THEMES IN FOOD SECURITY

Measuring Malnutrition

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1. Introduction

The purpose of this review is to provide a basic introduction to the various methods of nutritional assessments, at a level which may be of use to professionals concerned with: problem analysis in the field; management and evaluation of programmes; and information relevant to policy issues. The emphasis will primarily be upon the conceptual basis of techniques and with their relative advantages and limitations rather than with practical details. In common with most branches of science, this subject has its fair share of uncertainties and controversies over interpretation and these will be identified whenever possible, so as to provide some sense of the level of confidence that can be placed upon statements about the size and causes of nutrition problems.

In principle, there are two alternatives. We can either try to measure *nutritional status*, i.e. the outcome of previous nutrition, directly in terms of the presence or absence of deficiency signs, or of the failure of growth, or of some other important aspect of functional capacity. Alternatively, we can try to assess whether or not a person's *intake* of food is sufficient to ensure that those deficiency symptoms are unlikely to arise. Of course, the two methods are interdependent. If we choose to measure intakes we shall then need to compare them with some estimate of requirements, and these in turn will have had to be derived from past experience — research on the relationship between level of intake, and the symptoms that we have agreed to accept as evidence of deficiency.

In what follows, it is assumed that the first step in assessment will be to try to determine the degree of adequacy of the total food supply, i.e. the adequacy of dietary energy intakes. The word 'undernutrition' will be used to describe the effects of low intakes of dietary energy as distinct from the broader term 'malnutition', which is intended to cover the effects of deficiencies of any or all nutrients.[1] Here, the discussion will be limited to assessment of energy.

2. Assessing the Adequacy of Dietary Energy Supply

2.1 Defining energy requirements

Unlike many of the other essential nutrients, there are no very clear and unequivocal signs or symptoms which can be used to establish the threshold between adequacy and inadequacy of energy intake. *Any* change of intake results in compensatory adjustments in activity, body size or growth, body composition or metabolism, either singly, or all together. Moreover, the range of these adjustments is very wide.

In the absence of specific deficiency symptoms, energy requirements have until very recently been based on the *average observed intakes* of groups of people living in relatively affluent circumstances, and presumed to be healthy.

In practice, therefore, the intakes of groups of poorer people, or of the populations of poorer countries, have in effect been assessed by comparing them with those of richer people or richer countries. In this way, the 'standards' of size, growth and physical activity upon which these requirements are *implicitly* based have been those of affluent populations. This has always posed problems for committees advising on requirements. First, because people in developing countries are generally smaller at all ages than those of rich ones. Secondly, because the body weights of adults in affluent circumstances are increasingly considered to be too high, and their physical activity too low, to be consistent with optimum health. Notwithstanding these problems, since the first FAO (1950) committee on calorie requirements, reports of successive expert groups have suggested increasingly elaborate procedures for scaling the recommended levels to take account of age, sex, and body size differences between countries, although the basic figures for requirements per unit of body weight have remained substantially unchanged.

At least until 1985 all these committees have seen their function primarily as making *recommendations* about the amounts of food energy supply at the national level that would be consistent with a nutritionally healthy

[1] Vitamin A and iodine deficiencies are still considerable public health problems in many developing countries. In the Asian countries, high prevalence and large populations at risk combine to produce an estimated half million cases per year of children with active corneal lesions and 5 million non-corneal xeropthalmias. About 800 million people are at risk of iodine deficiency diseases which include endemic cretinism as well as goitre. Although it is possible to show approximate geographical distributions of populations 'at risk' there is a shortage both of national representative studies and of within-country distributions. Methodologies for measurements of status are technically demanding and expensive.

population. This has led to a general tendency to err on the side of safety, and to avoid any accusations of planning for suboptimal standards. Also until 1985, all the UN reports have been emphatic that these recommended levels should *not* be applied to individuals, but only to groups. Furthermore, they were not intended to be used as a yardstick for the detection of undernutrition, but only as normative indices for planning aggregate food supplies.

During the past few years, two things have happened which reflect changed ideas about requirements. First, the most recent UN Committee (1985) has acknowledged that there could be two quite different purposes for requirements and hence two different sets of values. Besides the more traditional *prescriptive* purposes of recommending intakes which *should* be anticipated in populations with adequate levels of incomes, social welfare and health provision, it would also be useful to have different estimates which could be used for *diagnostic* purposes, i.e. levels below which individuals would be likely to experience some detrimental effects.

Secondly, and despite some continuing dispute on the matter, it is becoming more accepted that for diagnostic purposes at least, the requirements of individuals can be assessed *on the basis of their existing body size:* individuals are no longer automatically classed as undernourished simply because they are smaller: indeed some people are prepared to concede that there may even be advantages to being small.

We shall return to this last point in the later section on assessing nutritional status. For the moment, however, the changes of ideas about energy requirements during the past 30 years are illustrated by the example in Table 1.

The first six lines relate to a 55kg male subject, chosen because this corresponds to the standard 'consumer unit' for India used as the basis for calculation of poverty line consumption levels by Sukhatme (1961) and by Dandekar (1971).

The first four lines show the energy needs of a 'moderately active' man of this body weight, as recommended by various committees over the past 30 years. These are different estimates of the normative or expected average requirement for men of this size. The WHO/FAO/UNU 1985 estimate was based on the use of 'international standards for basal energy metabolism'. [Basal metabolic rate is the rate of energy metabolism in a fasted [18 hours without food, i.e. overnight] person in a state of complete rest in warm surroundings.] However, if this is calculated using a regression equation known to give good predictions of basal values for Indian subjects, the requirement is reduced by 12 per cent. Even this estimate includes a component to cover desirable social and recreational activities [which the UN report refers to as 'discretionary']. If we were to adopt Rowntree's (1901) approach to defining absolute poverty as a condition in which life and working function is sustainable but *without decency*, then this discretionary component, which amounts to between 200 and 300 kcals per day, would be omitted.

Up to this point, it has been assumed that the body weight should be maintained at 55kg. The actual body sizes of many poor but active Indian men are lower than this. If a downward adjustment to 44kg is made,[2]

Table 1 **Energy requirements of a male adult with a nominal body weight of 55kg (BMI 22.4)**

Basis of calculation	*kcal/day*
FAO 1957 Moderate activity	2830
FAO 1973 Moderate activity	2530
WHO/FAO/UNU 1985 Moderate activity	2710
ICMR 1982 Moderate activity	2700
FAO 1985 Corrected for overestimation of BMR[1]	2450
As above, without 'discretionary' activity[2]	2200
As above, with body weight adjusted to 44kg (BMI 18)	1960
80% of ICMR Lipton (1983) 'ultra poor'	2100
FAO 1985 'survival' requirement (1.27 x BMR)[3]	1550
As above, with BMR adjusted by 15% (1.2 BMR)	1470

[1]BMR calculated using the equation of Quenouille *et al.* (1951)

[2]Discretionary activities are described in the 1985 UN report as those connected with social and recreational pursuits. They amount to about 250 kcals per day for a man of 55kg.

[3]Allows for minimal activities such as washing, dressing, standing, etc. No discretionary or occupational activities.

Source: Payne and Lipton (1990)

Table 2	Factorial components of energy requirements			
	Baby	*Girl*	*Adult Man*	*Adult Woman*
Age years	0	5	25	25
Weight kg	3.2	14.0	55	43.0
Maintenance	144	700	1400	1030
Growth kcals	133	17	0	0
Activity kcals	113	460	1310	710
Total kcal/day	390	1177	2710	1740

Source: Payne and Waterlow (1971)

the requirement falls still further to 1960 kcal/day. This estimate still allows for occupational expenditure at the 'moderate' level, but brings the figure very close to the 2100 kcals suggested by Lipton (1983) as the threshold for ultra-poverty. The next and lower figure in the Table is for an *unemployed* person surviving perhaps on food relief programmes, and denied the level of social and recreational activities consistent with a 'decent' lifestyle.

Finally, the last figure in the table includes a downward adjustment of 15 per cent of the basal metabolic rate component of maintenance, to allow for the possibility of what has been called metabolic adaptation. This is the amount by which the tissues of the body may lower their rate of energy use as an adaptive response to long continued exposure to low food intake.

In addition to these changes of ideas about the purposes for which energy requirements could be used and the significance of adaptive changes in body size, the basis on which the figures themselves are derived has also changed. Previous to 1985, the numbers were essentially representative of the observed intakes of 'normal' populations, presumed to be healthy, i.e. they were essentially normative. The more recent estimates are built up from 'factorial components', which represent the energy costs of separate processes-maintenance, growth and physical activity. We are therefore moving towards a situation where energy needs are based on knowledge of physiological processes. Table 2 gives some examples of the relative magnitudes of thse components at different ages.

Points to note are that the energy requirements for growth are a significant proportion of this total, for the baby only: in fact after the first year of life, growth is an insignificant component of food needs. The energy cost of activity includes that which is basic for life, i.e. sitting, standing, eating, washing, defecating etc: that which is essential for social interactions, plus that which is used for productive work.

[2] As will be seen later, this is about the lowest body weight consistent with survival and continued economic activity for a person of average height.

2.2 Measuring intakes

It often comes as a surprise to non-nutritionists to discover that direct measurement of food intakes is in fact the most difficult, expensive and probably the least satisfactory way of identifying malnourished people.

Figure 1 shows an overview of the food system of a country and whereabouts in the system attempts are commonly made at assessing food flow rates. The diagram also shows the various factors other than food availability, which influence the state of nutrition of households and individuals. As we shall see later, these other factors also complicate the problem of assessment, because they influence food requirements.

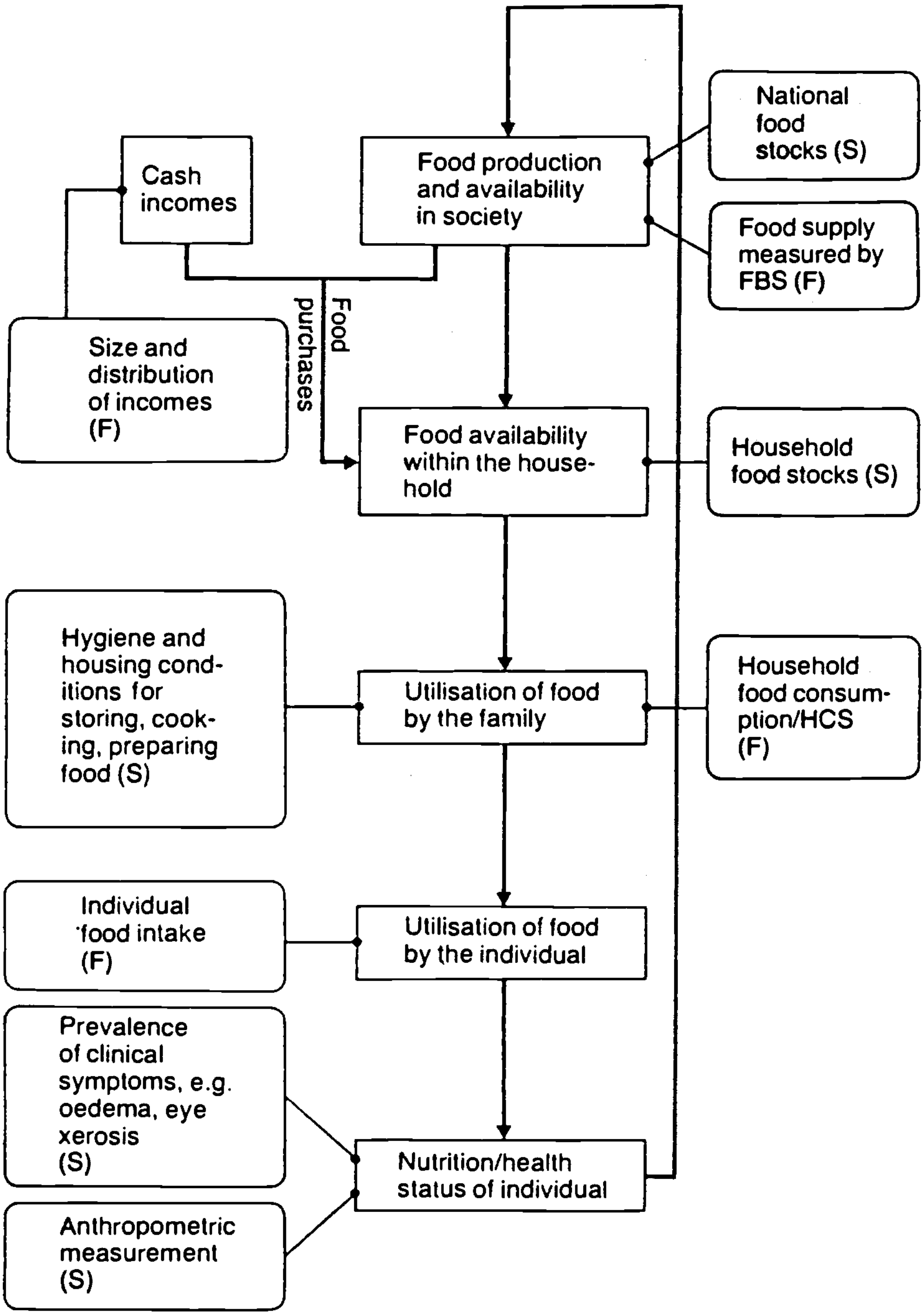
National level assessments

It seems a reasonable question to ask whether or not a particular country has a food supply adequate for the needs of its population. However, the very wide range of estimates of the numbers of people on a global scale considered to be malnourished, according to different methodological approaches and the bitterness of the controversy between the various proponents [see for example Sukhatme 1982; Dandekar 1982; Srinivasan 1987], suggest we should be cautious about accepting any of them.

The Food and Agricultural Organisation in its Fourth (1977) and Fifth (1986) World Food Surveys puts the proportion of their world populations living below a *minimum survival level* of energy consumption at about 15 per cent, whereas the World Bank (1986) assesses the numbers living on diets with less than *optimum energy* content at between 14 per cent and 51 per cent. Sukhatme (1977) (the most committed adaptationist) estimates that in India the numbers of people whose energy intakes are below the *lower limit*

Figure 1

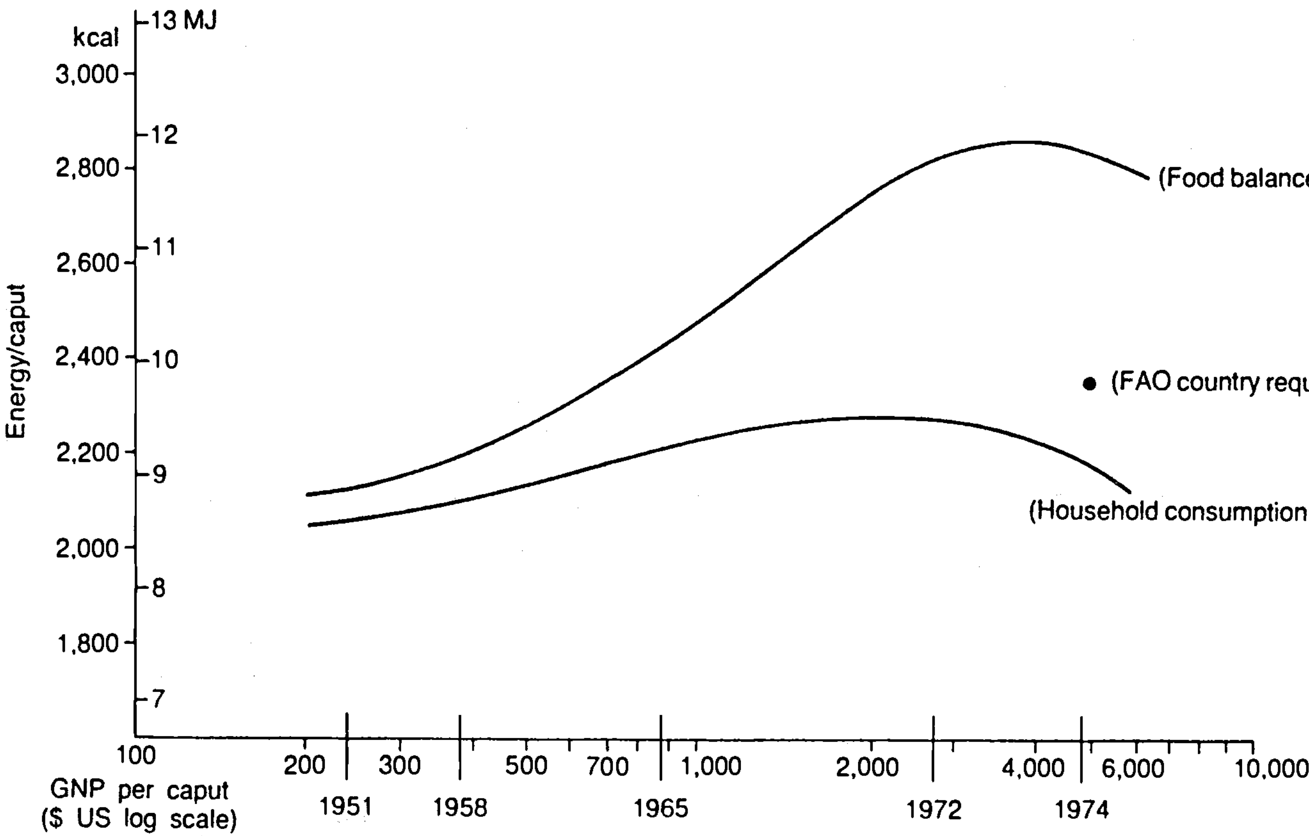
The food system of a region or nation showing some of the system variables which are commonly measured.



Notes: F denotes variables which measure flows through the system; S denotes variables which reflect conditions within the system.

Source: Pacey and Payne (1985)

Figure 2



Longitudinal comparison — Japan (energy and GNP/caput, energy supply data (food balance sheets) and energy intake data (household consumption surveys)).

Source: Dowler and Seo (1981)

of adaptation is 20 per cent of the population, whereas Dandekar and Rath (1971) estimated about twice that proportion to be unable to purchase a *minimum adequate diet*.

Most of these head-counting exercises, which purport to estimate the numbers of undernourished people at country or global level, do so on the basis of distributions of 'consumption' that are 'synthesised' from a combination of food balance sheet and household food expenditure data. The food balance sheets are used as a substitute for direct information about the *average* energy intake. But these seem to have systematic errors which lead to underestimation of consumption for low income countries, and overestimation for higher income populations[3] (Figure 2).

Household food expenditure is used to derive information about the distribution between households. However, as Casley and Lury (1981) have pointed out, there seems to be something fundamentally unsatisfactory about household expenditure as a measure of energy intake: most of the data sources, when stratified by income, generate class means which span a range from intakes which are from a physiological point of view, impossibly low, to ones seemingly impossibly high. Finally, the level of aggregation of these data sources forces us to express them in terms of consumption units, thus making the implicit assumption that intakes are allocated between age/sex groups in proportion to requirements.

Household level

As we go from the population level progressively towards more disaggregated measurements, some of the technical difficulties reduce and some get worse. In theory at least, it is possible to measure the amounts of food actually consumed at the level of households and, for example, to correct for wastage and meals eaten outside the home. However, as Figure 1 suggests, in other ways the problems are more complex. How, for example, can we take account of the demographic structure, the presence of disease and perhaps most serious, how can we correct for the wide differences in energy expended in work and other kinds of physical activity? At this point, however, it is worth noting that it is quite commonly stated as an established fact that the cause of much malnutrition in women and small children is unfair distribution of food within households.

In reality it is extremely difficult to establish whether or not such discrimination occurs, since this could only be detected on the basis of concurrent measurements of both intakes *and* expenditures of energy at the individual level, with, in addition, some assessment of outcome in terms of the nutritional status of the household members and of the impact of this on their contribution to household resources. Very few studies provide this kind of data, although, as it happens, those which most closely approach the ideal seem to show that, for example, in respect of regular and predictable seasonal food shortages, discrimination is, if anything, in favour of children: even in favour of girl children. Again, if anything, men show greater seasonal changes in weight status than women (Rosetta 1986) — partly because the latter seem to have more effective means of metabolic compensation. In response to severe and unpredictable stress, for example, prolonged famine, there *is* evidence of discrimination against the very young and the very old (Dirks 1980). However, in traditional societies at least, this only happens after the possibilities of sharing of food, fuel, time and other resources both within and between households has been exhausted. At this point, survival of those most likely to succeed in rebuilding the household becomes the first priority.

Where changes in income are the source of stress, rather than famines or seasonality, there are again problems of incompleteness of data from which to draw inferences as to the nature of the pattern of change within households: generally, we are forced to try to draw conclusions about these from income-related changes in households average consumption of energy, without knowledge of concomitant changes in energy expenditure. Generally, the evidence is of positive but unexpectedly small elasticities of consumption (Behrman and Wolfe 1984) and of discontinuities and non-linearities, instead of the smooth operation of the Engel and Bennett's 'laws' of consumption (Bouis and Haddad 1988). [Engel's Law states that as total expenditure rises, the proportion spent on food falls: Bennett's, that the proportion of food outlay devoted to starchy staples falls.] Evidently, the processes of adjustment to income as a source of stress involve complex shifts of behaviour and redistributions of consumption, and with substantial differences *between* families having similar levels of income, but depending on different types of employment opportunities, levels of education etc.

In practice therefore the best we can expect from the analysis of intake measurements is to get some assessment of the probability that dietary energy is *one* of the limiting constraints to improving the health and productivity of individual households, or of groups of households living in any specific socioeconomic or environmental circumstance.

The difficulty of drawing any further conclusions is complicated not only because of the likely contribution

[3] This is partly due to the methods used to estimate the non-marketed components of production, all of which are more prone to under- than to overestimate (Poleman 1981). Partly also to problems of double-counting in the food data systems of market economies, which increase with the complexity of processing of food products (Dowler and Seo 1985).

of specific nutrient deficiencies, but is further increased by the interactions of nutritional factors with the effects of infectious diseases. Repeated infectious episodes can initiate the process of becoming malnourished, through depression of appetite and increased losses of body tissues. The converse is also sometimes true: episodes of food restriction can increase the chances of severe infections. This means that a child is likely to have reached a state of clinical malnutrition through a sequence of episodes, which may or may not have been initially triggered or later reinforced by lack of available food (Martorell 1985; Beaton 1989).

Similarly, an adult experiencing a period either of illness or of food shortage might suffer an impaired capacity for physical work. If this happens at the critical time when hard work has to be done to prepare ground for the next crop, or at the only time in the year when scarce employment becomes available, the outcome would be the same — the initiation of a self-reinforcing process whereby the capacity for future production of food or cash is reduced to the point where hunger threatens to damage the health of perhaps an entire household. The difference of course is that in this case the 'system' which breaks down is that which comprises the network of food entitlement of the household as well as the sub-systems of physiological regulation which comprise its members. In these two examples, although a sequential analysis of changes of intake and body weight and episodes of morbidity might enable us to draw some inferences about initial causes, measurements made at a single point in time would not.

It should be said, however, that even if quantitative assessment of intakes is considered impractical or unjustifiable for these reasons, there may still be much to be learned from questionnaire assessments of *patterns* of food use and more specifically changes in those patterns either over time or consequent on changes in income or means of livelihood. The way people use foods can give very useful indications of the strategies they adopt to cope with seasonal or occupational changes in food entitlement.

3. Measurement of Nutritional Status

3.1 What should we measure?

If assessment of food intake is so problematic, why not just rely on the direct measurement of nutritional status? The usual process of developing a method for diagnosis of disease conditions is one by which accumulating experiences and knowledge of mechanisms, results in either a single symptom, or a set of symptoms coming to be recognised as characteristic of a specific causal agent — a disease organism, the presence of a particular toxic substance in the environment, or in the case of nutrition, the absence or insufficiency of energy or of a specific nutrient in the diet.

Logically then, a discussion of techniques for identifying and measuring undernutrition should begin with the identification of some symptom, or symptoms which exist in all individuals suffering from lack of dietary energy, but not in those suffering from any other deficiency or disease condition. The basic technique of measurement would then consist of assessing the extent and severity of these symptoms in affected populations. As we have seen, however, in respect of energy there *is* no set of symptoms which is unique to that particular cause. In practice, what is usually meant by people who speak of the extent of undernutrition in populations is the existence of individuals who are either relatively small in size for their age, or whose energy intakes imply levels of physical activity which are lower than is considered desirable.

3.2 Indicators and grades of status

A good many different anthropometric indicators have been devised for defining different classes or grades of severity of growth retardation. These will not be dealt with in any detail here. A good review will be found in WHO (1983). Generally they are based on estimates of the total mass of body tissues, measured as weight, arm circumference, or skinfold thickness. These are often complemented by measures of linear size, most commonly height, but sometimes head or chest circumference. In all cases, the measurement has to be related in some way to the age and sex of the individual. Table 3 summaries the basis and characteristics of four commonly used indicators.

As in the case of requirements, there are problems of interpretation. If undernutrition is to be assessed in terms of deficits from some 'well nourished' state, how can we define this state as a fixed point and how can we rank the importance of different degrees of departure from it? As with standards for requirements, the solution has been to resort to normative growth standards. The mean or median values of body dimensions of well fed and cared for populations are taken as a reference point and the individual variation around those mean values as an indication of how much deviation could be assumed to be of genetic (or at least of non-nutritional) origin. The various anthropometric classifications of individuals, as 'normal', 'mildly', 'moderately' or 'severely' undernourished, have all been derived in this way. The different grades of severity are in effect levels of the probability that such individuals are small because they are undernourished, rather than simply because of their genetic constitution.

3.3 Anthropometry and mortality risk

As in the case of assessment of food consumption, this

Table 3

Basis of measurement	*Reference standard*	*Grading of status*		*Characteristics*
Weight-for-age	Harvard child growth standards (40th centile)	[1]Normal 1st degree (mild) 2nd degree (moderate) 3rd degree (severe)	>90% 76-90% 61-75% <60%	Widely used and understood. Combines effects of past and present episodes of disease/ malnutrition.
Height-for-age	NCHS growth standards (median)	[1]Normal Mild Moderate	>95% 87.5-95% 80.0-87.5%	Integrates effects over whole of life up to age of measurements. Insensitive to acute episodes.
Weight-for-height-for-age	NCHS growth	[2]Normal Mild Moderate	>90% 80-90% 70-80%	Indicates current or recent episodes, insensitive to small but normal proportioned individuals.
Mid-upper arm circumference	Single figure of 16.5cm for all children between one and 5 years	[3]Normal Mild Moderate	>13.5cms 12.5-13.5cms <12.5cms	Indicates current or recent episodes. Fast, cheap, reliable (with careful training of observers). Good predictor of mortality risk. Needs only approximate ages.

Sources: [1]Gomez *et al*, 1956
[2]Waterlow *et al*, 1977
[3]Jelliffe, 1966

normative approach has come under attack, partly for the same reason that it seems to discount the possibility that people who have adjusted to their environment to the extent that they are 'mildly' or 'moderately' small, might not be at any overall disadvantage. Thus, there is a controversy over the issue of whether 'small is beautiful' (Seckler 1982), as opposed to those who say 'big is best' (Scrimshaw and Young 1989). Again, as in the case of food requirements, there has been a move away from prescriptions of what is needed to bring everyone up to normal size, in the direction of using anthropometry as a means of *diagnosing* problems in populations in terms of the existence of individuals exposed to high levels of life-threatening risk.

Figure 3 shows the results of two studies which recorded the weights of two to three year old children in terms of the per cent of the expected weight in a reference population (middle class children in the USA). Deaths were recorded subsequent to weighing and the graphs shown take the form of mortality 'risk' curves in relation to attained weight. These, and other studies since, suggest that there is a range of growth status over which the risk changes slightly, if at all, but a lower threshold below which mortality expectancy rises steeply (perhaps the lower boundary of a range of adaptive responses?).

3.4 Adult anthropometry

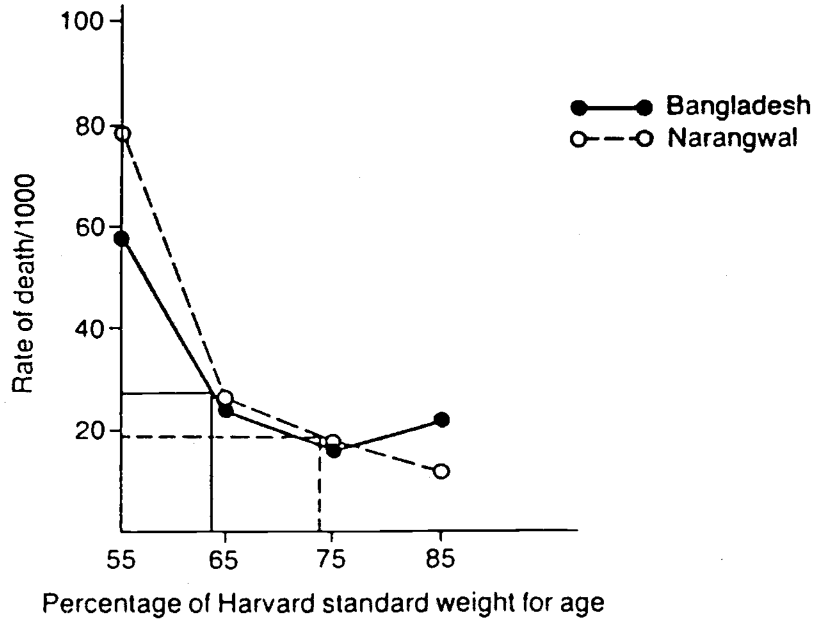
Similar analyses have been made of anthropometry of adults and prospective risk. Figure 4 shows the results of a survey of 1.8 million Norwegian adults, followed by 15 years of mortality registration. The measurements of weight and height are in the form of Body Mass Index (BMI), calculated as weight (kg) divided by height (metres) squared.

BMI is rapidly becoming accepted as the best anthropometric index to use in comparing the health status of adults. It could well prove useful as a way of extending the value of child anthropometry by including all the members of household units in a composite index of household health.

3.5 Small body size: a problem or a marker?

Although relating body size to mortality risk is an advance over the simple normative approach, it does nothing to resolve the problem of multiple causes. On the basis of growth measurements alone, it is simply not possible to say whether a person is suffering the direct and uncomplicated effects of low food

Figure 3

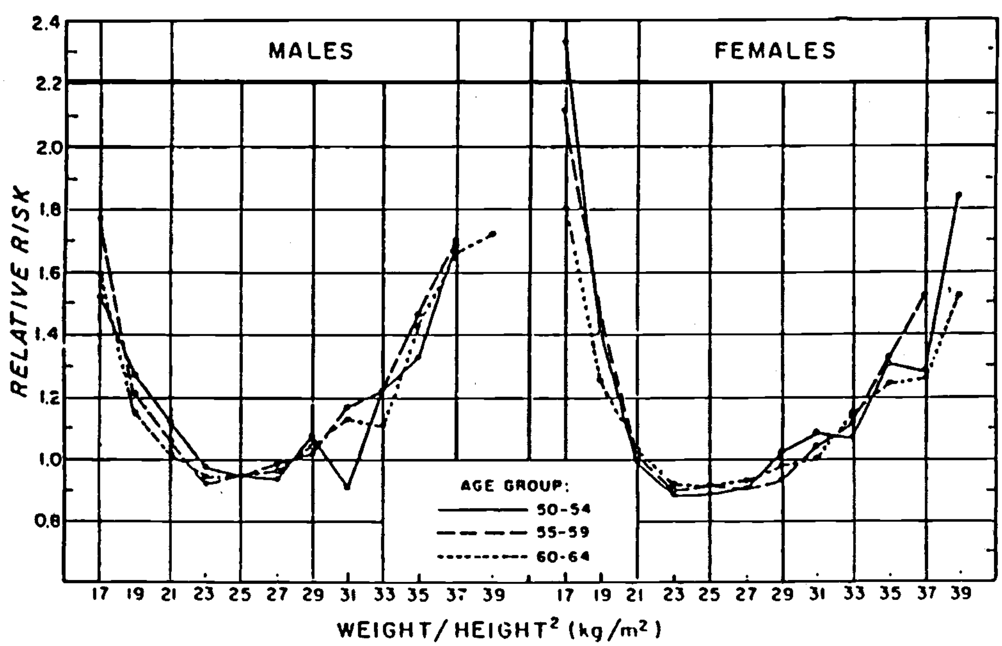


Variation of death rate vs weight-for-age for two groups of children: Bangladesh (children aged 12-24 months), Narangwal, India (children aged 0-36 months).

Notes: The vertical lines at 63 and 73 per cent weight-for-age represent Bairagi's view of the 'best cut-off points' for nutritional monitoring.

Source: Pacey and Payne (1985)

Figure 4



Source: Waaler (1984)

Figure 5

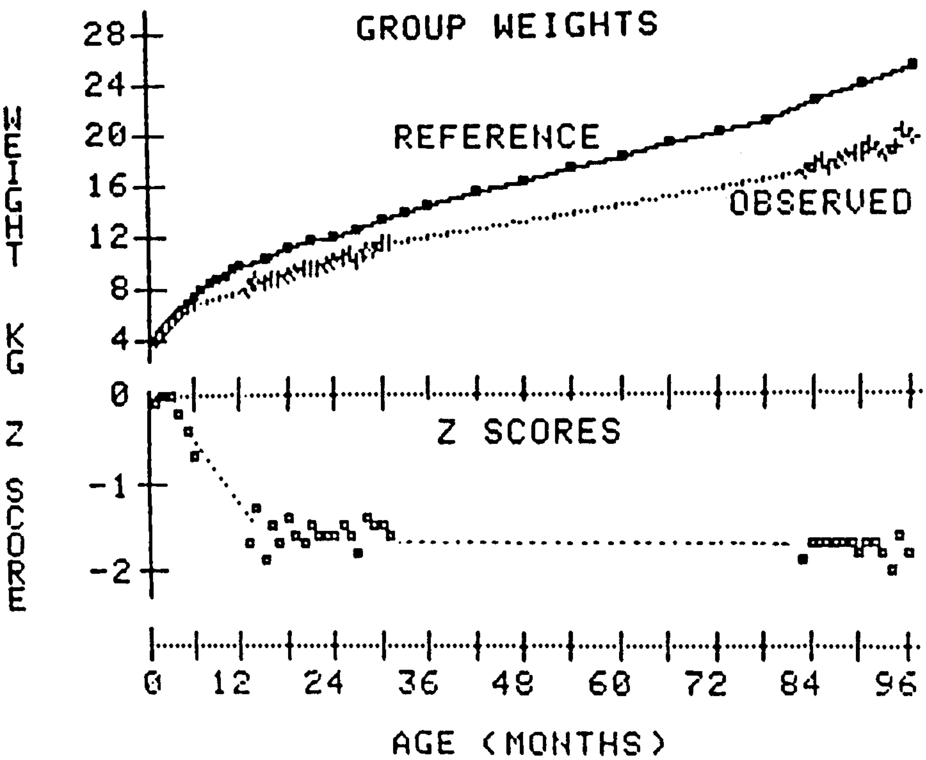


Figure 2. Observed pattern of weights seen in groups of children. In the top panel, observed means from a Kenyan study [mixture of longitudinal and cross sectional data; not selected to be representative] are compared with the normalised NCHS/CDD anthropometric reference. In the lower panel the difference between observed weights and reference weights are expressed in terms of standard deviations (z-scores). Note the apparent plateau in mean z-scores after 18 months.

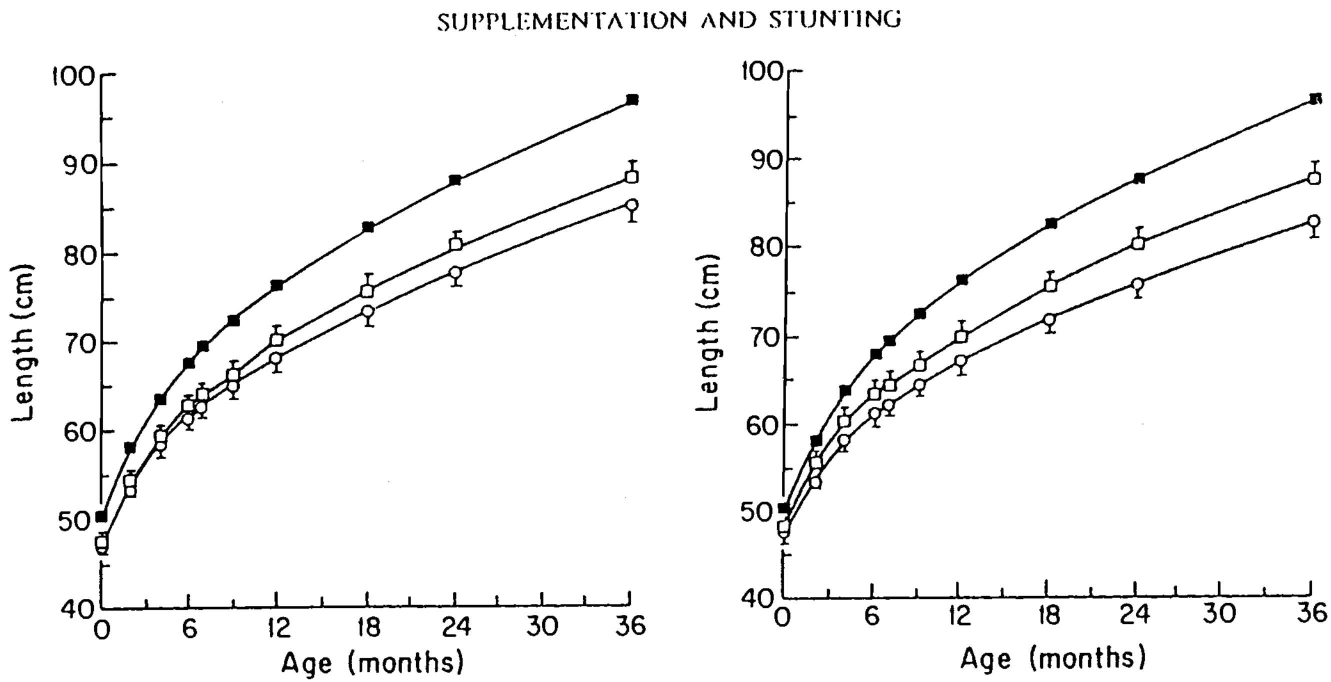
Source: Beaton (1989)

availability, or from the secondary effects (loss of appetite, toxic effects etc.) of infections. In addition, it is now becoming clear that when any environmental insult, be it energy or nutrient deficiency, an infectious disease or any other trauma, takes place very early in life (e.g. within the first two years), some of the effects on growth may persist throughout the whole of childhood or perhaps the rest of life.

This means that much of the small size seen in children and adults in poor countries is a record of *past episodes* of illness or deprivation and not necessarily of *current* conditions. Furthermore, it seems that when such reprogramming of growth control has been established it is not possible to completely reverse the effects. This explains why so many feeding programmes targeted towards under five year old children seem to have had so little effect on growth — they did little to improve the impact of disease during the weaning period, and were unable to reverse the effects of early (one to two years) diarrhoeal and other infections on subsequent growth.

Figures 5 and 6 illustrate these two environmental aspects of child growth. Figure 5, which is taken from Beaton (1989) shows the time course of growth of children living in Kenya. They came from 'middle farmer' families, i.e. neither the poorest nor the richest. The upper curve suggests that there is an increasing deficit in weight growth below the reference standard: the lower shows that in terms of the normal variance of the reference population (i.e. values plotted in units of standard deviations or 'z scores'), the divergence took place entirely within the first 12 months and was subsequently unchanged up to eight years. Figure 6, which is taken from Lutter *et al.* (1989), shows the effects on growth in length of a supplementation programme in Colombia, which provided a special weaning food (670 kcals/day) to all infants between three and six months along with a

Figure 6



Cumulative growth patterns in length of supplemented (□) and unsupplemented children (O) and NCHS median (■) (left) and of supplemented and unsupplemented children in the highest quartile of diarrheal disease and the NCHS median (right).

Source: Lutter *et al.* (1989)

600 kcal/day allowance of bread, powdered milk and cooking oil for all other members of the families. This was continued for several years. The growth curves show that as compared with unsupplemented controls, length growth was indeed increased by this quite massive level of supplementation and that the children with the highest amount of diarrhoeal disease benefited most. However, even after three years of continued supplementation, 75 per cent of the deficit in length (below the WHO growth standards) still remained.

Beaton (1989) has summarised the current situation with respect to the interpretation of growth data as follows:

> The inappropriate application of anthropometric measurements is the blind acceptance of the assumption that these are the sole or final definition of malnutrition. As has been emphasised in this paper, growth and achieved size are markers of many influences and constraints operating in early childhood. They are *not* specific markers of nutritional problems. One must not accept an argument that these children are 'adapted' to their environment or that they are free of the stigmata of developmental impairment, but neither can one accept blindly the argument that they are malnourished.
>
> One might well ask what difference this makes — after all, it is only a name that we apply to classifications. It may be much more. Given that we think of smallness and malnutrition as synonyms, we have built expectations that have not been fulfilled in practice. Food distribution programmes do not produce the weight responses that were assumed would follow when 'undernourished' children were fed. A general disillusionment with 'nutrition' has resulted. Perhaps even more important, by focusing on smallness as the measure of malnutrition, we have excluded or at least denigrated other routes of effect of undernutrition.

4. Implications for Policy

Despite the somewhat negative tone of the discussion so far, the changes of perception amongst nutritionists and health professionals during the past few years have contributed very usefully to dispelling some of the more simplistic ideas of the past. Thus, although we now know that assessing the extent of overall food deficiency in populations is much more difficult than was commonly believed, the implication is that there is in fact little basis for the estimates of *very* widespread food insufficiency which were common in the 1960s and 1970s. Although there are no doubt very good reasons for increasing agricultural production in poor countries, these are likely to be social and economic in the first instance and not mandated by the need to increase average consumption levels in the expectation of widespread nutritional and hence human capital benefits. The idea of malnutrition being a key link in the 'vicious cycle' of undevelopment, looks doubtful.

In the process of revising ideas about energy requirements, we have now at least some firmer estimates of the minimum amounts of energy, below which economically productive work is impossible and the life-threatening risk is high.

This has strengthened the validity of indicators of ultra-poverty such as the 80-80 rule suggested by Lipton (1983), and emphasised the need to see undernutrition primarily as an equity issue.

The significance of the substantial differences in body size between the populations of rich and poor countries can also now be reassessed. Reduction in body size turns out to be one of the most important adjustments that individuals and populations can make in response to adverse environments [including nutritional deprivation]. In so far as reduced growth [as compared to Western populations] seems to originate in events occurring within the first year or so of life, the current view is that the *state of being small* is not so much a problem in itself, as an indicator of adverse environmental processes which, amongst other perhaps more serious things cause child growth rates to be depressed. Except in the more severely affected individuals [i.e. those conventionally classified as severely malnourished, less than 60 per cent of reference weight-for-age, or more than two standard deviations below the reference median of height], there is very little evidence of functional disadvantage and, after the first two or three years of life, diminishing possibility of 'treatment', i.e. stimulating catch-up growth through food supplementation.

Controversy over the question of whether or not people can be said to 'adapt' to different nutritional and other environmental influences, has focused more attention on the mechanisms of physiological and behavioural responses to stress. In this area, it seems that changes in body size are of major importance. The following two examples illustrate this. Table 4 contrasts two ways in which an adult male might respond to a stress such as changes in wage rates or food prices which 'force' a 10 per cent reduction in energy consumption. The first alternative A consists of simply cutting physical expenditure to offset reduced intake while maintaining body weight. The second, B, loses body weight and hence lowers his maintenance energy requirements, whilst maintaining almost the original level of work output.

It is important to say that if the measurements were made correctly, and the calculations performed by the method now proposed by WHO (1985), both A and B would be judged to be consuming their own appropriate required amounts of energy (i.e. they are

Table 4 **Adjustment to 10% cut in energy intake**

	Two alternative strategies – A and B		
	Initial State	*Intake reduced by 10%* A	*Intake reduced by 10%* B
Energy intake (kcals/day)	2600	2340	2340
Maintenance energy (1.4 BMR kcals/day)	2000	2000	1740
Productive work (kcals/day)	600	340	550
Body weight kg	55	55	48
Body Mass Index	21	21	18.1

Source: Payne and Lipton (1990)

Table 5 **Effect of Growth Faltering on Energy Needs**
Reference (R) v energy stressed (S) female growth

(R) Age year	0.5	1	5	10	25
Weight kg	7.2	9.5	17.7	32.5	57
Kcal Expenditure breakdown					
BMR	360	618	885	1137	1368
Activity	224	317	584	705	847
Growth	83	50	25	67	00
Total/day	667	985	1494	1909	2215
Total/life	32214	81207	1760207	4862700	16360207
(S) Age year	0.5	1	5	10	25
Weight kg	7.2	9	14	22.5	43
Kcal Expenditure breakdown					
BMR	360	585	700	788	1032
Activity	224	300	462	488	713
Growth	83	22	17	33	00
Total/day	667	908	1179	1309	1745
Total/life	32214	79803	1503303	3693300	11905803
Kcal/day saved		77 (8%)	315 (21%)	600 (31%)	470 (21%)
Lifetime saving	1404	256904	116940	4454404	

Source: Payne and Lipton (1990)

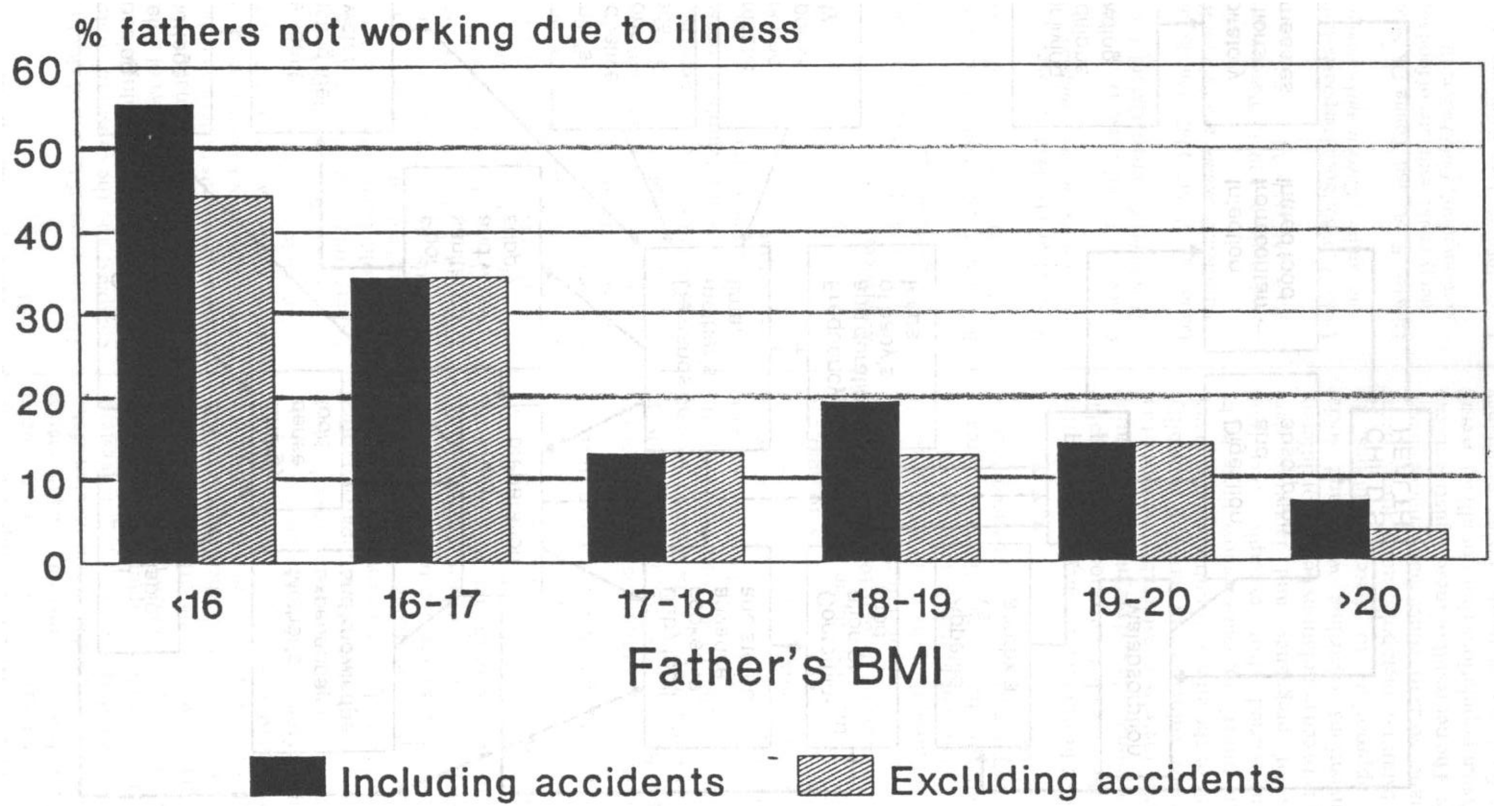
both in a sustainable state). B's body weight and BMI are lower than A's, but not seriously. In fact these values were based on those of typical middle and low class farmers in Tamil Nadu.

Any judgement about the acceptability or otherwise of these alternative strategies for coping with stress, would have to be based on other considerations. Are the new situations sustainable? Has A sacrificed energy expenditure previously used for sustaining social exchanges, honouring obligations etc? Will he be able to sustain output from his own plot of land without risk of losing employment opportunities?

B may show no ill effects in the short-run, but will he be able to absorb further stress, seasonal shortages, or labour peaks? Figure 7 shows that amongst labourers in Bangladesh, working days lost because of illness is much higher in those whose BMI falls below 17.

Figure 7

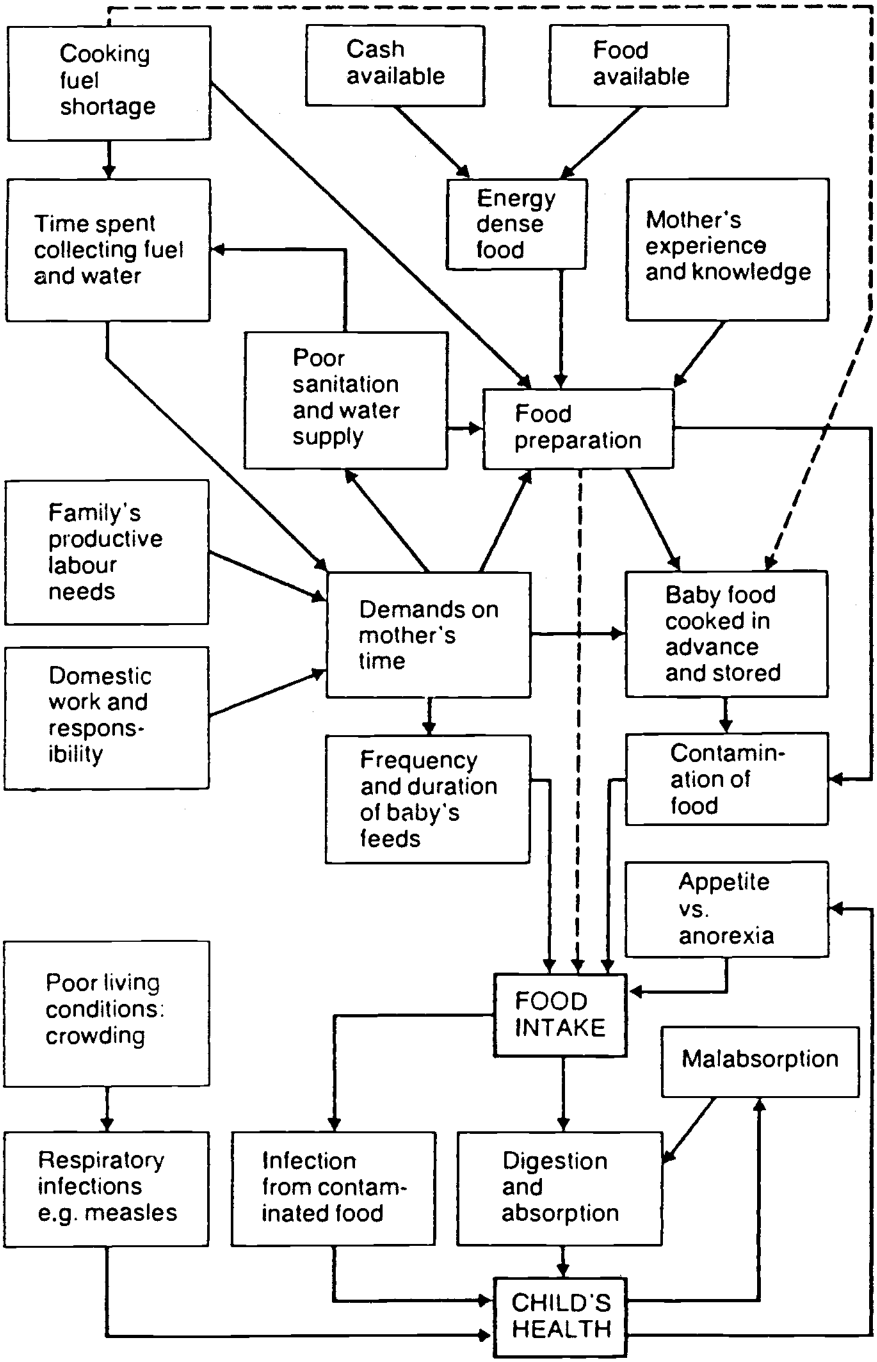
BMI and loss of work due to illness in previous month, in fathers of under 5 children



Source: J. Pryer, 1990

(n = 199)

Figure 8 **Summary of factors affecting the nutrition of small children**



Source: Pacey and Payne (1985)

The second example is of the relationship of body size and long term food needs. Table 5 shows in the upper section (R), the body weights and energy requirements of a girl growing to adulthood along the median of the reference growth standard (i.e. typical of a Western population). The lower section simulates the effect of early environmental stresses which result in a switch from the median down to the 5th centile of the reference standard by the end of the first year of life. This girl reaches an adult weight of 43kg, which is a growth path typical of many rural Asian populations. The bottom lines of the table show that the immediate 'saving' of food resulting from reduced growth rate is small, 77 kcals or 8 per cent, and in comparison with a likely *household* daily requirement of about 9,000 kcals/day, quite negligible. However, with increasing age the daily saving rises to between 20 and 30 per cent. Moreover, the cumulative saving of food over time is considerable: by the age of 25, the lifetime consumption of the smaller woman is some 4m kcals lower than her Western sized counterpart — an amount sufficient to provide for the life-time needs of another (slow growing) girl up to the age of 10 years.

The intention of these examples is not to give the impression that because man, like other animals, is highly adaptive, nothing needs to be done to improve child health or household food security. They are given to illustrate the extent to which physiological changes contribute to the various ways in which individuals and households cope with stress. The contribution of nutritional science is to improve understanding of the sustainable limits to those adjustments. Perhaps also though, to remind us that *if* primary health care services are effective in improving morbidity of children, then there will be increases in body size over time and therefore increases of food needs. It should not be assumed that these greater needs for consumption will necessarily be accompanied by greater productivity.

The attention of health sector policy makers is often focused on the so-called nutritionally vulnerable groups: the weanling child and pregnant and lactating women. Whilst there is considerable evidence that these groups *are* vulnerable in terms of mortality, morbidity and of the effects of nutrient deficiencies, studies of the underlying causes show these to be complex and varied. For example, the food requirements of pregnancy and lactation vary substantially between populations because of different cultural conventions regarding work and social interactions appropriate to these conditions. In addition, substantial metabolic adaptations occur during pregnancy so as to reduce maintenance energy requirements. The net result of these adjustments can be in some Asian populations (but not all) an overall reduction in food energy needs during pregnancy (McNeill and Payne 1985) and in some (but not all) African populations an increase [Nestle Foundation 1989].

The situation of the small child is certainly also very complex, and the causes of continued mortality and failure to thrive are multiple and not susceptible to simple interventions either of a nutritional or a general environmental health nature. The final diagram, Figure 7, attempts to draw together the various factors in the household environment, and these processes which are known to influence child health. Some of these relate to housing conditions, to possessions, or other endowments such as knowledge or education. Others relate to the processes of sustaining the household environment, feeding, cooking, fuelling, cleaning etc: and some to the often conflicting demands of sustaining the household economy, particularly the exchanges necessary to secure entitlement to food and health care. In many cases, there are connections between the outcome — the health status of the child and the household's food entitlement, either directly in terms of the amounts and quality of foods available, but much more often indirectly, through conflicting demands for non-food resources. These are especially human resources, time, knowledge and skills. Such complexity defies generalisation, and if there is any clear message emerging from attempts to measure the outcomes of nutritional programmes over the past few years, it is simply that.

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