RATIONS AND NUTRITIONAL NEEDS

BY

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Before the introduction of bread rationing the amounts of nutrients present in rationed foods* gave an inadequate picture of the sufficiency of the diet available to individuals or groups because of the large contribution made by bread to the nutritive value. The main contribution of bread is in respect of calories, protein, and the B vitamins, and its inclusion among the rationed foods was a step of fundamental importance. The rationing of bread reduced considerably the flexibility of the national diet; for it was formerly the main elastic reserve whereby those with large appetites could readily satisfy their needs. With the introduction of bread rationing it became inevitable to provide an increased supply for those with large energy requirements. Energy needs depend not only on obvious factors, such as body size and intensity of work, which are physiologically predictable, but also on unpredictables inherent in the personality or constitution of the individual. Because of the multiplicity of factors, particularly the unpredictables, that determine the needs for energy, it is beyond the wit of man to devise a workable scale of energy allowances strictly applicable to each individual in a mixed community. The rationing scheme is necessarily based on the average requirements of sections of the population. These averages embrace a wide range of variations which cannot be fully and accurately provided for in a national scheme. It is therefore inevitable that the rations should vary in accordance with individual requirements from relative excess on the one hand to relative deficiency on the other.

The purpose of this paper is to compare the amounts of nutrients, particularly calories, in the rations with the theoretical needs of different sections of the population, to ascertain the gaps between these two, and to examine the means whereby the gaps can be bridged.

One of the fundamental principles in the scheme of rationing is that it should provide the bulk of the essential nutrients required by mothers, children, and invalids (priority classes). Many of the foods of special value for these classes, such as milk and eggs, are also good sources of energy. Consequently, their rations yield a larger proportion of their energy needs than is the case with other classes, so that the gap between the energy content of the rations and theoretical needs is smaller. Notwithstanding the rationing of bread there still exists considerable flexibility in the rationing system, and this derives from one or more of the following: (a) unrationed foods; (b) canteen, school, or similar extra meals; (c) the use of "points" to the best advantage, including exchange of points into bread units (B.U.s); and (d) diversion of rations from family members with small needs to others with greater needs (the family pool).

(a) *Unrationed Foods*.—The chief of these is potatoes, but they are relatively bulky; 16 oz. (454 g.), which is probably as much as the ordinary consumer ever eats, yields only 260 calories. Fruit and vegetables are relatively poor sources of energy, 8 oz. (227 g.), which is a fairly generous daily amount, yields on the average only about 50 calories. There remain fish, offal, sausages, and a few other foods of less importance, the procurement of which depends upon a complexity of

factors; together they would probably yield not more than about 150 calories a day in normal circumstances.

(b) *Canteen and Other Meals*.—Those who have access to public eating-places could get almost any proportion of their requirements from this source, but permanent residents in hotels must surrender their ration books. School meals are planned to provide a maximum of 1,000 calories daily. Canteen meals and snacks could provide up to 1,000 calories or more daily.

(c) *Exchange of Points to B.U.s*.—The food value obtainable from a given number of points is variable, but, generally speaking, better nutritional value can be obtained from spending points on simple things, such as dried pulses and sardines, than on luxury foods, such as expensive canned fruits and biscuits. Exchange of all points to B.U.s would produce an average gain of some 350 calories, or about 50 per exchanged point a day.

(d) *The Family Pool*.—As pointed out below, the rations of young children provide in themselves more than enough calories for their needs. In addition, the energy needs of women and of old men are about 80%, or less, of those of the ordinary male, but the rations for all these are identical. It therefore follows that a family comprising one or more such people would have some spare rations to pass on to those with bigger appetites. For instance, about 100 calories a day would be provided by one ration of bacon and cheese, plus 1 oz. (28 g.) of fat weekly. These spare rations would, in addition, provide a "lubricant" for the greater consumption of unrationed foods such as potatoes.

Rations and Requirements Compared

Table I sets out the rations and allowances for different sections of the population, and Table II shows the amounts

TABLE I.—Food Rations, Priority Allowances, and Certain Expected Distributions, per week (November, 1946)

	Up to 1 year	1 year	2, 3 years	4 years	5-10 years	11-13 years	14-17 years	Normal Adult	Expectant Mother	Nursing Mother	Manual Worker (Male)	Manual Worker (Female)
Cheese (oz.)	2	2	2	2	2	2	2	2	2	2	2	2
Bacon (oz.)	3	3	3	3	3	3	3	3	3	3	3	3
Sugar (oz.)	8	8	8	8	8	8	8	8	8	8	8	8
Fats (oz.)	7	7	7	7	7	7	7	7	7	7	7	7
Bread (oz.)	35	35	35	63	63	91	91	63	77	63	105	77
Meat (cost)	8d.	8d.	8d.	8d.	1/4	1/4	1/4	1/4	2/-	1/4	1/4	1/4
Jam (oz.)	4	4	4	4	4	4	4	4	4	4	4	4
Milk (pints)	7	7	7	7	5½	5½	3½	2	9	7	2	2
Eggs (no.)	3	3	3	3	3	3	3	3	3	3	3	3
Dried egg (oz.)	4	4	4	4	4	4	4	4	4	4	4	4
Sweets (oz.)	8	8	8	8	8	8	8	8	8	8	8	8
Points (no.)	8	8	8	8	8	8	8	8	8	8	8	8
M/Food orange juice	×	×	×	×				×				
M/Food cod-liver oil	×	×	×	×				×				

The distribution of milk and eggs to non-priority consumers has been taken as 2 pints and ½ per week respectively. Infants under 6 months do not receive the priority allowance of eggs.

For conversion into metric measures, 1 pint = 568 ml., 1 oz. = 28.35 g.

of nutrients derivable from the rations and compares these amounts (less deductions for losses of vitamins B₁ and C due to cooking) with the requirements suggested by the Technical Commission of the League of Nations, which we regard as the appropriate scale for the population of Great Britain.

The most noteworthy features of the comparison are: *Children*: The rationed foods provide enough or more (a) of calories, protein, and iron up to 10 years, (b) of vitamins A and C up to 5 years, and (c) of calcium up to 2 years. *Expectant mothers*: The rationed foods provide enough or more of protein, calcium, iron, and vitamins A and C. *Nursing mothers*: The yield of all nutrients from the rationed foods is less than requirements. *Adolescents (14 to 17 years)*: The amounts of all nutrients provided by the rationed foods are less than requirements. *Normal consumers and manual workers*: The amounts of protein, calcium, and iron in the rationed foods are roughly

* By rationed foods is meant those strictly rationed (e.g., meat, bread, fats, cheese, etc.), all "points," and milk and eggs the distribution of which is controlled.

about the same as, and of all other nutrients less than, requirements.

We now consider for each section of the population how the gaps between rations and needs can be made up. We confine our attention to energy—for brevity, and because experience of present diets has made it clear that, given all rations and enough unrationed foods to provide the energy requirements, the resultant diet is usually about sufficient in all the nutrients cited in Table II and in riboflavine and niacin, which are not included in the table.

Young Child.—It is clear from Table II that if children below the age of 5 were to consume all their rations they would get more than enough energy without eating any unrationed foods at all. It is the general custom, however, and from the nutritional point of view one to be commended, that children from about the age of 2 participate in the family meals. In this way they would probably obtain about 100 calories or more daily, depending on age, from the unrationed foods. It follows that children below 5 years should have 500 or more calories a day to spare from their rationed foods to go into the family pool.

School-child and Adolescent.—Up to the age of 14 years* the feeding of the school-child should present no problems. Indeed, between 5 and 10 years the rations alone yield more calories than are needed, and if a school meal is eaten the family pool could be enriched by the equivalent in calories

about reach his target. But if he requires more than 3,000 calories a day, as an active youth of about 16 may well do, it would be necessary to get a substantial helping from the family pool and/or change more points into B.U.s, to the detriment of the diet in a qualitative sense. If the adolescent's occupation entitles him to the designation "manual worker" then the extra 12 oz. (340 g.) of cheese and six B.U.s (630 calories daily) which he can get should make it easily possible for him to satisfy his needs.

Normal Consumer.—We need only consider the normal male. The energy requirement of the average man in a community as given by the League of Nations is 3,000 calories, a figure which includes all grades of work from sedentary to very heavy. For the purposes of the bread-rationing scheme most classes of manual workers from moderate to very heavy are included in the category of manual workers. The normal male consumer therefore embraces the large group of men whose activities vary from sedentary to light work, probably a very small number of the moderate work category, and a large number of oldish men whose requirement is mostly less than that of the sedentary class. Weighing up all these varying requirements, it seems reasonable to place the average needs of the normal male consumer at about 2,600 calories, but it should be clearly understood that this average figure covers a range which may well be of the order of 2,200–3,000. At

TABLE II.—Nutrients Provided per Day by the Rations, Priority Allowances, and Expected Distributions of Milk and Fresh Eggs shown in Table I (November, 1946)

Age in years or Ration Group:	Up to 1		1		2 and 3		4		5–10		11–13		14–17		Normal Male		Expectant Mother		Nursing Mother		Manual Worker (Male)	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Calories	1,776	800	1,776	1,100	1,745	1,300	2,029	1,500	1,995	1,900	2,279	2,630	2,199	2,970	1,842	2,600	2,440	3,000	2,085	3,000	2,268	3,500
Protein (g.)	60		60	42	57	46	67	50	64	60	74	85	69	99	56	70	85	80	69	80	70	70
Calcium (g.)	1.1		1.1	1.1	1.1	1.2	1.1	1.3	0.9	1.4	1.0	1.5	0.8	1.4	0.6	0.8	1.5	1.5	1.1	1.5	0.7	0.8
Iron (mg.)	9		9	5	8	7	10	8	11	11	13	16	13	15	11	10	13	13	11	13	14	10
Vitamin A (i.u.)	6,019		6,019	3,000	5,822	3,000	5,822	3,000	1,578	3,000	1,578	3,000	1,484	3,000	1,398	3,000	5,892	5,000	1,684	5,000	1,398	3,000
B (mg.)	0.77		0.77	0.50	0.74	0.59	0.92	0.68	0.87	0.86	1.04	1.18	0.90	1.01	0.77	0.91	1.10	1.82	0.92	1.82	1.03	1.21
Ascorbic acid (mg.)	33		33	30	33	30	33	30	6	30	6	30	5	30	3	30	49	45	8	45	3	30

A = Nutrients provided by foods in Table I.

B = Requirements on the League of Nations scale.

and all nutrients. The gap between rations and needs is only about 300 calories between 11 and 13 years. This gap could be more than made good by the school meal, which is scheduled to supply up to 1,000 calories (Circular 1571, 1941, Board of Education). For adolescents between 14 and 17 years the gap is of the order of 800 calories or more. Adolescents who remain at school up to 18 and partake of the school meal should have no difficulty in satisfying their requirements. Those who leave school at 14 and go to work in a place provided with a canteen likewise should have little difficulty. For those with no such facilities it may not be easy to make good the gap of 800 or more calories. Certain categories of adolescents living in schools and colleges which are not eligible for school meal allowances can, on special application, get an extra allowance of three B.U.s weekly. These would provide about 215 calories daily, leaving still about 600 or more to be made up. How this could be done is shown in Table III. The special allowance of three extra B.U.s applies only when the student is in residence; when on vacation he is in exactly the same position as the adolescent who lives at home all the time and has no canteen or similar facility. It can be seen from Table III that such people may find it difficult to satisfy their needs unless there are younger children in the family with spare rations. The table shows that if he changes six of his eight points into B.U.s and eats 1½ lb. (680 g.) of potatoes a day he can just

* The school-leaving age has now been raised to 15 years.

the lower end of the range there would be no difficulty in securing enough, and there would almost certainly be a surplus to put into the family pool. At the top end of the range, however, there might be some difficulty in satisfying needs. If we place the needs of the ordinary male consumer at 2,600 calories he has to get 760, say 800, calories from unrationed foods or in other ways (see Table III). A meal taken in a restaurant should yield 600 calories or more, thus leaving about 200 calories to be made up from potatoes, etc. The figures in Table III make it clear that he should have little difficulty in doing this. If, however, he cannot get a restaurant meal he would have to change six of his eight weekly points into B.U.s and eat as much as 1½ lb. (680 g.) of potatoes daily to reach his requirements. This exchange would, however, impoverish his diet in a qualitative sense, and if he were to forgo the exchange he could probably get no more than about 500 calories from unrationed foods, thus leaving a gap of, say, 300 calories to be filled. Failing a family pool to dip into he would have to change all his points into B.U.s, eat more potatoes and other things such as sausages and fish if he can get them, or else go hungry.

Expectant Mother.—The rations of the expectant mother leave a gap of about 550 calories to be made good by potatoes, vegetables, fish, sausages, and offal, change of points into B.U.s, and, if need be, by dipping into the family pool. The way in which her diet could be brought up to the desired level of 3,000 calories is shown in

Table III. It is assumed that she can eat 1½ lb. (680 g.) of potatoes daily. If she prefers bread she could obtain only enough to replace 1 lb. (454 g.) of potatoes by changing five more points into B.U.s, but the variety of her diet would suffer. This situation, however, would only arise with the first child. Children in the family up to about 14 would provide a substantial reserve of rations.

Nursing Mother.—The rations of the nursing mother leave a gap of about 900 calories. Her infant's rations amount to about 1,800 calories, whereas its requirements are about 800. The nursing mother could therefore meet all her needs from the rations of herself and her infant without consuming any unrationed foods.

Manual Worker.—The male manual worker is left with a deficit of about 1,200 calories to make up. Large numbers of manual workers have access to canteens. Actual surveys of meals supplied at canteens operated by a well-known catering firm show that in the autumn of 1946 meals and snacks served daily provided from 530 to 1,570 calories per head. The canteens in which the surveys were carried out were for workers ranging in activity from sedentary to heavy work. It would therefore seem from this finding that the heavy worker is able to get up to 1,500 calories daily at his canteen, thus filling the gap for the man requiring 3,500 calories. If the worker's diet were still

It is very probable, therefore, that the numbers of people who require more than 3,500 calories a day are few and far between.

Miner.—The energy requirements of the miner are probably about 3,500 calories on the average. He is entitled to special rations of 12 oz. (340 g.) of cheese, 10d. worth of meat, and six B.U.s. These alone provide about 700 calories, leaving 500 calories to be made up from unrationed foods, which as Table III shows should present little difficulty. He would require to eat 1½ lb. (680 g.) of potatoes a day, but he need not change any points into B.U.s. Canteen facilities would, as in other instances, make it easy for him to secure his requirements. Those miners who require, say, 4,000 calories daily, and there may well be some, would obviously have less difficulty than the ordinary manual worker in attaining this or even a higher level of intake.

Hospital Patient.—There is no need to consider the patient suffering from complaints, such as peptic ulcer and diabetes, for which there are priority allowances. It will only be necessary to pay attention to those patients who are all relatively well, as in most hospitals these constitute the majority and require a fairly substantial diet. Broadly speaking, the rations of such a patient are the same as the domestic rations plus certain extras which the hospital

TABLE III.—*Bridging the Gaps between Rations and Requirements*

	Adolescent		Normal Male		Expectant Mother		Manual Worker (Male)		Miner		Hospital Patient	
	Amount per week	Calories per day	Amount per week	Calories per day	Amount per week	Calories per day	Amount per week	Calories per day	Amount per week	Calories per day	Amount per week	Calories per day
Rations		2,200		1,840		2,440		2,300		2,300		2,200
Requirements		3,000+		2,600		3,000		3,500+		3,500		2,500
Gap		800+		760		560		1,200		1,200		300
1. Canteen, school, or similar meals and snacks		1,000		600		600		1,500		1,500		—
2. Special B.U.s (No.)	3	215	—	—	—	—	6	430	6	430	—	—
3. Change points to B.U.s (No.)	6	300	6	300	—	—	6	300	—	—	—	—
4. Potatoes (oz.)	168	390	168	390	168	390	224	520	168	390	84	190
5. Vegetables and fruit (oz.)	56	50	56	50	56	50	56	50	56	50	56	50
6. Fish (oz.)	10½	20	10½	20	10½	20	10½	20	10½	20	21	40
7. Sausage or offal (oz.)	7	40	7	40	7	40	7	40	7	40	7	40
8. Extra cheese (oz.)	—	—	—	—	—	—	12	200	12	200	—	—
9. " meat (oz.)	—	—	—	—	—	—	—	10½	10½	100	—	—
Sum of Nos.	2-7	1,015	3-7	800	3-7	550	2 & 4-8	1,260	2 & 4-9	1,230	4-8	320
"	3-7	800	4-7	500	4-7	500	2-8	1,560	—	—	—	—

The rations of the expectant mother include her special allowances of meat, milk, eggs, and bread; the rations of the miner and manual worker (male) do not include the special allowances of cheese and meat, which are listed separately (see numbers 8 and 9) in Table III.

insufficient for his needs he would have to have recourse to the means indicated in Table III—change of points to B.U.s, etc. The British Restaurant or other eating-places could be used if a canteen were not available at the place of work, but those who are out of reach of any sort of extra meals are not so well placed to fill the gap between rations and requirements. Certain classes of heavy workers, such as farm workers, quarrymen, and lumbermen, are allowed an extra 12 oz. (340 g.) of cheese and six B.U.s weekly, providing about 630 calories a day, thus leaving about 570 to be obtained from unrationed foods. Table III shows that they should be able easily to get about 1,260 calories, but they would need to eat 2 lb. (908 g.) of potatoes daily. If a workman required substantially more than 3,500 calories he would, unless he were able to extract a substantial amount from the family pool, have to change more of his points into B.U.s in order to reach, say, the 4,000-calorie goal. If he changed his remaining two points into B.U.s he would get an additional 100 calories, which would give him altogether 3,960 (2,300 + 1,560 + 100) (Table III). Knowledge of the energetic expenditure of the modern industrial worker is scanty. The only figures we possess date from before or shortly after the 1914-18 war. Since that time workmen's tools and conditions in industry generally have so altered that work is becoming less and less laborious, thus demanding less energy expenditure.

patient gets. These extras amount approximately to the following: milk, 3 pints (1.7 l.); dried milk, 7 oz. (200 g.); fats, 2 oz. (57 g.); dried egg, 0.3 oz. (8.5 g.) weekly. These extras yield about 330 calories a day, and together with the amounts derivable from the ordinary rations make up a total of nearly 2,200 calories. The requirements for the average patient of the above type is probably about 2,500 calories, so that he has a gap of 300 calories, which can easily be filled in by unrationed foods (Table III). Even if there were no spare rations from patients who are on light diets there should be little difficulty in making up a diet to this level. In addition, certain other concessions have been made to hospitals—for instance, jellies, soft drinks, starch products; hospitals are also generally well placed to obtain supplies of fish and sometimes offal and poultry, all of which help to ease the burden of catering. The only account that has been taken of these concessions is that the allowance of fish in Table III has been placed at 3 oz. (85 g.) instead of 1½ oz. (42.5 g.) a day. Sick people are notoriously difficult to cater for, and the longer they remain in hospital the more exacting they become. In hospitals where the bulk of the patients are relatively well, and few are so ill as to be restricted to light diets, the provision of varied, appetizing, and adequate meals is a task demanding much ingenuity and artistry as well as knowledge of dietetics. In tuberculosis and orthopaedic

hospitals, for instance, the great majority of the patients are on full diet, and there are few, if any, spare rations.

Summary

The rations for each important section of the population have been evaluated and compared with the League of Nations scale of requirements. The comparison is summarized above.

In those instances where the yield of nutrients from the rationed foods is less than requirements, suggestions are made for meeting the deficit by one or more of the following, having regard to prevailing dietary habits: (a) consumption of unrationed foods; (b) canteen and similar meals; (c) exchange of points into B.U.s; and (d) the family pool.

In making these suggestions attention has been confined to energy requirements, because experience of wartime diets has shown that, given the full rations, the additional unrationed foods necessary to satisfy energy requirements also provide, or almost provide, a sufficiency of all important nutrients.

It has been found that the filling of the gap should present no great difficulty for the great mass of the population, who can, if necessary, supplement their rations from (b) and (c) sources; but it may not be easy for adolescent and other males whose requirements are above the average for their class and who are not entitled to special rations and cannot supplement their diet from sources (b), (c), or (d).

A SIMPLE FORMULA FOR THE CALCULATION OF ATMOSPHERIC DRYNESS

BY

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The following case, though an extreme one which occurred during the stresses of wartime, illustrates the fact that in British practice too little attention is usually devoted to the atmospheric conditions of operating theatres. They often get too hot, not only in summer-time but also in winter, when central heating is operated with more enthusiasm than discretion, and their humidity tends to rise with the addition of steam from sterilizers. The control of these conditions should be especially cared for in a place where the working staff are expected to maintain a high standard of mental alertness, and where the heat-regulating functions of the patient, like all the functions of his nervous system, are set in partial abeyance by anaesthesia.

Case Report

During the war an underground hospital was built with a view to its use in emergency. An anaesthetist was asked to comment on the suitability of the operating theatre it contained. The ventilation was far from efficient, and when the sterilizers were in operation and several people were working in the theatre the atmosphere became extremely hot and moist. The anaesthetist in his report pointed out that patients when anaesthetized tended to become poikilothermic, and that in such an atmosphere complications—for example, ether convulsions due to the breakdown of thermal equilibrium—would be likely. This report was not taken very seriously, and later the anaesthetist was required in circumstances which admitted of no denial to set to work in this operating theatre. Some 30 cases were operated on successfully. One day a man was brought in for operation on bilateral inguinal herniae.

He was a ship steward aged 31. His temperature was normal, pulse 60, respirations 18, and blood pressure 120/80. He had no history of previous illness. He was a perfectly healthy man except for the herniae which he wished to have operated on. After preliminary medication with omnopon and scopolamine, anaesthesia was induced by 0.75 g. of pentothal, and continued by 6 litres per minute of gas and oxygen (the latter in 25% concentration) with ether. After half an hour he was seen to be sweating profusely, as indeed everyone in the theatre was, and the volume of his respiration started to increase. The thermometer hanging on the wall registered 81° F. (27.2° C.)

and the atmosphere was very moist. The total volume of gases delivered to the mask was increased to 12 litres per minute, still in 25% concentration, and after 45 minutes ether was discontinued. After 55 minutes the patient was red and sweating, the hyperpnoea was no better, and his pulse had risen to 126. The hernia on the right side was finished in 60 minutes, and at the request of the anaesthetist the operation on the other side was abandoned. On the patient's return to the ward his temperature was found to be 106° F. (41.1° C.), and his pulse 160. Cooling treatment was given, and oxygen and CO₂ administered. Within an hour he was dead. At necropsy no appearances other than those of heat-stroke were found. The underground theatre was not thereafter used.

Noteworthy features of this case are: (1) it was a case of pure heat-stroke, unaccompanied by any sign of convulsions; (2) there was no question of sweating being impaired by atropine; (3) there was no question of anoxic anoxia; (4) if the hyperpnoea led to any serious degree of CO₂ deficiency, this was combated by the administration of CO₂ in mixture; (5) there was no question of sepsis or pre-existing fever.

Calculation of Drying Capacity of Air

Moisture in the atmosphere is usually estimated by means of the "wet- and dry-bulb thermometers," which when exposed to an atmosphere not entirely saturated with water vapour will show readings differing by a certain number of degrees. The lower temperature of the wet bulb is caused by abstraction of heat in the process of evaporation of some of the water covering it. For scientifically accurate results the thermometers must be subjected to considerable air movement, and in America the "sling-psychrometer" is used for this purpose. The instrument is whirled through the air at a considerable velocity on the end of a sling. In England the usual open-air method is to expose the thermometers in a Stevenson screen, by which they meet with a slighter movement of the air; and in indoor conditions the thermometers are simply hung in a room in comparative calm.

The partial pressure of the water vapour contained in the air may be expressed in millibars by the empirical formula:

$$P = S^w - f \Delta$$

where P is the actual pressure in millibars of water vapour in the observed conditions, S^w the pressure at saturation point at the temperature of the wet bulb, Δ the difference in Fahrenheit readings between the two thermometers, otherwise termed the "depression," and f is a constant which depends on the pressure and velocity of the air passing over the bulbs. When using the sling psychrometer the value of this constant is 0.367; in England, for use with the Stevenson screen, the Air Ministry have adopted the value of 0.444. In the calm and not very precise conditions of thermometers suspended in interiors the round value of 1/2 is probably accurate enough.

The continuous line follows the true curve; the broken line indicates the curve: $y = \frac{1}{100}x^2 - \frac{1}{2}x + 12$.

The values of the partial pressure of water vapour under saturated conditions at various temperatures are well known,