TB 8 (1927) USDA TECHNICAL BULLETINS
DIETARY SCALES AND STANDARDS FOR MEASURING A FAMILY'S NUTRITIVE NEEDS
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UPDATE
1 OF 1
NEED OF A STUDY OF DIETARY SCALES AND STANDARDS

Records of the cost of living have been collected from about 4,300 farm families during the last six years by the Bureau of Agricultural Economics and Home Economics. From the food-consumption data which appear on these schedules in considerable detail, it seemed that much might be learned about the farm families' habits, such as the kinds of food consumed and the adequacy of the diet. A study of this kind was, therefore, undertaken in the Bureau of Home Economics. In working out the method of analysis the need of an investigation of the various points involved became apparent.

In analyzing a diet for its adequacy it is necessary to know two things—(1), how much of the various nutrients a family needs for its health and proper development, and (2), whether the food that is consumed supplies the necessary nutrients in adequate quantities. The quantity that a family needs is usually computed by the use of a dietary scale, together with the standard on which it is based, and the amount of nutrients supplied by the food is ascertained by the use of average composition figures for food, such as those compiled by Atwater and Bryant (3) and Sherman (29).
The United States Bureau of Labor Statistics, for example, in planning a quantity and cost budget (37) assumed that a family of five, consisting of a man, a woman, and three dependent children, 11, 5, and 2 years old, was typical of the group for whom the budget was designed. By the use of a dietary scale and standard the energy need of this family was calculated as equivalent to that of 3.35 adult-male units, or 11,780 calories per day. By the use of average food-composition figures the food suggested in the budget is found to provide an energy allowance of about 11,800 calories per day. A comparison of this figure with the family's estimated need shows that the diet is adequate to meet its energy requirement. In the discussion that follows, the relation between the two aspects of the problem dealing with nutritive need and food consumption should be kept clearly in mind.

Although such an analysis seems simple, questions may arise at every step, and decisions must be made. For instance, in calculating the nutritive factors contained in the food consumed one may ask whether the average composition figures fit the data fairly closely or whether the deviation of the foods under consideration from the average is great, and if so, how great it is. Such questions, however, belong to the second phase of the problem, which deals with the nutritive value of the food consumed, and will not be discussed in this bulletin. Here the first aspect, that of estimating the family's nutritive need, will be emphasized, and the first problem that arises in this study is the choice of a suitable dietary scale and standard for calculating the nutritive requirements of a family.

Five such scales and standards have been proposed in the United States, and four of them have been rather widely used not only here but also in Great Britain and other European countries. A study of these scales and standards and the use that has been made of them opens many questions that need answering. For example, are the differences that appear in dietary studies caused by the scales that were used for calculating the family's energy need, or were there real differences in food consumption among the groups studied? If the differences are due to the scales that were employed, is it possible to find suitable corrective factors which may be used to make the results from the various studies comparable? In some of them allowance is not made for unusual activity in the adult. Does this mean that in such a family when the nutritive need is just met the woman and children may, in reality, be undernourished because of the greater need of the man? The fact that each scale is based on a definite dietary standard has been disregarded by some of the investigators, and in consequence they have called diets adequate which may have been decidedly inadequate. Can such results be compared with those obtained by the correct use of a dietary scale? The five scales that have been proposed are based on energy requirements alone. They have been used also to calculate the protein and mineral needs of a family. Are we justified in assuming that the needs of children for these nutrients vary according to sex and age in the same proportion that the energy need varies, or is a separate scale needed for measuring the protein and mineral requirements of children?

Food-consumption studies in considerable number are either already in progress or in the course of preparation. Before any more
food data are collected and analyzed, however, it is essential that a
study be made of these questions. It is the purpose of this bulletin
to try to clarify some of the problems that are connected with the
use of dietary scales and standards in determining the nutritive need
of a family.

DIETARY SCALES AND STANDARDS DEFINED

The terms “dietary scales” and “dietary standards” are some-
times used interchangeably. In this bulletin, however, a distinction
is made between them. A dietary standard is regarded as having a
definite value. For instance, the statement that a man’s protein
requirement is 70 grams per day, or a woman’s 60 grams per day, is
referred to as a dietary standard. In a dietary scale, on the other
hand, the nutritive need is expressed relatively, usually in terms of
man’s requirement. That is, the statement that the average woman
requires 0.8 as much food as the average man, or that a family’s need
is equivalent to that of 3.3 adult-male units, is arrived at by the use
of a dietary scale. In making such a statement, however, it should
be recognized that each dietary scale is based on a definite dietary
standard and that each figure, therefore, has a definite value.

The term “adult-male unit,” which is frequently used in dietary
studies, means that the nutritive need of the individuals making up
the family has been reduced to a common base and that man’s
standard has been taken as the unit of measurement. A food-con-
sumption figure per man expresses the same idea.

DESCRIPTION OF ENERGY SCALES AND STANDARDS

In the evolution of dietary scales different units have been used.
The earliest investigators considered the needs of two children as
equal to those of one adult, which they regarded as their unit. From
this beginning two methods have developed. In 1886 Atwater, an
American scientist, worked out a dietary scale based on the standards
proposed by German scientists. He used the need of the adult male
as his unit and expressed the need of other individuals in terms of
that unit. This scale was first published in a report made by the

Nine years later Engel (8, p. 5), a Saxon statistician, chose the
infant during the first year as his unit, which he called “quet,” and
calculated on the basis of height-weight statistics that an increase
of one-tenth over the demands for the first year was needed for each
additional year. The adult requirement, which, according to Engel,
is reached at 20 years by the woman and at 25 by the man, is 3 and
3.5 quets, respectively. This method of expressing a dietary scale has
not been so generally followed as the one suggested by Atwater.

When Atwater, 41 years ago, undertook the study of American
food habits he saw the necessity of simplifying the process of
analysis as much as possible. The problem is stated thus (19, p. 266):

If . . . we could take a particular class, as laboring men at moderate work,
and find to how many average men of this class the people nourished by each
dietary would be equivalent in their demands for nutrients, we should simply
have to divide the total quantity of nutrients supplied per day by this equiva-
\*lent number of men to get the quantities per man per day.
Results obtained in this way may be easily compared with each other or with a standard for measuring adequacy. He therefore took the energy standard which had been worked out by Voit, a German scientist, and by interpolating an assumed value for children from 2 to 6 years of age, stated it in terms of man's need. The two statements of energy requirements are shown in Table 1 (19, p. 287):

<table>
<thead>
<tr>
<th>Members of family</th>
<th>Voit's standard</th>
<th>Atwater's scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calories per day</td>
<td>Relative quantities of potential energy</td>
</tr>
<tr>
<td>Laboring man at moderate work</td>
<td>3,055</td>
<td>18</td>
</tr>
<tr>
<td>Woman at ordinary work</td>
<td>2,424</td>
<td>9</td>
</tr>
<tr>
<td>Child, 2 to 6 years</td>
<td>1,942</td>
<td>5</td>
</tr>
<tr>
<td>Child, to 114 years</td>
<td>707</td>
<td>5</td>
</tr>
</tbody>
</table>

After studying the dietary habits of more than 100 American families Atwater expanded and revised his scale and increased the energy standard from 3,055 calories per man per day to 3,400 calories. He states the factors used in calculating the meals consumed in dietary studies as follows (2, p. 33):

- Man at hard muscular work requires 1.2 the food of a man at moderately active muscular work.
- Man with light muscular work and boy 15 to 16 years old require 0.9 the food of a man at moderately active muscular work.
- Man at sedentary occupation, woman at moderately active work, boy 13 to 14, and girl 15 to 16 years old require 0.8 the food of a man at moderately active muscular work.
- Woman at light work, boy 12, and girl 13 to 14 years old require 0.7 the food of a man at moderately active muscular work.
- Boy 10 to 11 and girl 10 to 12 years old require 0.6 the food of a man at moderately active muscular work.
- Child 6 to 9 years old requires 0.5 the food of a man at moderately active muscular work.
- Child 2 to 5 years old requires 0.4 the food of a man at moderately active muscular work.
- Child under 2 years old requires 0.3 the food of a man at moderately active muscular work.

The former Office of Home Economics in cooperation with the Bureau of Labor Statistics suggested a slight modification of this scale which provided for more liberal food allowances for the boy 13 to 14 years old and the girl 15 to 16 years old (36, p. 1073), but since the scale as given by Atwater is the form commonly used it is the one included in this study.

At the same time that the United States Department of Agriculture, under the direction of W. O. Atwater, was making dietary studies, the United States Department of Labor, under the direction of Carroll D. Wright, was making surveys of the cost of living. Although Wright had worked with Atwater in Massachusetts and was apparently familiar with the dietary scale that he was using, the United States Department of Labor in analyzing the food data that it collected proposed quite a different scale and has used it rather consistently ever since (35, p. 621). It is shown in Table 2.
The United States Commissioner of Labor made the statement in his eighteenth annual report that "the relative consuming powers of the different members of the normal families were estimated after careful comparison and study" (34, p. 19), but he does not say what data were used for comparison and study. There is evidence, however, that this scale was designed primarily for measuring relative food expenditures, but since it has been used so generally in studies of nutritive value it seems desirable to include it in this study of dietary scales. In most of the studies made in the Department of Labor this scale was used for the purpose of reducing the quantity of each foodstuff consumed and the expenditure for food to a common base—the adult-male unit. The standard on which it is based was not indicated, therefore, until in 1919 the Bureau of Labor Statistics, in using it to plan a quantity-and-cost budget for a family of five, stated that an allowance of 3,100 to 3,200 calories per man per day was made (37, p. 15).

During the years 1886 to 1915 the study of nutritional problems went on apace, and considerable work was done to throw light on nutritive needs. Because of this fact and because dietary scales had been used inconsistently by some investigators and social workers in calculating the nutritive requirements of the various members of the family, Sherman thought it essential that the accumulated data on energy needs of children be assembled and expressed in calories instead of in per cent of man's need. He says in the introduction to Gillett's study (9, p. 3):

In computing the food requirements of family groups, it has been customary to regard the man as the unit and assume that the food of each child may be represented by some appropriate fraction of the food of the father. This practice naturally arose from the fact that the food requirements of men had been longer studied and were better known than those of children, few investigations having been made upon children by accurate laboratory methods until within comparatively recent years.

But * * * the food requirement of a man varies so greatly, according to his occupation, that it seems hardly logical to make this the basis for estimating the dietary needs of a family. Thus a carpenter may require 3500 calories per day; a tailor, 2500; a 14-year-old son of either of these men, 2800 calories. With the carpenter as the unit, the boy's requirement would be represented by 0.8 of that of the father; but with the tailor as the unit, the allowance of 0.8 would obviously provide far too little food for the boy's needs. The Atwater dietary standards for children were stated as decimal fractions of the requirement of a man at moderately active muscular work, such as a carpenter requiring 3400 or 3500 calories.

In practice, the dietitian who makes use of these decimal fractions in computing the food requirements of the family, finds it difficult to avoid the tendency to reckon the child's food requirement according to that of the father, which works serious injustice to the child if the father have a low food
requirement because of being engaged in an occupation which does not involve active muscular work. Obviously, it is equally inaccurate to assume that the needs of all men are nearly the same, in order that the allowances for the children may approximate uniformity. In our opinion the food requirement of each member of the family should be determined on his own merits rather than in terms of the man's requirement.

As a result of the need of further study pointed out by Sherman, Gillett brought together all the dietary studies and metabolism and respiration experiments that contained data on the energy requirements of healthy children. On the evidence presented by 564 studies she proposed the standards shown in Table 3 (9, p. 8).

Table 3.—Food allowances for children, recommended by H. C. Sherman and L. H. Gillett

<table>
<thead>
<tr>
<th>Ages of members of family (years)</th>
<th>Calories needed per day by</th>
<th>Ages of members of family (years)</th>
<th>Calories needed per day by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------</td>
<td>-----------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Under 2</td>
<td>900 to 1,200</td>
<td>900 to 1,200</td>
<td>1,700 to 2,000</td>
</tr>
<tr>
<td>2 to 3</td>
<td>1,000 to 1,300</td>
<td>960 to 1,200</td>
<td>1,650 to 1,850</td>
</tr>
<tr>
<td>3 to 4</td>
<td>1,100 to 1,400</td>
<td>1,000 to 1,300</td>
<td>1,750 to 2,050</td>
</tr>
<tr>
<td>4 to 5</td>
<td>1,200 to 1,500</td>
<td>1,140 to 1,440</td>
<td>2,000 to 2,300</td>
</tr>
<tr>
<td>5 to 6</td>
<td>1,300 to 1,600</td>
<td>1,250 to 1,550</td>
<td>2,250 to 2,550</td>
</tr>
<tr>
<td>6 to 7</td>
<td>1,400 to 1,700</td>
<td>1,320 to 1,620</td>
<td>2,500 to 2,750</td>
</tr>
<tr>
<td>7 to 8</td>
<td>1,500 to 1,800</td>
<td>1,380 to 1,680</td>
<td>2,700 to 3,000</td>
</tr>
<tr>
<td>8 to 9</td>
<td>1,600 to 1,900</td>
<td>1,450 to 1,750</td>
<td>2,900 to 3,200</td>
</tr>
</tbody>
</table>

In 1917 the interallied conference held in Paris directed that an interallied scientific food commission be appointed to place the provisioning of the allied countries on a sound scientific basis. One of the first steps in the problem was to ascertain just how much food each country needed, and in order to do so the population had to be reduced to a common base. This involved the adoption of a suitable dietary scale for making the calculation, and to Graham Lusk, of the United States, was intrusted the task of choosing a scale. Using the results of the most recent and authentic work on energy metabolism, he drew up the following energy scale, which is based on a standard of 3,000 calories per man per day for food as eaten, or 3,300 calories for food as purchased (18, p. 716):

<table>
<thead>
<tr>
<th>Age group</th>
<th>Energy standard (calories per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult male</td>
<td>1,000</td>
</tr>
<tr>
<td>Adult female</td>
<td>0.85</td>
</tr>
<tr>
<td>Boys 14 to 18</td>
<td>1.00</td>
</tr>
<tr>
<td>Girls 14 to 18</td>
<td>0.83</td>
</tr>
<tr>
<td>Children 10 to 13</td>
<td>0.83</td>
</tr>
<tr>
<td>Children 6 to 9</td>
<td>0.70</td>
</tr>
<tr>
<td>Children under 6</td>
<td>0.50</td>
</tr>
</tbody>
</table>

He states that the data used in preparing this scale may be classified thus (77, p. 821):

1. **Absolutely accurate.**—Basal metabolism of all ages and sexes, and the increase in metabolism due to (a) standing, (b) walking, (c) carrying a load.
2. **Approximately accurate.**—Metabolism in industrial pursuits.
3. **Hypothetic.**—Metabolism of children during exercise.

Holt in a series of lectures in 1921 proposed the energy standard shown in Table 4 (18, p. 84).
In deriving these figures Holt took into account the child's energy needs for basal metabolism, growth, activity, and losses in excreta. He used Benedict and Talbot's data for calculating basal metabolism. For ascertaining growth needs he followed the method proposed by Rubner, who estimated that about 80 calories a day are needed to increase the weight of the body 1 kilo in one year (13, p. 54). From his own studies he estimated that the loss of calories in excreta amounts to 10 per cent of the food intake for children of all ages after infancy. It was more difficult to arrive at suitable figures for activity, but he based his estimates chiefly on the work of Lusk and the dietary study made by Gephart at St. Paul's School at Concord, N. H. After arriving at the above values he tested them by collecting food-consumption data for more than 100 healthy, normal children from 1 to 16 years of age and found that his figures agreed rather well with the average for the various age groups.

COMPARISON OF ENERGY SCALES AND STANDARDS

Different methods of expressing energy need have been used in the construction of the five scales and standards presented above. In Holt's (13) and in Sherman and Gillett's (30) standards, for instance, the energy allowance for each year up to the end of the growth period for both boys and girls was calculated, and the requirement was expressed in calories. Atwater, Lusk, and the Department of Labor, on the other hand, estimated the average requirement over a period of years and expressed this as a percentage of man's need.

The age groups chosen for the three scales do not agree, however. Atwater (2) gave values for the following age groups: 15 to 16, 13 to 14, for both boys and girls; 10 to 12 for girls; 12 and 10 to 11 for boys; 6 to 9, 2 to 5, and under 2 for children of both sexes. Lusk
made the following divisions: 14 to 18 for both boys and girls; 10 to 13, 6 to 9, and under 6 for children of both sexes. The Department of Labor (33) divided the ages as follows: 11 to 14, 7 to 10, 4 to 6, and under 4, making no distinction in sex.

As the figures suggested by the various authors stand, it is obviously impossible to make a satisfactory comparison of the five dietary scales and standards, and to overcome this difficulty the writer has expressed all of them in calories for each year until the end of the growth period. The figures, as given in Table 6, are obtained from Figure 1, which is constructed on the assumption that there is a constant increase in the energy need of the child as growth proceeds. The relative values given by Atwater, Lusk, and the Department of Labor were expressed as calories and plotted on the chart. In adjusting these scales to the calorie basis it was assumed that a figure covering several years represents the need of the child at the intermediate age. That is, if the energy need of children 3 to 10 years of age, inclusive, was given as 70 per cent of man's need, it was assumed that this value indicates the energy need of the child during his ninth year. These points as plotted were connected, and from the resultant curve the energy need at each year was ascertained.

In order to show the existing relationships more clearly logarithmic paper is used for the graphs. In Figure 1 some interesting differences in the scales and standards are brought out. From the graph in which the energy requirement of boys of varying ages is shown it appears that the allowances made by Sherman and Gillett and by Atwater are similar up to the age of 16. After that age Atwater's allowance is considerably higher than that advocated by Sherman and Gillett. Lusk's allowance, on the other hand, is almost 20 per cent higher than Atwater's during the first 11 years. After the twelfth year Lusk's follows Sherman and Gillett's standard.
Fig. 1.—The relation of the energy needs of individuals according to age and sex, as calculated from the scales and standards suggested by Holt, Sherman and Gillett, Atwater, Department of Labor, and Lusk. Energy need is expressed in calories per day.
rather closely. Holt’s standard, which is much like Atwater’s before the eighth year, provides for a rapid increase in the energy need of boys after the age of 9, and this continues into the seventeenth year. The scale commonly used by the Department of Labor differs in many ways from the others. The energy allowance for the first six years is considerably lower than that for the same period in any other standard, and for the years 8 to 12 it is higher. After the fifteenth year it follows a trend similar to that of Sherman and Gillett’s but about 5 per cent higher.

The energy allowance for girls is, on the whole, somewhat less than that for boys. In Sherman and Gillett’s scales differences are made on the basis of sex after the second year, and in Holt’s a slight difference appears from the beginning. Lusk does not differentiate for sex until the fourteenth year. Atwater differentiates after the tenth year and the Department of Labor after the twelfth year.

The allowances made by Atwater, Holt, Lusk, and the Department of Labor for children under 11 years of age, as shown in Figure 1, bear similar relations to each other. But Sherman and Gillett’s standard for girls bears a relation to the others that is very different from that of their scales for boys. Their allowance for boys up to the age of 16 is similar to Atwater’s, but their allowance for girls is below Atwater’s throughout, and the difference between the two increases, until at the age of 16 it stands almost 15 per cent below Atwater’s. According to Holt, the energy requirement of girls increases rapidly after the eighth year and reaches its high point in the fifteenth year.

The differences that occur in the energy allowances made by the different investigators are probably caused largely by the data used in arriving at their standards. The data used by the Department of Labor are not given, but the scale proposed by that department is obviously not based on energy requirements. The other four, however, are designed to measure energy need. The allowances proposed by Atwater and by Sherman and Gillett are based largely on food-consumption figures, whereas those proposed by Lusk and Holt are compiled from figures on the factors that make up the demand for energy—basal metabolism, growth, and activity.

ENERGY SCALE USED IN THE BUREAU OF HOME ECONOMICS

The study of American dietaries which was undertaken by the writer in the Bureau of Home Economics made it essential that a suitable scale be chosen for calculating the family’s energy need, and the problem of choosing from these scales or standards arose.

The scale used by the Department of Labor was discarded because it is obviously not an energy scale. Atwater’s scale is, on the whole, in harmony with the other energy scales, but it is based on a standard of 3,400 calories per man per day. More recent work on the energy need of a moderately active man weighing 70 kilograms indicates that his requirement is about 3,000 calories. Recent work has also emphasized the need of a higher energy standard for the adolescent boy and girl than Atwater allows. This need was recognized by the former Office of Home Economics (p. 4), which suggested higher figures for use in Atwater’s scale. The choice of this scale for a dietary analysis would mean therefore a restatement of the factors if the present knowledge of energy need is taken into account.
Sherman and Gillett's energy allowance for boys is similar to Atwater's, but their allowance for girls is considerably lower than any of the others. This may be caused by the small number of experiments on which the figures are based. There were but 71 experiments on girls over 1 year of age, and, as Holt points out, some of the data were based on children who were somewhat abnormal (13, p. 60-62). Because of these facts it seemed that a scale for calculating a family's energy need based on Sherman and Gillett's figures would be inadequate.

Although both Lusk's and Holt's allowances during growth are, on the whole, higher than those of the other investigators, they are not in agreement. Lusk emphasizes the energy need of children under 10 years of age and Holt that of children over 10. Lusk did not test his figures in any way, but Holt reports that he collected records of the food consumed by 100 children of various ages to check his energy figures and that they were in close agreement.

Before choosing an energy scale for use in dietary studies the writer tested the four energy standards presented above by the consumption figures published by Sherman and Hawley (31) in their study of calcium requirement during childhood. They report 115 experiments on 14 healthy children, mostly girls, varying in age from 3 to 14. By averaging the figures for each year the writer found that the energy of the food consumed by the children approximated figures obtained by averaging the energy allowances made by Lusk and by Holt. There were but few exceptions. The food consumed by four girls 6 to 9 years of age agreed with Sherman and Gillett's allowance for these years. But they were Italian children unaccustomed to American food, and they found the nine days of experimentation difficult for that reason. The younger children and those over 10 enjoyed the experiments, and their appetites never flagged. Their food-consumption figures give values in agreement with the average of Lusk's and Holt's allowances.

Because of these facts an energy scale which is now being used by the writer in analyzing dietary studies in the Bureau of Home Economics was prepared by averaging Holt's and Lusk's figures. Holt states that he allowed for an energy loss of 10 per cent in the excreta (13, p. 59-60). Since in the factors commonly used for computing the energy value of foods allowance is made for the average loss in digestion, it seemed that this need was doubly provided for when Holt's scale was used in studying a dietary. The figures suggested by Holt were therefore reduced 10 per cent before they were averaged with Lusk's. The figures on which the energy scale described in this bulletin is based are given in Table 6. In Table 7 the figures as indicated by this scale are shown for each year during childhood. The scale as it is now being used is shown in Table 13. A comparison of this scale with the scales suggested by Atwater and by Sherman and Gillett is made in Figure 2. It seems unnecessary to compare it with Lusk's and Holt's, since it is the mean between those two.

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3 Foods when oxidized to the end-products that are formed in the body yield the following factors: Carbohydrate, 4.1 calories per gram; protein, 4.35 calories per gram; and fat, 9.411 calories per gram. But because of the losses in the process of digestion the factors 4 for carbohydrates and protein and 9 for fat are commonly used in computing the energy supplied by the food.
Fig. 2.—The energy need of individuals of different age and sex according to the scale used by the writer, compared with the allowances recommended by Atwater and by Sherman and Gillett. Energy need is expressed in calories per day.
### Table 6.—Figures on which the energy scale used by Hawley is based, expressed in calories per day

<table>
<thead>
<tr>
<th>Age of individual (years)</th>
<th>Energy allowance according to—</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Holt’s scale (reduced 10 per cent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For male</td>
<td>For female</td>
<td>For male</td>
<td>For female</td>
<td>For male</td>
<td>For female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adul t</td>
<td>Calories</td>
<td>Calories</td>
<td>Calories</td>
<td>Calories</td>
<td>Calories</td>
<td>Calories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 12</td>
<td>3,165</td>
<td>2,525</td>
<td>3,000</td>
<td>2,500</td>
<td>3,359</td>
<td>2,887</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 14</td>
<td>3,405</td>
<td>2,765</td>
<td>3,000</td>
<td>2,500</td>
<td>3,659</td>
<td>3,187</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 16</td>
<td>3,645</td>
<td>3,005</td>
<td>3,000</td>
<td>2,500</td>
<td>3,969</td>
<td>3,497</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 18</td>
<td>3,885</td>
<td>3,265</td>
<td>3,000</td>
<td>2,500</td>
<td>4,279</td>
<td>3,807</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 18</td>
<td>4,125</td>
<td>3,525</td>
<td>3,000</td>
<td>2,500</td>
<td>4,589</td>
<td>4,117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 20</td>
<td>4,365</td>
<td>3,765</td>
<td>3,000</td>
<td>2,500</td>
<td>4,899</td>
<td>4,427</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 30</td>
<td>4,605</td>
<td>4,005</td>
<td>3,000</td>
<td>2,500</td>
<td>5,209</td>
<td>4,737</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 40</td>
<td>4,845</td>
<td>4,265</td>
<td>3,000</td>
<td>2,500</td>
<td>5,519</td>
<td>5,047</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 50</td>
<td>5,085</td>
<td>4,525</td>
<td>3,000</td>
<td>2,500</td>
<td>5,829</td>
<td>5,357</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. In making this deduction it was assumed that the figures given by Holt were 10 per cent above the desired figures, which were regarded as 100.

### Table 7.—Energy allowance during childhood, according to age and sex, as calculated from the scale used by Hawley, in calories per day

<table>
<thead>
<tr>
<th>Age of individual (year)</th>
<th>Energy allowance for males</th>
<th>Energy allowance for females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 18</td>
<td>4,125</td>
<td>3,525</td>
</tr>
<tr>
<td>Eighth</td>
<td>3,165</td>
<td>2,525</td>
</tr>
<tr>
<td>Seventh</td>
<td>3,160</td>
<td>2,520</td>
</tr>
<tr>
<td>Sixth</td>
<td>3,160</td>
<td>2,520</td>
</tr>
<tr>
<td>Fifth</td>
<td>2,965</td>
<td>2,365</td>
</tr>
<tr>
<td>Fourth</td>
<td>2,765</td>
<td>2,165</td>
</tr>
<tr>
<td>Third</td>
<td>2,565</td>
<td>1,965</td>
</tr>
<tr>
<td>Under 2</td>
<td>1,965</td>
<td>1,365</td>
</tr>
</tbody>
</table>

The scale that is now being used by the writer in the Bureau of Home Economics for calculating the energy need of boys follows the same general trend as Atwater’s and Sherman and Gillett’s. (Fig. 2.) It makes a somewhat higher allowance during the first 12 years, but the allowance for the other years agrees rather closely. This is not true, however, of the allowance for girls. Sherman and Gillett’s allowance is consistently lower than that of this bureau. Atwater’s agrees fairly well with the proposed scale until the seventh year. From that time until the fifteenth year his allowance is lower, and at 14, when the greatest difference occurs, it is 15 per cent lower. After the fifteenth year Atwater’s scale is higher.

The outstanding difference between the energy scale now in use in the Bureau of Home Economics and those suggested by the older investigators seems to be in the energy allowance for girls. Since the standards for activity in girls have changed radically in the United States during the last 25 years, an increased energy allowance over the older standards should be expected. The differences between the energy needs of boys and girls during growth, according to this scale, are not of any importance until the fifteenth year, when the energy need of girls declines, whereas the boys’ need increases until
the seventeenth year. This is shown graphically in Figure 8. This
difference is caused largely by the fact that girls attain their growth
at an earlier age than boys.

As Sherman pointed out in his introduction to Gillett’s study
(9, p. 3), the energy need of a man varies greatly according to his
occupation, whereas the energy need of children of a given age and
sex is relatively constant. A carpenter, for example, may need 3,500
calories per day; a tailor, 2,500; a 14-year-old son of either of these
men, 2,800 calories. Because some investigators in using Atwater’s
scale, in which the child’s need is expressed in terms of man’s-need,
lost sight of this fact and used the scale incorrectly, Sherman sug-
gested that the child’s allowance be expressed in calories. But in
a study of a large number of diets the time involved in calculat-
ing a family’s energy need by the use of a calorie standard is so
great that it makes such a study almost impossible. It is desirable
therefore in order to simplify the process to state these needs in
terms of the adult-male unit. In the proposed scale the method
suggested by Atwater for allowing for man’s activity is followed.
(Table 13.) The energy need of an active man is given as equivalent
to that of 1.2 adult-male units and that of a man in a sedentary
occupation as 0.8 adult-male unit. Since there is evidence that the
energy need of an individual declines in later life, provision is made
in the scale for a reduced requirement after the age of 60. These
figures have been chosen arbitrarily.

USE MADE OF ENERGY SCALES AND STANDARDS IN FAMILY
DIETARY STUDIES

As has been pointed out, it is customary in analyzing a large num-
ber of diets to use a scale based on man’s standard for calculating
the energy need of the family. In judging a diet for adequacy, how-
ever, it is necessary to choose a standard in harmony with the scale
used, and this is where many investigators have had trouble. Instead
of recognizing that the scale chosen for calculating the family’s
nutritive need is based on a definite energy standard, many of them
have chosen one scale for calculating the family’s food requirements
and a different standard for judging the adequacy of the food in
meeting these requirements. Such an inconsistency brings out results
that are hard to evaluate.

To-day most investigators base their judgment of the adequacy
of a diet not on energy alone but also on the amount of protein, cal-
cium, phosphorus, and iron furnished by the food. Although the
dietary scales used by them are based only on energy need, it has
been assumed by them that the protein and mineral needs of children
bear the same relation to man’s need that the energy requirement
does. This opens the question whether such an assumption is justi-
l. It will be discussed in the section that deals with a double scale
for calculating a family’s nutritive need. Only the energy analyses will
be included here. In evaluating the results of such investigations,
however, it must be recognized that there are two possible sources of
error. First the investigator may have failed to take into con-
sideration the standard on which the scale used by him is based.
This sometimes introduces considerable error. In addition the figures
which he analyzed may have been for food as purchased, and he may
have disregarded the fact that these would probably be higher than figures for food as eaten. The standards suggested by the various investigators are based on food as eaten. When figures for food as purchased are analyzed, allowance should be made for the fact.

An illustration will show how much results may be vitiated when suitable figures are not chosen for the analysis. If the investigator calculated the family's nutritive need by the use of Atwater's scale, for instance, and judged the adequacy of the food by the use of his standard of 3,400 calories per man per day, the results are consistent. But if, by chance, Lusk's standard of 3,000 calories is used to measure adequacy after Atwater's scale has been used to measure the family's energy need, an error of 12 per cent is introduced into the results. And if, in addition, the figures which he analyzes are for food as purchased and he uses a standard based on food as eaten to judge the adequacy of the diet, the error is further increased. Both types of error occur in the dietary studies discussed in this section.

The family-dietary studies which have been made in the United States are brought together in Table 8 for the purpose of showing the scale chosen in each case for calculating the family's nutritive need, together with the energy standard on which it is based and the standard used by the investigator for judging the adequacy of the diet. They are divided into two groups—those in which the food-consumption figures used in the calculation were for food as eaten and those in which the figures were for food as purchased. In the first group there are seven studies based on food records from 1,146 families, and in the second group are four studies based on records from 2,291 families. Columns are included in the latter group in Table 8 for food as eaten and for food as purchased. These figures were calculated by the writer and are based on the estimate that the wastage of food in the home amounts on the average to 10 per cent of the quantity purchased.

From this table it appears that in the studies made by W. O. Atwater (2), Sherman and Gillett (30), Ogburn (23), and Hawley (27), suitable standards were chosen for the scales used to measure the family's need. Ogburn allowed a little over 10 per cent for the waste in the foods analyzed by him. In the majority of the studies that have been made of the nutritive value of the diet, however, inconsistencies occur. In the study made by the Bureau of Labor Statistics of the Department of Labor (35), for instance, the standard used by the investigator for judging adequacy is 14 per cent below the standard of the scale used in calculating the family's nutritive need; in Phillips and Howell's study (24) there is a similar discrepancy of 12 per cent; and in H. W. Atwater's study (1) a difference of 7 per cent is found for the same reason. If 10 per cent is a suitable allowance for waste when foods as purchased are analyzed, greater discrepancies appear in the second group. In the studies made by Chapin (5) and by the Bureau of Municipal Research of Philadelphia (4) in which both types of error appear, the difference is as great as 20 per cent. The analysis reported by Davis (7) shows an error of only 9 per cent, due to a failure to allow for waste. In the two studies made by Mudge (20, 21) the scale used in calculating the family's nutritive needs is not given.
### Table 8.—Energy scales and standards as they have been used in family dietary studies

**A—FIGURES BASED ON FOOD AS EATEN**

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Date</th>
<th>Number of families studied</th>
<th>Scale used in calculating family's nutritive need</th>
<th>Standard used by investigator in judging adequacy of diet</th>
<th>Error introduced by choice of standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. O. Atwater</td>
<td>1908-1909</td>
<td>231</td>
<td>Atwater</td>
<td>3,400, 3,500, 3,100</td>
<td>0</td>
</tr>
<tr>
<td>Sherman and Gillett</td>
<td>1914-1916</td>
<td>102</td>
<td>Sherman and Gillett</td>
<td>3,150, 3,500, 3,100</td>
<td>0</td>
</tr>
<tr>
<td>Bureau Labor Statistics, Department of Labor</td>
<td>1917</td>
<td>31</td>
<td>Atwater</td>
<td>3,150, 3,500, 3,100</td>
<td>-14</td>
</tr>
<tr>
<td>Bell and Howell</td>
<td>1918</td>
<td>102</td>
<td>Atwater</td>
<td>3,150, 3,500, 3,100</td>
<td>-12</td>
</tr>
<tr>
<td>Mudge</td>
<td>1922</td>
<td>30</td>
<td>Not given</td>
<td>3,150, 3,500, 3,100</td>
<td>-7</td>
</tr>
<tr>
<td>Davis</td>
<td>1924</td>
<td>30</td>
<td>Not given</td>
<td>3,150, 3,500, 3,100</td>
<td>-7</td>
</tr>
</tbody>
</table>

**B—FIGURES BASED ON FOOD AS PURCHASED**

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Date</th>
<th>Number of families studied</th>
<th>Scale used in calculating family's nutritive need</th>
<th>Standard used by investigator in judging adequacy of diet</th>
<th>Error introduced by choice of standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaplin</td>
<td>1917</td>
<td>100</td>
<td>Atwater</td>
<td>3,400, 3,740, 3,100</td>
<td>-30</td>
</tr>
<tr>
<td>Davis</td>
<td>1917</td>
<td>200</td>
<td>Sherman and Gillett</td>
<td>3,150, 3,500, 3,100</td>
<td>-30</td>
</tr>
<tr>
<td>Bureau Municipal Research, Philadelphia</td>
<td>1917</td>
<td>200</td>
<td>Atwater</td>
<td>3,150, 3,500, 3,100</td>
<td>-10</td>
</tr>
<tr>
<td>Ogilvie</td>
<td>1919</td>
<td>1,000</td>
<td>Department of Labor</td>
<td>3,150, 3,455, 3,900</td>
<td>+1</td>
</tr>
<tr>
<td>Hawley</td>
<td>1920</td>
<td>1,331</td>
<td>Hawley</td>
<td>3,000, 3,500, 3,500</td>
<td>0</td>
</tr>
</tbody>
</table>

1 Modified to increase the energy allowance of children in the adolescent group.
2 An allowance of 10 per cent for waste was made by the writer. This is based on the estimate that is commonly given.
3 Approximately.

This survey of dietary studies brings out the fact that most of the investigators have disregarded two important factors in arriving at their conclusions. It may be argued that food yielding 3,000 to 3,100 calories per day is enough for a man who is moderately active. That may be true, but if that standard is chosen, Atwater's scale based on 3,400 calories should not be used for calculating the children's energy need. If it is, a diet that is inadequate to meet the family's need will probably be judged as adequate. Unless the exact method and figures used in arriving at the final result are given, the study is therefore of little value. When figures based on food as purchased are being analyzed the possibility of some waste in the household must be recognized and allowance made for the factor.

The relationship that exists between these five scales and standards and the effect of the use of each in a dietary study are brought out more clearly in the following section in which an attempt is made to find suitable corrective factors for reducing the results obtained by the various scales and standards to a common base so that they may be more justly compared.
CORRECTIVE FACTORS FOR REDUCING RESULTS OBTAINED BY DIFFERENT SCALES TO A COMMON BASE

The next question that arises in a study of dietary scales concerns itself with the possibility of comparing the results of various investigators. In the previous section on the use that has been made of energy scales and standards in family dietary studies emphasis was put on the relation that exists between a scale and the standard used in its construction, and the need of using the two consistently. This is essential when a diet is being judged for adequacy—that is, when a comparison is being made between the energy yielded by the food consumed and that needed by the family.

Many food-consumption studies, however, offer a somewhat different type of problem. Instead of using the standard on which the energy scale used by him is based for evaluating his results, an investigator may choose to evaluate his results by comparing them with those reported in other studies of family food consumption. An investigator may find, for instance, that the food consumed by the average family studied by him yielded 3,000 calories per man per day. In evaluating this figure he may choose to compare it with those reported by other investigators. But when he tries to do so, he finds that a variety of figures are reported, such as 3,750, 3,150, 3,500 and 3,300 calories per man per day, and he wonders whether he can justly compare them as they stand. Two factors operate to make these differences—the quantities of food consumed by the families in the different studies vary, and different energy scales were used in making the calculations. The first is the one he wants to compare, and he naturally asks how he can eliminate the second so that he may compare the actual differences in food consumption.

Such a question brings up the task of finding corrective factors suitable for eliminating the differences caused by the use of different energy scales. The first problem that must be studied, however, is whether the families commonly included in dietary studies are sufficiently homogeneous so that the results obtained by the use of the various scales will bear a fairly constant relation to each other. If such a relation exists so that a factor can be found for each scale, the problem then becomes one of using it correctly, with full recognition of its limitations and meaning.

Two studies have recently been made in Great Britain in which the investigators tried to solve this problem. In both cases, however, the families used for finding a corrective factor were individual families assumed to be typical of the groups they were studying. The Medical Research Council (10, p. 20-21), for instance, assumed that a typical family consisted of a man, a woman, and three children, 11, 8, and 4 years of age. Because Lusk's energy scale, when used for calculating the number of adult-male units in this family, indicated an energy need 14 per cent above the figure given when Atwater's scale was used, the Medical Research Council concluded that Lusk's scale was 14 per cent higher than Atwater's and accordingly adjusted figures obtained by the use of the two scales to a common base.

Hill (12, p. 213-213) pointed out that if a family of different make-up were chosen these two energy scales would give results very dif-
different from those obtained by the Medical Research Council. For instance, if a family consisting of a man, a woman, a girl aged 20 years, and a boy of 8 were chosen, the difference between the scales is 5.2 per cent; whereas if a family consisting of a man, a woman, a boy aged 12, and two girls aged 10 and 8 were used, the difference is 16.9 per cent. Hill therefore concluded that a corrective factor for adjusting results obtained by the use of different energy scales to a common base is not possible because of the wide variations that occur in family make-up.

The criticism that should be made of both of these studies is that the investigators, without making any attempt to define a typical family, used individual families as a basis of a corrective factor. It is obvious that Hill's conclusion is true that a suitable factor cannot be obtained when individual families of varying composition are used for the calculation. But in both studies the investigators wanted to compare figures for the energy value of the average family's diet obtained by the use of different scales. The number of families for whom average consumption figures were given ranged from 19 to 396. Why then should these investigators have tried to use individual families for arriving at a corrective factor for adjusting these figures to a common base?

In attempting to find such factors, a family of average make-up must be used. The writer was fortunate in finding nine studies in which the age and sex of the individuals were given in such detail that the average family's energy need in each study could be calculated by any scale. These were accordingly used for calculating corrective factors for the six scales that have been presented.

The nine studies from which 23 groups of families were obtained for this investigation of the effect of families of varying composition on these six scales show a wide variation in the number of families included. They range from 23 carefully chosen families to the 24,351,676 constituting the entire population of the United States. The individuals in each study are grouped differently by the various investigators. The individuals who made up the 402 farm families in New York studied by Kirkpatrick, Atwater, and Bailey were reported in eight age groups (15, p. 12). The Bureau of Labor Statistics made two studies. In both the number of individuals according to sex was reported in six age groups. One study included 12,094 families (38, p. 120-263); the other included 100 families (36). Noble studied 92 families and reported the number of children at each age (32, p. 8). Little and Cotton (16), who studied 23 families, and W. F. and D. W. Worcester (39), who studied 35 families, show the composition of each family. In a preliminary report by Clark and Kirkpatrick of the clothing purchased by 1,337 farm families (6, p. 7), the individuals are divided into eight age groups. Kirkpatrick in his study of 2,886 farm families used the same divisions (14, p. 30). And the United States Census publishes the number of individuals in the United States, and in many of the subdivisions, for each 5-year age group (33, p. 170-305). The 24,351,676 so-called families reported by the census include not only families in the usual sense of the word, but also institutions and hotels. The use of these figures, however, gives results that are comparable with those from the other sources. All
of these sources were used in calculating corrective factors for the different energy scales.

From the figures shown in Tables 5 and 7 were prepared six energy scales with age groups corresponding to the age groups given in the nine studies listed above. These were used for calculating the total number of adult-male units included in each study. This figure was divided in each case by the number of families reported to find the number of adult-male units per family. This study of families was not undertaken to find the typical family as such, but rather to learn whether the results obtained by the use of these six scales in calculating the energy need of the families reported in these studies bear a fairly constant relation to each other. In order to wipe out differences caused by variations in the average size of the families and to show only the effect of the family composition on the results obtained by the use of the various scales, it is necessary to express the figures in percentage. In Table 9, which gives the average size of each group of families, it is shown that the families studied by Worcester (39) are on the average almost 150 per cent larger than those studied by Noble (22). The other studies are between these two extremes. It is necessary to eliminate such influences from a corrective factor, and this is done in Table 10 by using the figures obtained by the proposed scale as the base and expressing the figures obtained by the other energy scales in percentage of those results. With such an expression each study is treated independently, but the percentages that are derived take account of only the one factor—the differences in the energy scales.

**Table 9.**—The average size of 23 groups of families in terms of adult-male units as calculated by the use of six energy scales

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of families studied</th>
<th>Hawley's scale</th>
<th>Holt's scale</th>
<th>Sherman and Gilbert's scale</th>
<th>Atwater's scale</th>
<th>Department of Labor's scale</th>
<th>Lykken's scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States Bureau of Labor Statistics:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>12,004</td>
<td>3.43</td>
<td>3.32</td>
<td>3.26</td>
<td>3.13</td>
<td>2.29</td>
<td>3.43</td>
</tr>
<tr>
<td>New York City</td>
<td>100</td>
<td>3.81</td>
<td>3.66</td>
<td>3.64</td>
<td>3.47</td>
<td>3.59</td>
<td>3.87</td>
</tr>
<tr>
<td>Clark and Kirkpatrick</td>
<td>1,237</td>
<td>3.18</td>
<td>3.12</td>
<td>3.06</td>
<td>2.94</td>
<td>3.17</td>
<td>3.18</td>
</tr>
<tr>
<td>Kirkpatrick et al.: New York</td>
<td>462</td>
<td>3.31</td>
<td>3.25</td>
<td>3.20</td>
<td>3.13</td>
<td>3.21</td>
<td>3.34</td>
</tr>
<tr>
<td>Kirkpatrick</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern States</td>
<td>1,637</td>
<td>3.31</td>
<td>3.25</td>
<td>3.20</td>
<td>3.13</td>
<td>3.21</td>
<td>3.34</td>
</tr>
<tr>
<td>New England States</td>
<td>317</td>
<td>3.21</td>
<td>3.15</td>
<td>3.10</td>
<td>3.03</td>
<td>3.15</td>
<td>3.28</td>
</tr>
<tr>
<td>North Central States</td>
<td>2,439</td>
<td>3.36</td>
<td>3.30</td>
<td>3.23</td>
<td>3.15</td>
<td>3.23</td>
<td>3.40</td>
</tr>
<tr>
<td>Little and Cotton</td>
<td>35</td>
<td>4.47</td>
<td>4.34</td>
<td>4.26</td>
<td>4.12</td>
<td>4.24</td>
<td>4.41</td>
</tr>
<tr>
<td>Noble</td>
<td>527</td>
<td>3.52</td>
<td>3.46</td>
<td>3.39</td>
<td>3.26</td>
<td>3.39</td>
<td>3.62</td>
</tr>
<tr>
<td>Worcester</td>
<td>1,366</td>
<td>3.36</td>
<td>3.32</td>
<td>3.26</td>
<td>3.19</td>
<td>3.27</td>
<td>3.52</td>
</tr>
<tr>
<td>United States Census:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>24,251,626</td>
<td>3.68</td>
<td>3.61</td>
<td>3.54</td>
<td>3.48</td>
<td>3.56</td>
<td>3.62</td>
</tr>
<tr>
<td>New England States</td>
<td>7,703,812</td>
<td>3.61</td>
<td>3.47</td>
<td>3.41</td>
<td>3.33</td>
<td>3.32</td>
<td>3.58</td>
</tr>
<tr>
<td>Pacific division</td>
<td>1,943,350</td>
<td>3.21</td>
<td>3.16</td>
<td>3.10</td>
<td>3.04</td>
<td>3.10</td>
<td>3.24</td>
</tr>
<tr>
<td>Colorado</td>
<td>230,286</td>
<td>3.48</td>
<td>3.33</td>
<td>3.29</td>
<td>3.26</td>
<td>3.21</td>
<td>3.48</td>
</tr>
<tr>
<td>Indiana</td>
<td>767,767</td>
<td>3.52</td>
<td>3.35</td>
<td>3.34</td>
<td>3.22</td>
<td>3.19</td>
<td>3.37</td>
</tr>
<tr>
<td>Iowa</td>
<td>286,670</td>
<td>3.41</td>
<td>3.34</td>
<td>3.34</td>
<td>3.22</td>
<td>3.21</td>
<td>3.44</td>
</tr>
<tr>
<td>Nebraska</td>
<td>116,291</td>
<td>3.78</td>
<td>3.51</td>
<td>3.48</td>
<td>3.37</td>
<td>3.37</td>
<td>3.63</td>
</tr>
<tr>
<td>Ohio</td>
<td>526,912</td>
<td>3.57</td>
<td>3.40</td>
<td>3.36</td>
<td>3.28</td>
<td>3.26</td>
<td>3.58</td>
</tr>
<tr>
<td>Detroit</td>
<td>298,972</td>
<td>3.76</td>
<td>3.51</td>
<td>3.47</td>
<td>3.37</td>
<td>3.37</td>
<td>3.65</td>
</tr>
<tr>
<td>New York City</td>
<td>1,278,341</td>
<td>3.62</td>
<td>3.56</td>
<td>3.49</td>
<td>3.41</td>
<td>3.41</td>
<td>3.62</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>150,274</td>
<td>3.76</td>
<td>3.61</td>
<td>3.58</td>
<td>3.49</td>
<td>3.49</td>
<td>3.80</td>
</tr>
<tr>
<td>St. Louis</td>
<td>199,015</td>
<td>3.62</td>
<td>3.55</td>
<td>3.50</td>
<td>3.42</td>
<td>3.42</td>
<td>3.60</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>3.62</td>
<td>3.56</td>
<td>3.50</td>
<td>3.42</td>
<td>3.42</td>
<td>3.60</td>
</tr>
</tbody>
</table>
A study of Table 10 brings out the fact that, although there are wide differences in the number and size of families included for study, the relation between the results is, on the whole, remarkably uniform. The arithmetic mean of the 23 groups indicates that Holt's scale gives figures on family size in terms of adult-male units 1.9 per cent below those obtained by the proposed scale; Sherman and Gillett's is 3.3 per cent below; Atwater's is 6.5 per cent below; the Department of Labor's is 0.7 per cent below; and Lusk's is 1.3 per cent above this new scale. The figures from the census for the United States gives results close to the arithmetic mean. The standard deviations from the mean are also shown in this table. From these it may be concluded that, if the distribution of individuals in the families chosen by the investigator for study are fairly similar to that of the average family in the United States, corrective factors obtained by the arithmetic mean are correct, on the whole, within 1 per cent.

The corrective factor of -1.9 per cent for adjusting the results obtained by the use of Holt's scale to make them comparable with results obtained by the proposed scale, will in the majority of cases be correct within 0.9 per cent. That is, the results obtained by the use of Holt's scale will usually be within 97.2 to 98.0 per cent of those which would have been obtained if the proposed scale had been used for the calculation. In the same way a corrective factor of -3.3 per cent for Sherman and Gillett's scale will also in the majority of cases be correct within 0.7 per cent. For Lusk's scale a corrective factor of -1.3 will usually be correct within 0.8 per cent. Atwater's scale and that of the Department of Labor show
somewhat less uniformity than the other three. If the make-up of the families is similar to that of the average for the United States, the results obtained by the use of Atwater's scale will usually be between 5.5 and 7.5 per cent below those obtained by the proposed scale, whereas the results obtained by the scale of the Department of Labor will be on the whole from 2.2 per cent below to 0.8 per cent above those obtained by the proposed scale.

The differences between these six energy scales may of course be greater than are indicated above. Such differences are caused by variations in the composition of the families. There are only two studies, however, which deviate more than 2 per cent from the means shown in Table 10. These are the two studies made by the Bureau of Labor Statistics in which the families are made up entirely of parents and dependent children. Such a distribution of age groups is not typical of the families in the United States.

From a study of these groups the writer found that in a typical family the number of males and females is about equal, the number of adults is about 75 per cent greater than the number of children, and the number of children under 10 is somewhat greater than the number over 10. When the proportion of children is increased, and especially the proportion of children under 10 years of age, as is done in the two studies made by the Bureau of Labor Statistics, the estimated energy need of the family according to Sherman and Gillett, Atwater, and the Department of Labor is relatively smaller than when a group of families of typical composition is studied. According to Lusk, on the other hand, the estimated energy need of such families is higher in relation to the proposed scale than when typical families are studied.

This study of 23 groups of families has shown that when a family of average composition is used the differences that appear in the make-up of individual families are on the whole eliminated, and corrective factors for adjusting results arrived at by different scales to a common base may thus be obtained. The next question that arises therefore is how to use them, and this again brings up the problem of the relation that exists between energy scales and standards.

The figures in Table 10 indicate that when a family of average make-up is studied results obtained by Holt's scale are 1.9 per cent lower than those obtained by the writer's scale; those by the scale of Sherman and Gillett are 3.3 per cent lower; of Atwater, 6.5 per cent lower; of the Department of Labor, 0.7 per cent lower; and of Lusk, 1.3 per cent higher. In this calculation, however, only the relative figures in terms of adult-male units were used. This means that the actual energy allowance for the adult-male unit is not taken into account. When the standards on which the energy scales are based are the same, however, as they are in Lusk's, in Sherman and Gillett's, and in the proposed scale, the adult-male unit is the same in each case, and the corrective factors given in Table 10 account for all the differences between the scales and standards which are used to determine the family's energy need expressed in calories. When the standards are not the same these corrective factors do not give a complete picture. Atwater, for instance, allows 13.3 per cent more energy for his adult-male unit than is allowed in the proposed scale. Since for the typical family his scale, as shown in Table 10, is
6.5 per cent lower, his actual energy allowance is 93.5 per cent of 113.3, or 105.9 per cent of the writer's. In other words, the estimated energy need calculated by his scale is 5.9 per cent higher than when the proposed scale is used. In the same way Holt's actual energy allowance for the family is 6.7 per cent higher than the writer's, his standard for man being 8.8 per cent higher and his scale 1.9 per cent lower. The Department of Labor allows 5 per cent more energy for its adult-male unit than the writer, but its scale is 0.7 per cent lower. The difference therefore between the actual energy allowances for the family according to the two is 4.8 per cent. These figures are shown in Table 11 for the purpose of bringing out the relation between energy scales and standards more clearly.

**Table 11.—Relation between the six energy standards, the scales, and the combined scales and standards with the proposed scale and standard as the base**

<table>
<thead>
<tr>
<th>Authority</th>
<th>Energy standard for adult-male unit</th>
<th>Energy standard for adult-male units as per cent of Hawley's standard</th>
<th>Energy scale for calculating the number of adult-male units as per cent of Hawley's scale</th>
<th>Energy scale and standard for calculating the family's energy need as per cent of Hawley's scale and standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawley</td>
<td>3,000</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Holt</td>
<td>3,795</td>
<td>105.8</td>
<td>95.1</td>
<td>100.7</td>
</tr>
<tr>
<td>Sherman and Gillett</td>
<td>3,000</td>
<td>100.0</td>
<td>98.7</td>
<td>98.7</td>
</tr>
<tr>
<td>Atwater</td>
<td>3,400</td>
<td>112.5</td>
<td>92.5</td>
<td>102.3</td>
</tr>
<tr>
<td>Department of Labor</td>
<td>3,150</td>
<td>105.0</td>
<td>92.3</td>
<td>104.3</td>
</tr>
<tr>
<td>Lusk</td>
<td>3,000</td>
<td>100.0</td>
<td>101.3</td>
<td>104.8</td>
</tr>
</tbody>
</table>

The type of problem for which a corrective factor for adjusting results to a common base is necessary has already been indicated. One may wish to compare results on the food consumption of families obtained by the use of different scales. He may find, for instance, that five studies report the energy yielded by the food consumed by average families as 3,750, 3,150, 3,500, 3,300, and 3,000 calories per man per day. The first was calculated by the use of Atwater's scale, the second by the use of Lusk's scale, the third by the use of the Department of Labor scale, the fourth by the use of the proposed scale, and the fifth by the use of Sherman and Gillet's scale. How many of the differences that appear are due to differences in the energy scales?

Another type of problem which is similar involves the consumption of actual foodstuffs instead of the nutrients, such as energy. One study, for instance, may report that an average family consumes 250 pounds of potatoes per man per year, calculated by the use of the Department of Labor scale. According to another study, the average family may consume 200 pounds of potatoes per man per year, calculated by the use of the proposed scale. How can figures like these be compared?

There are two methods of reducing such figures to a common base so that they become comparable. The first and simpler method takes
into account only the energy scale expressed in relative terms. The
other method takes into account the differences caused by both the
scale and the standard on which it is based.

In order to express food-consumption figures in terms of the
adult-male unit, the quantity of food consumed by the family
(either in calories or pounds) is calculated and this figure is divided
by the number of adult-male units in the family. The calculation is
made by using only the adult-male units expressed in relative values.
The corrective factors indicated in Table 10 are therefore suitable
for eliminating the differences in the six energy scales and for re­
ducing them to a common base. The method is simple. In order to
make the four energy figures shown above comparable with the
figure obtained by the use of the proposed scale, the 3,750 calories
obtained by the use of Atwater's scale should be reduced 6.5 per cent,
giving 3,500 calories; the 3,150 calories obtained by the use of
Lusk's scale should be increased 1.3 per cent, giving 3,190 calories;
the 3,500 obtained by the use of the Department of Labor scale should
be reduced 0.7 per cent, making 3,475 calories; the 3,800 obtained
by the use of the writer's scale remains constant; and the 3,000
obtained by the use of Sherman and Gillett's scale should be re­
duced 3.3 per cent, making 2,901 calories. If the relation between
these figures, 3,506, 3,190, 3,475, 3,800, and 2,901, which are now on
the same base, is expressed as a per cent of 3,300, the figures ob­
tained in the study in which the proposed scale was used, the figures
3,506 and 3,475 give figures 6.2 per cent and 5.3 per cent, respec­
tively, above that value; whereas, 3,190 and 2,901 give figures 3.3
per cent and 12.1 per cent, respectively, below that value. The
figures which are thus obtained represent the assumed differences
in actual food consumption in the five studies.

If one wants to compare the adequacy of the diet in the five
studies under consideration, it may be done by dividing each of the
derived figures by 3,000, the standard of adequacy adopted for the
adult-male unit. The results are 116.9, 106.3, 115.8, 110.0, and 96.7
per cent, meaning that according to this standard the food consumed
by the families in the Atwater study yielded 16.9 per cent more
energy than they needed, in the Lusk study it was 6.3 per cent above
the family's estimated need, in the Department of Labor study it
was 15.8 per cent above, in the study of the Bureau of Home Eco­
nomics it was 10 per cent above, and in Sherman and Gillett's study
it was 3.3 per cent below the family's energy need.

The other method of eliminating the differences caused by the
use of different energy scales takes into account the standard on
which the scale is based. In comparing figures obtained by the use
of different scales, the first step is to determine the adequacy of the
diet in terms of the author's standard. That is, figures obtained by
the use of Atwater's scale should be referred to his standard, 3,400
calories; those obtained by the use of the proposed scale should be
referred to its standard, 3,000 calories; and so on. It should next
be recognized that adequacy does not mean the same thing in the
six energy scales and standards, and suitable corrective figures should
be chosen for reducing the results to a common adequacy base. The
results obtained thus will be the same as those obtained by the first
method of evaluating the figures for adequacy.
If the same figures are used for this problem as were used above, the method will doubtless be clearer. Reference should be made to Table 11 for the corrective factors used here for the various standards and for the combined scales and standards. In terms of adequacy the figure 3,750 calories per man per day, obtained by the use of Atwater's scale, is 10.3 per cent above his estimated need of the adult-male unit. His allowance for the family (see column 4, Table 11) is 5.9 per cent above that of the writer. This means that in terms of adequacy the figure 3,750 is 16.8 per cent above the estimated requirement according to the standard used by the Bureau of Home Economics. By the same reasoning the figure 3,150 calories per man per day, obtained by the use of Lusk's scale, is 6.3 per cent above this adequacy standard; 3,500 calories, obtained by the use of the Department of Labor scale, is 15.9 per cent above; 3,000 calories, obtained by the use of the proposed scale, is 3.3 per cent below the writer's adequacy standard. On the assumption that the adequacy standard is 100, the computations may be expressed thus:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Atwater's</th>
<th>Lusk's</th>
<th>Department of Labor's</th>
<th>Hawley's</th>
<th>Sherman and Gillett's</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3,750</td>
<td>3,150</td>
<td>3,500</td>
<td>3,300</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>3,400</td>
<td>3,000</td>
<td>3,150</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>110.3</td>
<td>105.0</td>
<td>111.1</td>
<td>110.0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>105.9</td>
<td>105.3</td>
<td>104.3</td>
<td>106.0</td>
<td>96.7</td>
</tr>
<tr>
<td></td>
<td>110.8</td>
<td>106.3</td>
<td>115.9</td>
<td>110.0</td>
<td>96.7</td>
</tr>
<tr>
<td></td>
<td>110.3X105.9=110.8 per cent of adequacy standard adopted by Bureau of Home Economics.</td>
<td>105.0X101.3=106.3 per cent of adequacy standard adopted by Bureau of Home Economics.</td>
<td>111.1X104.3=115.9 per cent of adequacy standard adopted by Bureau of Home Economics.</td>
<td>110.0X106.0=110.0 per cent of adequacy standard adopted by Bureau of Home Economics.</td>
<td>100.0X96.7=96.7 per cent of adequacy standard adopted by Bureau of Home Economics.</td>
</tr>
</tbody>
</table>

The corrective factors, as they are shown in Tables 10 and 11 and as they have been used in the problems given for illustration, are carried to tenths of a per cent. This was done to bring out more accurately the relationships that exist between the various aspects of the problem, but in actual practice it is a refinement that is not justified by these figures.

In using these corrective factors their limitations should always be kept in mind. The families used for obtaining them are probably typical of the United States as a whole. But any specially picked group within the United States may show a very different distribution of individuals from that shown by this typical family. In studying dietaries from such families, these corrective factors should be used with caution. Without further study it is impossible to say whether these factors are suitable for families in countries other than the United States.

DOUBLE SCALE FOR CALCULATING A FAMILY'S NUTRITIVE NEEDS

In reviewing the dietary scales that have been proposed for calculating a family's nutritive requirement the fact that they are based on energy need alone has been emphasized. Since, however, the necessity of including an examination of the quantity of protein, calcium, phosphorus, and iron, as well as of potential energy, supplied by the food is increasingly recognized in judging the adequacy of a diet, the question of the suitability of an energy scale for
calculating the protein and mineral needs of the individual arises. That is, is one justified in concluding that the child who needs 1,500 calories per day, or 0.5 of the requirement of an adult-male unit, needs only 0.034 gram of calcium, or half of Sherman's allowance for a man?

Although man's energy and protein needs have been pretty widely studied the most extensive work on calcium and phosphorus requirements has been done by Sherman. He included protein data also in his study. From a review of the metabolism experiments that were available he suggested comparable standards for the three nutrients based on a 50 per cent increase over the arithmetic mean of the quantities required for maintenance, as given by approximately 100 experiments for each factor (26, 28, 27). In making the computations all data were reduced to the indicated requirement per 70 kilos of body weight. The standards as finally proposed by Sherman are 50 per cent above the average minimum requirement, making 67 grams of protein, 0.68 gram of calcium, and 1.32 grams of phosphorus per man per day. His protein standard is considerably lower than Atwater's allowance of 125 grams per man per day, largely because it is based on actual requirement as indicated by metabolism experiments instead of on quantities consumed as indicated by dietary studies.

Although it is commonly recognized that the protein and mineral needs of children are relatively greater than those of man because of the growth factor, not much work has been done to ascertain just what these requirements are for the different ages. Sherman and Hawley suggest as the result of their study of the calcium needs of children that it would perhaps be well to allow 1 gram or more of calcium per man per day in all cases in which the group of people to be fed includes growing children (31, p. 398). Holt found that the energy derived from protein in the diet of children over 1 year of age approximates 15 per cent of the total calories (13, p. 101-112).

It is obvious that the quantity of food consumed, and therefore the total calories of the diet, influence the quantity of protein consumed, and it has been suggested that the allowance for this factor be expressed in terms of calories. For instance, Sherman states (29, p. 541) that it is customary to consider for family groups that 10 to 15 per cent of the total calories should be in the form of protein. Holt also suggests that a child's protein allowance should provide 15 per cent of the total calories.

From these suggestions it would seem that if the mineral needs of the child are proportional to the protein need, an adjustment might be made in the standards on which a scale is based so that a single scale might be worked out which would be suitable for calculating the family's need of the various nutrients. In a scale prepared by that method the adult-male unit would be defined in terms of all the nutrients instead of in energy alone. Such a scale was tried by the writer. The suggestion made by Sherman was followed—that if it is desired to provide as liberal a margin of safety for the minerals as in the case of a protein allowance of 100 grams per man per day, the figures 0.68 gram for calcium, 1.32 grams for phosphorus, and 0.015 gram for iron must obviously be increased by one-half (29, p. 542). One of the energy scales was used for calculating the number of adult-male units. For finding the nutritive needs of the family, a
value of 3,000 calories, 100 grams of protein, 1.02 grams of calcium, 1.98 grams of phosphorus, and 0.023 gram of iron was assigned to the adult-male unit.

When this scale was applied to families of different make-up, however, the results were misleading. Families made up largely of adults were estimated as having an unnecessarily high protein and mineral need, and the diets fully adequate to meet such a family’s need may have been judged inadequate. The diets of families made up largely of young children, on the other hand, were oftentimes judged as adequate when they may not have furnished enough protein and minerals to meet their needs.

Because families are not uniform in their composition it seems that two scales are necessary for calculating a family’s nutritive requirement. This might be done according to the suggestions of Sherman and Holt. That is, if we assume that man’s protein requirement is covered when 10 per cent of his total calories are yielded by protein—75 grams of protein to every 3,000 calories—an allowance of 15 per cent throughout childhood would give a scale somewhat higher than the energy scale, but it would bear a constant relation to that scale because it is based on a percentage relationship. This of course raises the question whether the protein and mineral needs of the child are directly related to its energy need.

The evidence concerning this point is sketchy, but a scale based on the consumption figures which are available is probably better than one based on the assumption that the protein and mineral needs of children parallel their energy needs. Holt reports the quantity of protein consumed by more than 100 healthy children from 1 to 17 years of age (13, p. 107), and Sherman and Hawley report the quantity of calcium in the diet of 78 children and the quantity of phosphorus in the diet of 37 children from 1 month to 14 years of age (31, p. 384). These are expressed in all cases in terms of body weight.

Following Holt’s suggestions for energy and protein in the child’s diet, and using Sherman and Hawley’s results on its calcium and phosphorus content, therefore, it appears that an adult should have an allowance of 46 calories, 1 gram of protein, 0.01 gram of calcium, and 0.02 gram of phosphorus per kilo per day. On the basis of these food-consumption figures an infant needs an allowance of 100 calories, 4 grams of protein, and 0.09 gram of calcium per kilo per day. For a child 5 to 6 years old an allowance of about 80 calories, 3 grams of protein, 0.04 gram of calcium, and 0.05 gram of phosphorus per kilo per day is adequate, and for a child in adolescence an allowance of 80 calories, 2.8 grams of protein, 0.027 gram of calcium, and 0.04 gram of phosphorus per kilo per day would seem to be adequate.

These figures are brought together in Table 12. They indicate that on the basis of body weight the need of the individual for all these nutrients becomes less as growth proceeds, but the demand for protein and minerals during growth is distinctly different from that for energy. The energy need of the child per kilo is from 70 to 120 per cent higher than man’s requirement, and it seems to remain fairly constant from the fourth year until the end of the active growth period. The infant’s protein and calcium requirement, on the other

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2 No figure is given by Sherman and Hawley for phosphorus consumption at this age.
DIETARY SCALES AND STANDARDS

hand, is relatively four to nine times as great as man's, but this difference becomes smaller as growth proceeds. Children of 5 years of age need from three to four times as much protein and minerals as man for each kilo of body weight, and the adolescent child's need per kilo is from two to three times as great. The fact that the calcium figure for the child of 1 year is relatively so much higher than the other figures is probably due to the fact that milk plays such an important part in his diet. The change has usually been made from mother's milk to cow's milk, which is three and a half times as rich in calcium as human milk. The result, of course, shows a high calcium consumption. This irregularity is wiped out when a normal mixed diet is taken.

TABLE 12.—Figures on which the protein and mineral scale proposed in this bulletin is based, expressed in terms of body weight

<table>
<thead>
<tr>
<th>Age of individual (years)</th>
<th>Energy per kilo of weight per day</th>
<th>Protein per kilo of weight per day</th>
<th>Calcium per kilo of weight per day</th>
<th>Phosphorus per kilo of weight per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>Calories</td>
<td>Grams</td>
<td>Grams</td>
<td>Grams</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>1.0</td>
<td>.01</td>
<td>.02</td>
</tr>
<tr>
<td>11 to 12</td>
<td>80</td>
<td>2.8</td>
<td>.07</td>
<td>.04</td>
</tr>
<tr>
<td>5 to 6</td>
<td>80</td>
<td>3.0</td>
<td>.07</td>
<td>.05</td>
</tr>
<tr>
<td>1 to 2</td>
<td>100</td>
<td>4.0</td>
<td>.08</td>
<td>.06</td>
</tr>
</tbody>
</table>

Such evidence indicates that the protein and mineral needs during growth do not bear a constant relation to the energy need. Since the relative need of the body for protein and minerals remains so close at the different ages, however, it would seem that one scale for these nutrients is adequate, and in constructing this scale allowance has been made for the progressively decreasing demand of the body per kilo for these nutrients as growth proceeds.

The double scale that has been worked out for calculating the nutritive needs of the family is shown in Table 13 and Figure 3. The data on which the energy scale is based are described in detail in the section that deals with the energy scale used in the Bureau of Home Economics. The protein and mineral scale was obtained by using the data on protein, calcium, and phosphorus consumption described above. The quantity consumed per kilo was multiplied by the following weights for the various ages: 32.1 kilograms for boys and 31.6 kilograms for girls 11 to 12 years of age, 18.4 kilograms for children 5 to 6 years of age, and 10.5 kilograms for children 1 to 2 years of age, and these were then expressed in per cent of man's need. On the assumption that there is a fairly constant increase in food requirements as growth proceeds, the data for the three nutrients were plotted, and a consumption curve was obtained for each. Although the curves were not identical, the phosphorus curves being somewhat lower throughout than the other two curves, the trend was so similar that a composite curve for use in determining a protein and mineral scale seemed justified. From this curve relative figures were obtained for the same age groups that are used in the energy scale. Since the energy need of boys is greatest between 16 and 17 and that of girls at the age of 14, it was assumed that the
protein and mineral requirements of children were also at their maximum at these points.

Table 13.—Double scale for calculating the energy and the protein and mineral needs of a family

<table>
<thead>
<tr>
<th>Age of individual (years)</th>
<th>Degree of activity</th>
<th>Energy scale</th>
<th>Protein and minerals scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Over 60</td>
<td>Moderately active</td>
<td>0.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Over 55</td>
<td>Sedentary</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>18 to 20</td>
<td>Active</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Do</td>
<td>Moderately active</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>16 to 17</td>
<td>Sedentary</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>16 to 17</td>
<td>Moderately active</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>10 to 14</td>
<td>do</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>10 to 14</td>
<td>do</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>9 to 12</td>
<td>do</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>9 to 11</td>
<td>do</td>
<td>0.4</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The standard for each nutrient is based on food as eaten and indicates the nutritive need of a moderately active man of 70 kilograms in weight.

Since these figures were calculated, Ohio Agricultural Experiment Station Bulletin 400 entitled "The phosphorus intake of school children as shown by a dietary study made by the individual method" by Hughina McKay has been received. From the food-consumption figures given there it would seem that the standard shown in Table 13 is probably not too high. According to McKay, 18 children, 5 to 4 years of age, consumed food yielding the following factors per day: 1,200 calories, 40.3 grams of protein, 0.87 grams of calcium, 0.92 grams of phosphorus, and 0.0057 gram of iron. From Table 13 the corresponding figures are: 1,200 calories, 6.1 grams of protein, 0.54 gram of calcium, 1.04 grams of phosphorus, and 0.012 grams of iron.

In analyzing dietaries in the Bureau of Home Economics this scale is also used to determine the iron need of the family. Since very little work has been done on iron requirement it seemed best to assume that relatively the need of the body for iron during growth is similar to that for calcium and phosphorus. Further experimentation in this field may show that a separate scale is necessary for calculating the need of each nutrient, but with the present knowledge of nutritive requirements during childhood it would seem that two scales are adequate for calculating the nutritive needs of a family.

Only the three minerals, phosphorus, calcium, and iron, are included in this scale. Although there is considerable evidence (28) that iodine may be deficient in the diet it is not feasible to try to incorporate it in a dietary study at present because the data for judging the adequacy of iodine are too scanty. Provisions for estimating the vitamin content of a diet should also be made, but the only method that seems possible as yet is a consideration of the proportion of vitamin-rich foods appearing in the diet.

**HOW TO USE A DOUBLE SCALE IN CALCULATING A FAMILY'S NUTRITIVE NEEDS**

The use of a double scale instead of a single scale for ascertaining the nutritive needs of a family does not appreciably increase the time required for making an analysis of a dietary for the five nutrients included here, and the application of the method is not difficult. An illustration of the procedure may be desirable.

By the use of Table 13 it is found that for a family of five consisting of a man who is moderately active, a woman, a boy of 15, a
Dietary Scales and Standards

A girl of 11, and a child of 8, the energy need is equivalent to that of 4.3 adult-male units, or 12,900 calories per day. Its protein and mineral requirements, expressed in terms of the adult-male unit, are 5.5. This is equivalent to a daily requirement of 369 grams of protein, 7.15 grams of phosphorus, 3.74 grams of calcium, and 0.083 gram of iron.

One may want to determine the importance of a given food in its yield of the various nutrients, as for instance the proportion of the total energy and calcium supplied by the milk consumed. If he assumes that the family under consideration consumes 5 pounds of milk per day he finds that it will furnish 1,570 calories, or 12.2 per cent of the family's energy need, and 2.73 grams of calcium, or 73 per cent of its calcium requirement.

If one wants to know the quantity of nutrient this milk would furnish for each adult-male unit he finds that it supplies 365 calories and 0.50 gram of calcium per man per day. The following method is used in arriving at these figures. The number of pounds of milk, 5, is divided by the two factors, 4.3 which indicates the calorie need

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**Fig. 3.—Comparison of the energy need of children with their protein and mineral need, as recommended in the double scale. Nutritive needs are expressed as percentages of man's need, which is 100.**

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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 ADULT

AGE IN YEARS

100

50

10

0 100 200 300 400 500 600 700 800 900 1000

IN PER CENT OF MAN'S NEED

Energy need of boys
Energy need of girls
Protein and mineral need of boys
Protein and mineral need of girls
of the family, and 5.5 which indicates its protein and mineral requirements in terms of adult-male units. This gives the value 1.16 pounds of milk per adult-male energy unit, and 0.91 pound of milk per adult-male protein and mineral unit. The former, 1.16, multiplied by 314, the calories in a pound of whole milk, gives 365 calories per man per day. The latter, 0.91, multiplied by 0.546, the number of grams of calcium in a pound of whole milk, gives 0.50 gram of calcium per man per day. The protein, phosphorus, and iron of milk are calculated in the same way as the calcium.

SUMMARY AND CONCLUSIONS

The five energy scales and standards that have been proposed in the United States are reviewed and compared, and as a result a new scale is proposed for calculating the energy need of the family. It is based on the evidence presented by Lusk and by Holt concerning the energy need of children, and differs from the older standards primarily by increasing the energy allowance of girls. The comparison of energy scales also emphasizes the fact that the Department of Labor scale is not based on energy requirements and should not be used for ascertaining a family’s energy need.

A study of the use to which dietary scales and standards have been put in the dietary studies made in the United States brings out two points: (1) In the majority of dietary studies the investigators have failed to recognize the relationship that exists between energy scales and standards and have accepted results which may be as much as 20 per cent from the true figure. (2) In order to compare results obtained by the use of different energy scales, corrective factors may be necessary. It is possible to derive such a factor for each scale if average families selected from a large number of samples are used in determining these factors. Corrective factors based on the arithmetic means of 23 studies are given.

The evidence available on the protein and mineral needs of children indicates that the relative demand for these nutrients does not run parallel with the child’s demand for energy. On the basis of this evidence a separate scale is proposed for calculating the protein and mineral needs of a family. The double scale that has been worked out for calculating the nutritive needs of a family is shown, together with the standards on which it is based, and a description of the method of using a double scale is given. Allowance is made in the scale for unusual activity in the adult and for decreased energy metabolism in old age.

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