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Nutritional individuality

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We are all individualists, and nowhere more so than over the matter of food. Each one of us has food habits and food prejudices which are different from those of others, but which are very important to us. They are largely psychological in origin, and such topics as the psychology of eating and the human factor in group feeding have already been discussed at meetings of (The) Nutrition Society (1953, 1959). It is not my purpose to say anything about this aspect of nutritional individuality. I am concerned with the physiological characteristics, inherent in each one of us, that influence our nutritional requirements.

Calorie intakes and requirements

My attention was first drawn to this matter in 1936, when I studied the individual food intakes of sixty-three men and sixty-three women of the English middle classes (Widdowson, 1936; Widdowson & McCance, 1936). Up to that time dietary surveys had generally been made on whole families, and no information was obtained about the individuals within those families. I was at once struck by the wide variation in calorie intake from one person to another. This variation is illustrated in Fig. 1, which shows the frequency distribution of calorie intake of these sixty-three men and women. In both sexes one person ate food which provided him or her with more than twice as many calories as another. If calorie intakes are any measure of calorie requirements, which they must be if an adult is maintaining a steady body-weight, then it must mean that some people require twice as many calories as others. This variation is not peculiar to adults, for when later I made a similar study on over 1000 children (Widdowson, 1947) I found that of the twenty or more boys in every yearly age group from 1 to 18 years there was without exception one who ate enough food to provide twice as many calories as the food of another. One 16-year-old boy took fewer calories than a 1-year-old boy. Fig. 2 shows that the same variation was found among the girls, and a 15-year-old girl took fewer calories than a girl of 1.

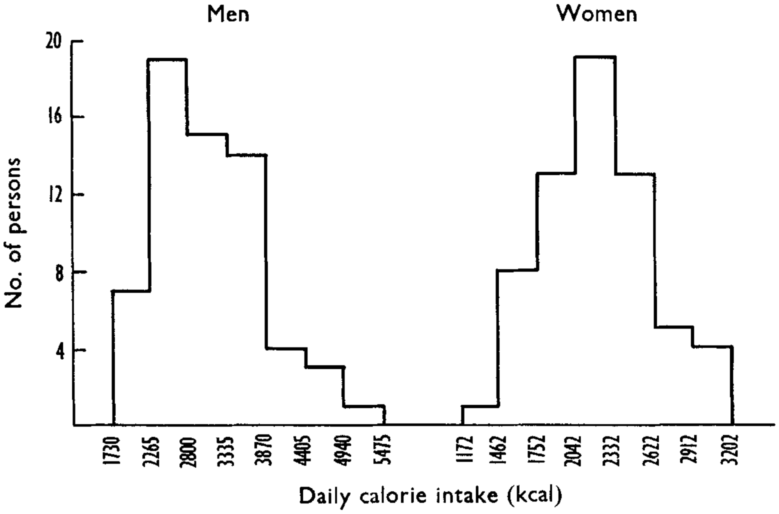

Fig. 1. Frequency distribution of calorie intake of sixty-three men and sixty-three women (from Widdowson, 1936; Widdowson & McCance, 1936).

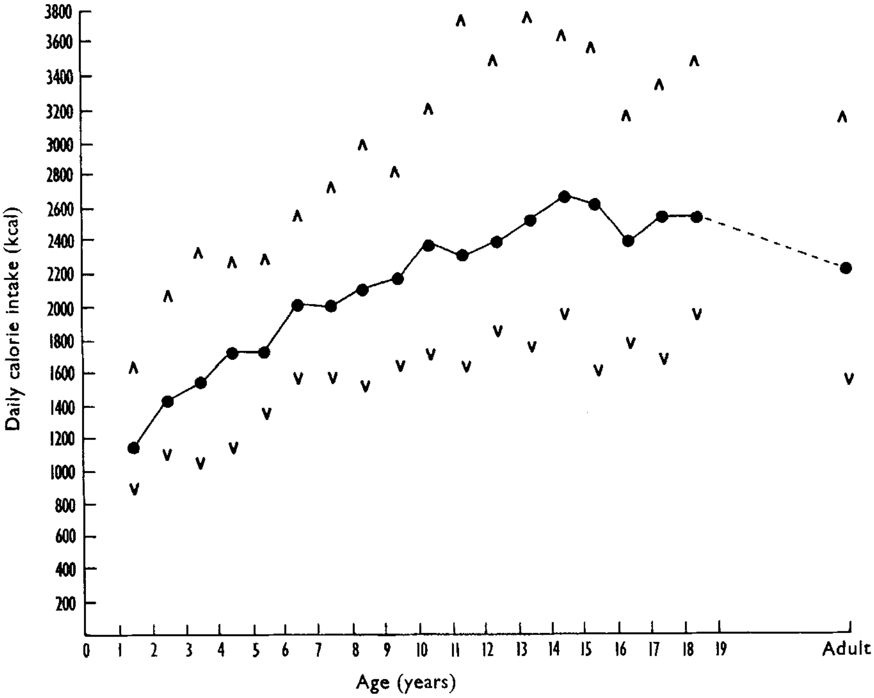

Fig. 2. Calorie intake of girls. ●—●, mean for twenty or more at each age; Λ, maximum; V, minimum.

The variations are evident at 1–2 years and probably begin earlier. Big children did not necessarily take the most calories, and the calorie intake/kg body-weight varied almost as much as total calorie intake (Fig. 3). It is true that the calorie intake does

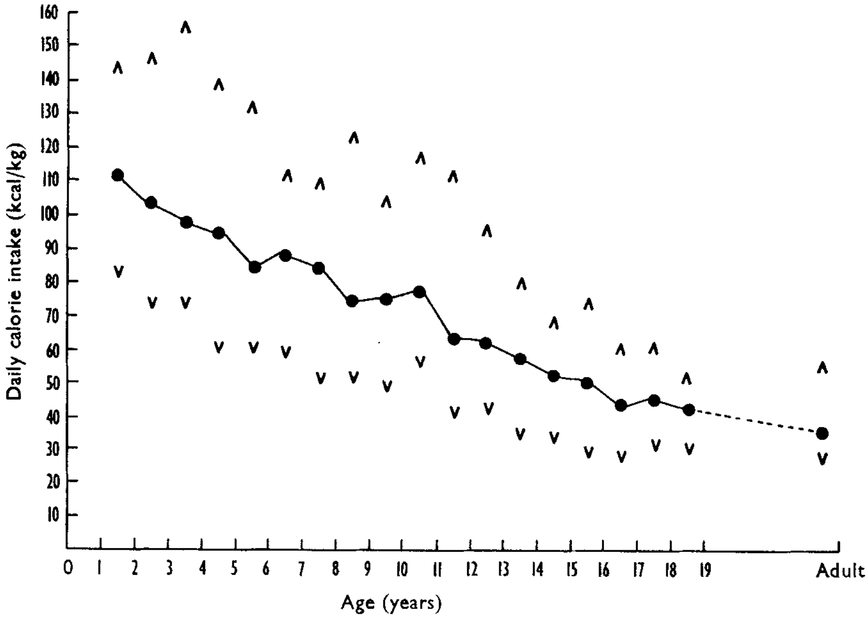

Fig. 3. Calorie intake of girls per kg body-weight. ●—●, mean for twenty or more at each age; Λ, maximum; V, minimum.

not remain constant from day to day, but in my experience a week is long enough to give a general idea of a person's diet. Measurements were made of the food intake of a number of children during 4 successive weeks, and of others for 2 separate weeks at intervals of about a year. For all of them the calorie intake on the later occasion was not very different from that on the first. The big eater remained the big eater, and the person who had a small appetite during the 1st week still ate less than the average on the 2nd. Other workers who have made similar investigations in the past 10 years or so have found just the same variability, and we must accept the general principle that people do not all eat, and do not all require, the same amount of food. The reason they do not has still never been satisfactorily explained. Differences in physical activity go part way towards accounting for it, and even the basal metabolic rate has been found to vary among healthy individuals much more widely than was hitherto generally appreciated; the energy expenditure while sitting varies in a similar way (Edholm, Fletcher, Widdowson & McCance, 1955; Booyens & McCance, 1957). We have supposed that, since most people spend so much of their time lying and sitting, variations in rate of energy expenditure at these two occupations explain much of the difference in total energy expenditure and hence in total calorie intake between one person and another. However, I have tried to relate the rate of energy expenditure lying and sitting with total energy expenditure and with total calorie intake both for military cadets (Edholm *et al.* 1955) and for miners and clerks in East Fife (Garry, Passmore, Warnock & Durnin, 1955), and I can find no relation whatever. Rose & Williams (1961) measured the basal oxygen consumption of large and small eaters, and they came to the same conclusion. To what then does the man whose body runs on comparatively few calories owe his efficiency? It is certainly not because he digests his food materials more completely than others, for losses of calorific material through the bowel vary from 3 to 6% of the intake, whereas calorie intakes vary by 100% or more. Is the efficiency something to do with the thyroid, the tone of the muscles, general relaxation, or to something else? When a person is having his oxygen consumption measured he is expected to lie, sit and stand relaxed and still, and in fact the measurement is often repeated until the lowest possible reading is obtained. This is not how many people lie, sit and stand, for they move and fidget all the time. Rose & Williams (1961) found that fidgeting increased the oxygen consumption by 80%, and it seems likely that, though the recorded value for lying, sitting and standing is for some people representative of their oxygen consumption in real life, for others it may be much less than the true value, and the variation from one person to another may be far greater than we even now suppose.

Mineral requirements

As far as we know appetite is regulated on total calories, and not on any specific nutrient. The person with the big appetite, who needs and takes more calories than another, will generally get more of each of the separate dietary constituents. Table 1 shows the intake of calories, and of protein, fat, carbohydrate, calcium and iron by the man and woman of the sixty-three with the highest and lowest calorie intake, all expressed as a percentage of the mean for the group. It is clear that the man and woman taking most calories also took more of each of the nutrients, and the person taking least calories obtained less than the average amounts of them. Does this matter? Does the person who needs and takes the fewest number of calories also need the least Ca, for example? Requirements for calories and requirements for Ca seem to be governed by quite different rules, and there is no relation between them. The person who has a low calorie requirement, who eats comparatively little food, may well have a Ca requirement above the average, although his intake will probably be below. An important factor in determining a person's Ca requirement is his ability to absorb dietary Ca from his intestine. Variation in losses through the bowel are negligible when it comes to accounting for differences in calorie requirements, but they are of great importance with Ca and other minerals. Some people

Table 1. *Mean intake of nutrients by the man and the woman with (A) the maximum and (B) the minimum calorie intake, expressed as a percentage of the mean intake by the group of sixty-three men and sixty-three women*

(From Widdowson, 1936; Widdowson & McCance, 1936)

	Men		Women	
	A	B	A	B
Calories: total	162	58	142	66
/kg body-weight	171	62	155	73
Protein	171	58	126	86
Fat	154	53	140	77
Carbohydrate	169	58	152	52
Calcium	225	89	127	62
Iron	170	48	127	76

are good absorbers and others are bad absorbers of Ca, and this is true whatever type of diet they are eating. The amount of Ca in the diet influences the amount absorbed, but a person who absorbs well on a low intake will also absorb better than the average on a higher one. This fact is illustrated in Table 2, which shows the absorptions of Ca by two men, first when they were having a diet containing about 0·5 g Ca/day and second when they were having one containing more than twice as much (McCance & Widdowson, 1942*a*). N.K. absorbed less than half as much Ca as E.B. at the lower level of intake, and he also absorbed less at the higher one.

Table 2. *Effect of increasing the amount of calcium in the diet on the absorption of calcium by two individuals*

(g/day)

	E.B.	N.K.
Intake	0·50	0·48
Absorption	0·31	0·13
Intake	1·03	1·30
Absorption	0·40	0·28

Two characteristics that are related to the facility with which a person absorbs the inorganic constituents from his diet are the rate of passage of material through the gut and the amount of faeces passed each day, and on the whole the more rapid the passage the greater the volume of stools and the lower the absorption. One person passes a marker 12 h after taking it by mouth; with another eating a similar diet, it is 3 or 4 days before the marker appears. An increase in the amount of unavailable carbohydrate in the diet decreases the transit time (McCance, Prior & Widdowson, 1953), but the individual who passes the marker slowly on the diet low in 'roughage' will also pass it more slowly than the average on the diet containing more. Babies show this individuality when they are a few days old. One breast-fed baby, for example, passed his marker after 8 h when he was 6 days old, and after 8 h when he was 10 days old. For another breast-fed baby the corresponding times were 24 and 28 h (Slater, 1960).

The amount of unavailable carbohydrate in the diet also influences the amount of faeces, but the person who habitually passes only a small stool each day on a diet low in roughage will also pass a comparatively small one on a diet containing more, as Table 3 illustrates. B. and McA. were studied on two occasions, once when their diet included white bread and almost no vegetables or fruit, and again when they were having brown bread and fruit and vegetables, and hence more unavailable carbohydrate (J. V. G. A. Durnin & D. A. T. Southgate, unpublished observations). The Ca intakes remained approximately the same. Both passed more faeces on the second diet than on the first, but McA. passed more than twice as much as B. on both diets, and in fact the weight of his faeces on the diet low in roughage was the same as that of B.'s on the high-roughage diet. The effect of this change in diet on the absorption of Ca is also shown in Table 3. On both diets B. absorbed more than

Table 3. *Effect of increasing the amount of unavailable carbohydrate in the diet of two individuals on the weight of faeces and absorption of calcium*

(g/day)

	B.	McA.
Little unavailable carbohydrate		
Weight of fresh faeces	38	102
Ca: intake	1·15	1·28
absorption	0·59	0·36
Much unavailable carbohydrate		
Weight of fresh faeces	100	196
Ca: intake	1·10	1·14
absorption	0·37	0·14

McA., and McA.'s Ca absorption on the diet low in roughage (and also in phytate) was equal to B.'s on the high-roughage diet.

Urinary excretion

The excretion of materials in the urine is also an individual characteristic. It has been shown that the amount of Ca excreted in the urine varies a great deal from one person to another (Knapp, 1947), but it is obvious that in a healthy adult urinary excretion must run with intestinal absorption. Table 4 shows the absorptions and urinary excretions of Ca by two individuals, E.B. and A.M. (McCance & Widdowson, 1942*b*). As the absorption was stepped up, first by decreasing the phytate and unavailable carbohydrate by changing from brown bread to white, the urinary excretion of Ca also increased, and it increased again when absorption was raised by adding Ca to the white bread eaten, and so raising the Ca intake. E.B. always absorbed more Ca from his food than A.M. and he also excreted more in the urine. In the absence of bone disease, the amount of Ca in the urine depends largely upon the amount absorbed, but the urinary excretions do not vary to the same extent as the intestinal absorptions. If absorption is very much depressed, as it may be by a diet containing much brown bread, urinary excretion seldom falls to the same extent, and the person loses Ca from the skeleton and is in negative Ca balance. If, on the

Table 4. *Absorption and urinary excretion of calcium by two individuals*

(g/day)

	E.B.	A.M.
Diet with brown bread		
Absorption	89	6
Urinary excretion	153	60
Diet with white bread		
Absorption	250	142
Urinary excretion	239	123
Diet with white bread containing added calcium		
Absorption	404	272
Urinary excretion	354	153

other hand, absorption is particularly high, it tends to exceed the amount excreted in the urine and the difference is deposited in the bones. The poor absorber of Ca will be found in negative balance much more often than the good absorber when dietary conditions are unfavourable, and this must be one reason why some old people lose Ca from their bones and others do not do so to the same extent.

In children the situation is a little different for there is another variable, the deposition of Ca in the bones. A newborn baby has about 30 g Ca in its bones and an adult has about 1230 g. Between birth and adult life, therefore, about 1200 g Ca must be retained. If we suppose that it is laid down at a constant rate over a period of 18 years, the retention must amount to nearly 200 mg/day. We know that Ca is not laid down in the bones at a constant rate throughout the growth period, and variations in the rate of deposition of Ca in the bones from time to time undoubtedly account for changes in absorption and the lack of correlation between absorption and urinary excretion of Ca by children (Knapp, 1947).

Which comes first, the intestine or the kidney? Is it the ability of the intestine to absorb that varies from one person to another, or is it the readiness of the kidney to excrete? I believe it is intestinal absorption that is variable, and the kidney simply performs its proper function of regulating the constancy of the internal environment. If absorption becomes too low, or becomes a negative quantity because more calcium is excreted in the faeces than is contained in the food, nothing that the kidney alone can do will maintain the concentration of Ca in the serum at the correct level, and Ca salts are liberated from the bones in order to achieve this level. Again there are individual characteristics, for some people seem to be able to keep up the level of serum Ca in these circumstances more easily than others. Professor McCance, who is a poor Ca absorber, has produced tetany in himself more than once by eating a lot of brown bread.

Other aspects

There are many other aspects of nutritional individuality which I have not mentioned, for example the fact that some people find certain foods very indigestible, whereas others are able to digest them perfectly well. Some people lose much more sodium chloride than others in their sweat, so that in hot climates they require to take in more. Some women lose much more blood and therefore much more iron than others during menstruation, so they need to absorb correspondingly more iron from their food.

How far nutritional characteristics are inherited I do not know, but I believe that we are born with many of them. Durnin, Blake & Brockway (1957) measured the energy intake and expenditure of twelve middle-aged middle-class housewives and their grown-up working daughters, and there did seem to be some relation between the mother's calorie intake and her daughter's, but many more pairs would have to be studied before we could be sure. It would be interesting to know whether 'good' and 'bad' absorbers from the intestine run in families. At present we have no idea. We do know that emotional upsets hinder the absorption of Ca (Macy, 1942; Malm, 1961) and probably of other nutrients as well. It may be partly because they hasten the passage of the products of digestion through the gut and increase the amount of digestive juices lost in the faeces. Emotional disturbances also increase the metabolic rate, and therefore the calorie requirement. We do not know how much variations in emotional stability from one person to another account for differences in the requirements for calories and nutrients; it is clear that if we want to make the most of our food materials we must keep calm and not worry!

Practical applications

Nutritional individuality as regards requirement for calories and ability to absorb nutrients from the intestine has important practical applications. All may be well in times of plenty, when there is an ample supply of good food and money available to buy it, but in times of food shortage and famine the person with the high energy requirement and the one who is a poor absorber must come off badly. Rations that are adequate for some may be quite inadequate for others, and it is well known that deficiency diseases often appear in some members of a population long before they do in others. Some people get hunger oedema when food is short and others do not; some get beriberi when the rations are low in thiamine, while others show no signs of deficiency. In the old days some but never all the children in a community got rickets. Further, the wide variation from one person to another in intake and expenditure of energy and in the ability to absorb nutrients from the intestine makes it futile to attempt to give one single figure for 'requirement'. The only reasonable way of setting out dietary requirements, if we have to set them out at all, is to show a range, and the range must be wide. We do not all need the same amount of food, and we should face up to it. It has been faced before, for when the manna appeared the Children of Israel were instructed 'Gather of it every man according to his eating' (*Exodus*, XVI, 16).

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