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### Nutrition surveys—clinical signs and biochemical measurements

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#### *Introduction*

In assessing standards of health, especially in relation to nutrition, there is a danger of confusing primary conditions and secondary indices. For practical purposes the latter are usually emphasized, but it is well to remember that their relative importance may vary according to circumstances. The malarial parasite cannot flourish in erythrocytes containing sickle-cell haemoglobin (Allison, 1957), so that the sickle-cell trait is advantageous in areas where malaria is endemic and is there a feature of good, rather than poor, health. Growth is taken as an index of nutritional status, and until recently maximum rate of growth and maximum size have been regarded with favour. But in some communities rapid growth and large body size are now viewed with concern.

In defining optimal health, or optimal nutrition, it is necessary to look for absolute standards. We do not know the meaning of life and can therefore only suggest tentative criteria of normality. Perhaps survival is a main criterion: survival of the individual, the family and the human race. But survival alone does not seem enough and well-being might be added. It also seems desirable to include an idea of function, and this could be expressed as efficiency. Good nutrition would allow, and poor nutrition would partially or wholly inhibit, survival, well-being and efficiency.

Ill-health, whether through inadequate nutrition or some other cause, should ultimately be measured in terms of such criteria. But in nutrition surveys attention must be given to features of the body that can immediately be observed or measured. There is no sharp contrast between optimal health and various degrees of departure from it. In the diagram (Fig. 1) I have indicated some of the features associated with different levels of nutritional status in the individual and in the community. Manifestations of malnutrition are frequently in the form of infective processes or simulate the effects of such processes. This is to say that it is usually impossible to separate syndromes entirely due to infection from those entirely due to malnutrition. In any event nutritional factors must be evaluated in order to plan programmes for improving standards of health.

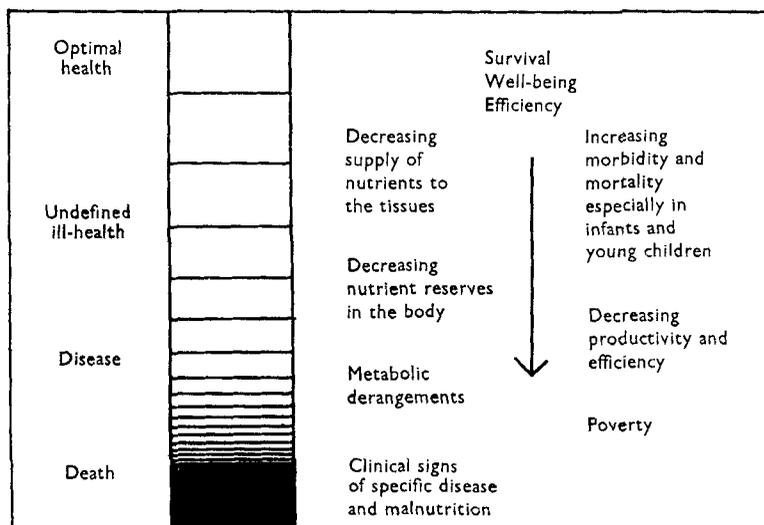


Fig. 1. Diagrammatic representation of grades of health status with associated phenomena in the body and in the community.

To allow for these considerations a nutrition survey would be concerned with observations in a given community of departures from optimal health as judged by signs of dysfunction of the body, including the effects of specific diseases and of dietary habits or indications of these.

#### *The importance of measurement*

Public health nutrition practice consists of manoeuvres designed to maintain, and if necessary to improve, standards of health through modification of dietary habits in the context of an ever-changing situation. The activities involved must usually operate on a national, and in some respects on an international, scale and may markedly affect national economy in one way or another. It is therefore most important that they be planned on information as correct as possible, and this information should be capable of being measured. Failure to express the nature and dimensions of nutrition problems in terms precise enough to convince administrators or to evaluate progress is, in my opinion, the reason for failure throughout most of the world to deal effectively with the ever-increasing problem of malnutrition which faces us today.

#### *What can be measured?*

If survival is accepted as a criterion of optimal nutrition, mortality rate provides an index of malnutrition in a community. Of course, individual life is normally limited, but the evidence is that with certain kinds of diet and in environmental conditions to some extent controlled, survival at least to adult life is to be expected. Failure of a high proportion of children to survive until adult life is a feature of communities living on diets restricted in variety, and to some extent, quantity. It is reasonable to assume that mortality rates among the younger age groups are good

indices of inadequate nutrition, and they lend themselves to precise measurement. Unfortunately, in places most affected by malnutrition, records of vital statistics either do not exist or are extremely unreliable. Information about mortality and morbidity rates must therefore be gathered first-hand, and this is not usually possible in a nutrition survey.

When estimates have to be made in the course of a single survey conducted over a limited time attention must be confined to clinical, biochemical and dietary observations.

*Clinical signs.* I believe that the unreliability of judging nutritional status through clinical examination is by no means fully appreciated even by doctors. The reliability of clinical assessments not only of 'general condition', but of such specific indices as the position of the heart apex beat, blood pressure, or abnormal clinical signs, stand up very poorly to statistical analysis (Sinclair, 1948; Bransby & Hammond, 1951). This finding is of great practical importance, because different observers can give quite different assessments of the nutritional status of a community, and the same observer may give different opinions when observing the same population on two different occasions.

Though in some communities obvious clinical signs of malnutrition such as oedema, angular stomatitis and dermatosis are encountered with appreciable frequency, there are others, perhaps the majority, in which specific signs are not seen. The latter communities, however, are far from well-nourished as would be revealed if resistance to infection, for example, could be measured. The situation is made more difficult in some areas where acute infantile beriberi is probably a major cause of death because the common victim is the one who appears well-nourished (Burgess, 1958). Furthermore, the most seriously malnourished may quickly be removed through death, or may be concealed during a survey.

For these reasons it must be concluded that clinical surveys do not usually supply the kind of measurement necessary on which to base public health nutrition programmes except in certain special circumstances.

Anthropometric measurement including skinfold thickness and upper-arm diameter can provide estimates of the amount of muscle (McFie, 1956; D. B. Jelliffe & H. F. Welbourn, 1962, private communication), and should therefore be more extensively used in nutrition surveys.

*Dietary habits.* We are as ignorant of the composition of the ideal diet as we are of optimal health. So in an absolute sense we are no better off in assessing dietary habits than in assessing physical status. But dietary inquiries have two important attributes. They can be measured, and they provide direct information about the only factor in a nutritional sense capable of modification in the interests of health. Unfortunately, the information needed is very difficult to obtain and involves tedious and prolonged studies of food consumption by individual members of the family. It is certainly not information obtainable in the usual nutrition survey.

Even when detailed information on food consumption is obtained there are still difficulties in assessing adequacy or defects in the diet. A diet can be considered adequate only if it allows absorption through the intestinal mucosa of nutrients in

certain amounts. Aside from the metabolic condition of the subject and pathological effects brought about, for example by wheat protein, absorption can be influenced by the extent of digestion and the chemical nature of the contents in different parts of the lumen of the gut. For example, the presence of phytate in amounts commonly found in diets consisting largely of cereals and pulses requires relatively high intakes of iron to allow a positive balance (Hussain & Patwardhan, 1959). The amount of iron available for absorption may not be revealed by dietary analysis based on standard food composition tables, because appreciable amounts of iron may be lost or added during commercial or kitchen processing (Wadsworth, 1962). In addition, the amount released by digestion is not proportionate to the total iron content of whole food, and may be strongly influenced by cooking (Sanford, 1960).

*Biochemical measurements.* Though it is important to measure dietary intake, it is not possible in surveys for the reasons given above. However, biochemical measurements should be very useful in this respect both because they can often be made during a survey, and because they give assessments of actual absorption of nutrients. A good example is to be found in ascorbic acid (Table 1), the serum and urinary levels of which are directly related to the dietary intake. There is a maximum level of about 1 mg/100 ml in the serum which is usually attained with an intake of about 75 mg/day. Higher intakes do not increase serum levels, but lead to greater losses in the urine.

Table 1. *Dietary and serum ascorbic acid levels in men*

(From Morgan, Gillum & Williams, 1955)

Intake (mg/day)	Age (years)	Serum level (mg/100 ml)
136	{ 60-64	0.94
44		0.27
89	{ 65-69	0.91
41		0.29

Unfortunately, blood and urinary levels of nutrients may be affected markedly by factors other than the dietary content. Thus, in disease of the liver, serum vitamin B<sub>12</sub> levels can attain the enormous value of 7000  $\mu\mu\text{g/ml}$  (Cowling & Mackay, 1959). Nutrients in the blood are conjugated with plasma protein fractions, and are thus affected by variation in the concentrations of these fractions. Thus, serum iron levels, and serum iron-binding capacity, are decreased in protein deficiency in correlation with concentrations of  $\beta$ -globulin (Edozien & Udeozo, 1960). Serum vitamin A levels are influenced directly by the diet (Gillum, Morgan & Sailer, 1955), but are influenced also by plasma protein concentrations. In protein deficiency serum carotene and vitamin A concentrations can be relatively low and can be raised by treatment with protein alone (Gopalan, 1961). Vitamin A is conjugated with albumin in the blood, and vitamin A and albumin levels in man are closely correlated (Woodruff & Stewart, 1962). This is true also in experimental animals (Friend, Heard, Platt, Stewart & Turner, 1960) and blood levels are independent of the amount of vitamin A in the liver. Carotene is associated with  $\beta$ -lipoprotein in

plasma, and in a patient without it no carotene at all was present in the blood (Salt, Wolff, Lloyd, Fosbrooke, Cameron & Hubble, 1960). It is of interest that in spite of very low levels of vitamin A as well as the absence of serum carotene, no signs of vitamin A deficiency were reported in this patient.

Biochemical measurements can provide two further kinds of information, namely the extent of nutrient stores in the tissues and of deranged metabolism resulting from tissue malnutrition. For either of them, special procedures or analytical methods are needed but are not readily applicable under survey conditions.

*Excretion of nitrogenous materials in the urine.* Diets that lead to malnutrition of various sorts and degrees are those that contain small amounts of foods of appreciable protein content. The effects of such diets may not be entirely due to lack of protein but also to lack of minerals and vitamins, because foods rich in protein also supply appreciable amounts of other nutrients. The higher the protein content of the diet the more likely it is to contain adequate amounts of all nutrients. Estimates of protein intake therefore have a special value in assessment of nutritional status. Fortunately, biochemical measurements provide a means of making such estimates.

The total daily loss of nitrogenous material in the urine is closely correlated with the dietary protein intake, but the great difficulty of collecting 24 h urine samples under field conditions precludes the measurement of this loss in nutrition surveys. However, the proportion of urea N to total N excreted in single urine samples is highly correlated with total N excretion (Patwardhan, 1961) or with creatinine excretion. Hence an assessment of protein intake can be made from estimations of the proportionate amount of urea in samples of urine collected over a short period of time, or even on a single occasion (Fig. 2). Of interest is the observation that proportionate urea excretion is related not only to the total amount of

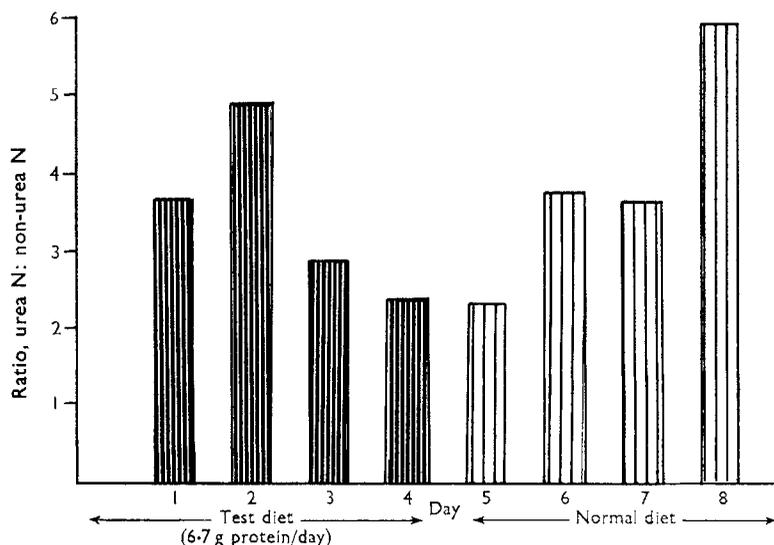


Fig. 2. Effect on the ratio of urea N to non-urea N excreted in the urine of restricting dietary protein in a normal adult male (based on results reported by Wadsworth & Lee, 1959).

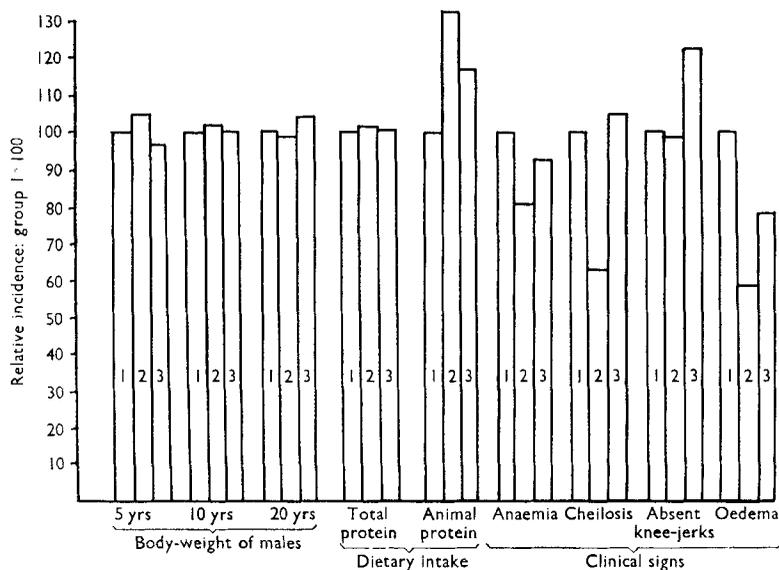


Fig. 3. Relative body-weights, protein intakes and clinical signs in Japanese households in three different socio-economic groups, 1960. 1, agricultural productive group; 2, non-agricultural productive group; 3, others. (From (Japanese) Ministry of Health and Welfare, 1961).

dietary protein but also to its probable biological value (Patwardhan, 1961), at least in so far as the latter is dependent on digestibility. The correlation between dietary intake of protein and urinary excretion of nitrogenous material may be markedly disturbed in some instances, for example after surgical operations (Wadsworth & Lee, 1959) and in severe malnutrition (Dean, 1961), but this effect would be unlikely to vitiate the use of urinary nitrogen studies in field surveys.

An indication of the possible value of protein intake as an index of nutritional status is given by results of detailed surveys conducted in Japan by the Ministry of Health and Welfare (1961) (Fig. 3). It will be seen that the community with a relatively high intake of animal protein contained children who were relatively heavy, and exhibited relatively few signs of malnutrition. It is of interest that the incidence of loss of knee-jerks is an exception. This observation is a reminder that residual signs of previous malnutrition must be differentiated from signs of present malnutrition. As a rule it is not possible to make field surveys with the precision and detail of the systematic Japanese inquiries, but estimations of urinary urea N and creatinine are feasible and could provide relatively precise and meaningful information about diet and nutritional status.

#### Conclusions

Many people are aware that a very serious situation obtains throughout the world in relation to food supplies and health, a situation which is likely to get much worse. In spite of it, effective public health programmes designed to deal with nutritional problems are not being universally devised. I believe that one important reason is a lack of precise assessments of the situation in various parts of the world.

Furthermore, the public and administrators have been conditioned to think in terms of calories, whereas the real problem is probably better expressed in terms of protein. Field surveys of conventional type do not seem to provide evidence with sufficient precision and require more time and workers than are available. In these circumstances analysis of urine for nitrogenous materials offers the possibility of providing relatively quickly an estimate of the extent and urgency of dietary deficiency and therefore of malnutrition. For this purpose urine can be collected from individuals or from pooled samples and the work would involve relatively little time and few workers.

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