diets were manifestly adequate in terms of current targets for 'optimum' nutrition in the community. In Table 4, the Q1 line for social class C, indicating the levels below which one-quarter of the subjects in that class fell, can scarcely be regarded as satisfactory even on the basis of 'minimum nutrition'. The energy intake (about 2000 Cal.) is barely sufficient for a non-pregnant woman doing light work. The calcium intake (about 0·7 g or less) may be barely sufficient for metabolic equilibrium. It therefore appears that a *prima facie* case can be made out that a fairly high proportion of the diets investigated was such that clinically undesirable consequences during pregnancy might reasonably be expected. But, as Thomson (1959) shows, this first impression is to some extent misleading.

*Comparisons from the literature*

Much has been written about diet in pregnancy but most of it is descriptive only, in terms of foods eaten or not eaten, or of the percentage attained of allowances or requirements on some approved standard. The number of surveys is small in which the composition of even the average diet of a group is given in absolute terms. Some mean values are given in Table 6. The report of McCance *et al.* (1938) is the only one that draws special attention to a social gradient in the nutritive value of diets. Their survey was made about the time of the industrial depression of the 1930's, and it is scarcely surprising that the means for wives of unemployed men were lower than those found among the poorest classes in Aberdeen nearly 20 years later. On the other hand, the diets of the wives of the professional and artisan classes appear to have been broadly similar to those found in Aberdeen. The Edinburgh and Bristol surveys (Roscoe & McKay, 1946; Hobson, 1948) gave results also broadly similar to those of the Aberdeen survey, but the protein intakes reported are higher. The Aberdeen data agree well with the results of chemical analysis of the diets of Iowa housewives (Coons, 1933–4). Records made without direct measurement, summarized in the

Table 6. *Mean daily intake of nutrients by pregnant women in different surveys*

| Place | Subjects | Calories (Cal.) | Protein (g) | Calcium (g) | Vitamin A (i.u.) | Thiamine (mg) | Riboflavin (mg) | Nicotinic acid (mg) | Ascorbic acid (mg) | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Chemical analysis of duplicate servings | | | | | |
| Chicago and Oklahoma | 15 housewives | 2497 | 70 | 1·25 | — | — | — | — | — | Coons, 1933–4 |
| | | | | | Dietary record, quantities weighed | | | | | |
| England and Wales | 26 professional class | 2498 | 80 | 0·90 | — | — | — | — | — | McCance *et al.* 1938 |
| | 21 artisan class | 2700 | 82 | 0·80 | — | — | — | — | — | |
| | 20 wives of employed labourers | 2389 | 73 | 0·60 | — | — | — | — | — | |
| | 32 wives of unemployed miners in Gateshead | 2138 | 66 | 0·60 | — | — | — | — | — | |
| | 21 wives of unemployed miners in Wales | 2081 | 54 | 0·50 | — | — | — | — | — | |
| | 16 poorest group | 2211 | 60 | 0·50 | — | — | — | — | — | |
| Edinburgh | 35 housewifes. Husbands in Armed Forces or skilled artisans | 2550 | 91 | — | — | — | — | — | 29–56 | Roscoe & McKay, 1946 |
| Bristol | 111 primigravidae, 'better type of woman in poor and middle classes' | 2400 | 90 | 1·20 | 7600 | 1·25 | 1·70 | 10·0 | 81 | Hobson, 1948 |
| Aberdeen | 489 primigravidae: | | | | | | | | | |
| | 101 in social class A | 2633 | 80 | 1·20 | 9900 | 1·22 | 2·05 | 12·0 | 79 | Present study |
| | 109 in social class B | 2521 | 78 | 1·10 | 8100 | 1·18 | 1·89 | 11·4 | 65 | |
| | 279 in social class C | 2354 | 72 | 0·90 | 7500 | 1·16 | 1·74 | 11·6 | 61 | |
| | | | | | Dietary record, quantities in household measures | | | | | |
| Philadelphia | 382 white and 132 negro clinic and private patients | 2013 | 66 | 0·70 | 2700 (median) | 1·02 (median) | 1·30 | — | 53 (median) | Williams & Fralin, 1942 |
| Tennessee | 2046 hospital patients, low to moderate income, 3rd trimester of pregnancy | 2020 | 70 | 1·00 | 5900 (median) | 1·40 | 2·30 | 11·0 | 55 (median) | Darby *et al.* 1953 |
| Mexico City | 101 women, low economic status | 2114 | 72 | 0·78 | 4750 | 1·33 | 1·17 | 8·6 | 49 | Anderson, Robinson Calvo & Payne, 1946 |
| | | | | | Dietary history or questionnaire or both | | | | | |
| Glasgow | 100 women, low economic status with full-term infants | 1946 | 72 | 1·22 | — | — | — | — | — | Cameron & Graham, 1944 |
| Iowa | 62 students' wives | 2535 | 75 | 1·14 | 9000 | 1·76 | 2·18 | — | 97 | Jeans, Smith & Stearns, 1952 |
| | 288 wives of labourers | 2463 | 60 | 0·53 | 6400 | 1·58 | 1·46 | — | 73 | |
| New York | 38 white and 32 negro women, with full-term infants | 2520 | 91 | 1·43 | 6700 | 1·50 | 2·70 | 11·6 | 112 | Speert, Graff & Graff, 1951 |
| Holland | 270 women, mostly rural, in mid-pregnancy | 2770 | 78 | 0·98 | 1640* | 1·38 | 1·57 | 14·0 | 114 | den Hartog, Posthuma & de Haas, 1953 |

* Not including 2100 mg carotene.

two lower sections of Table 6, vary widely, probably more on account of errors of estimation than of real differences. It should be noted that three of the questionnaire or diet-history surveys (Cameron & Graham, 1944; Jeans *et al.* 1952; Speert *et al.* 1951) appear to have been made retrospectively, i.e. referring to pregnancy but made at or after the end of pregnancy.

The values for ascorbic acid in Table 6 must be interpreted with special caution, since it is often not clear from the reports whether the data have been corrected for cooking losses and, if so, by what method.

Only Darby, McGanity, Martin, Bridgforth, Densen, Kaser, Ogle, Newbill, Stockell, Ferguson, Touster, McClellan, Williams & Cannon (1953) appear to have related their data to the trimester of pregnancy in which the survey was made; Table 6 gives their data for the final trimester. The results in the first two trimesters are slightly higher; the mean daily calorie intake in the first trimester is reported as 2140 Cal. and in the second as 2200. It can be said, at least, that there is no evidence of any marked increase of appetite during late pregnancy, as might be inferred from accepted standards of energy requirements during pregnancy. Clinical experience in Aberdeen shows that the healthy primigravida experiences a surge of appetite about the end of the first trimester, sometimes following, or even concurrent with, nausea and vomiting. Appetite may decline a little in late pregnancy, possibly in association with some restriction of activity.

The large variation between the diets of individual pregnant women found in the present survey confirms previous findings. The reports of Coons (1933–4) and of McCance *et al.* (1938) give data for individuals; those of Hobson (1948), Darby *et al.* (1953) and Jeans *et al.* (1952) give standard deviations; and those of Roscoe & McKay (1946) and Speert *et al.* (1951) give maxima and minima. It seems clear that patients differ widely in the amounts and nutritive values of the diets they take during pregnancy. The question is whether these variations have any clinical significance.

## SUMMARY

1. Preliminary investigations indicated that, in a dietary survey, reliable quantitative data can be obtained only by weighing, and that the results of weighing-inventory surveys vary less from week to week in individuals than they do from individual to individual.

2. The methods used in an individual weighing-inventory survey of primigravidae are described and discussed.

3. Apparently reliable data were obtained from 93% of 101 subjects in social class A (husbands in non-manual occupation), 75% of 109 subjects in social class B (skilled manual occupations), and 61% of 495 subjects in social class C (semi-skilled and unskilled manual occupations). Reasons for failures to obtain reliable data are discussed.

4. The mean nutritive values of diets in each social class showed an obvious downward gradient from class A to class C. It is thought that the gradient has been underestimated owing to the progressively higher rates of failure to obtain reliable data as social status diminishes. There was considerable overlap of nutritive values between classes.

5. A comparison of the survey data with the recommended allowances of the British Medical Association: Committee on Nutrition (1950) for late pregnancy indicates that many diets, especially in social class C, did not attain the recommended values.

6. The findings are compared with those in the literature.

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