

Problems of Diet in Old Age

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There have been repeated claims, especially by physicians of the sixteenth and seventeenth centuries, that moderation in eating is the best recipe for a healthy old age and a prolonged life. Luigi Cornaro, who lived from 1467 to 1567, in his *Sure and Certain Methods of Attaining a Long and Healthful Life*, evaluated the methods he himself used in attaining and enjoying a ripe old age. Dr George Cheyne (1743) says of Cornaro:

‘He secured the valuable blessings of old age by mere force of regimen, even after a luxurious and consequently unhealthy and dispirited youth. At forty he began to curb his appetite and to manage his Diet, which after several essays he fixed at 12 ounces of Food and 14 of Wine in the twenty-four hours; from this time gradually lessening his Diet till he reduced it to the Yolk of an Egg (about an ounce of solid food in the twenty-four hours). He enjoyed a perfect State of Health and was at the same time in high Spirits to the Age of an Hundred’.

Cheyne continues:

‘For I am quite persuaded, that if instead of this Stinted Quantity of Animal Food, he had, at the age of 40, confined himself to Cow’s Milk and Bread, to Vegetables and Water only he might probably have lived to a much greater Age, with a clearer Head and Higher Spirits’.

AGEING AND NUTRITION

The life histories of centenarians show that they have usually been small eaters, especially of meat. Although the claims of super-longevity in certain mountainous areas of the world have recently been disputed perhaps those of Vilcabamba in Ecuador can be substantiated since ages can be verified from baptismal certificates. Davies (1973) has described the life-style of these very old people. It is remarkable that the number of male centenarians greatly exceeds that of the females, in contradistinction to the higher proportion of long-lived women found in most Western civilisations. Hypertension, heart disease

and cancer are comparatively uncommon and death usually results from influenza infection or accident. Their meals are frugal, consisting chiefly of grain, corn, yuka, beans and potatoes. Vegetables are eaten in considerable quantity but the amount of meat taken is about one ounce per head per week.

The first experimental proof that restriction of food intake can influence the life span of animals came with the work of McCay and his colleagues (1935) who showed that rats whose growth was almost completely arrested by a period of severe food restriction lived longer than those fed *ad libitum*. Although a marked increase in the length of life span was achieved, Miller and Payne (1968) commented upon the miserable state of the long-living rats; they were underweight and in poor condition. These authors examined the longevity of animals whose nutrient intake was adjusted for growth rather than being fed with a dietary regime of constant composition throughout life. The greatest prolongation of life was achieved in animals fed a stock diet until mature (120 days) and thereafter a mixture of 20 per cent stock diet and 80 per cent starch. These animals lived on average a hundred days longer than those on a stock diet throughout life, and a higher proportion of the animals survived a longer time; moreover, they appeared healthy in old age. This extended life span after maturity must be contrasted with the rats in the McCay experiments who had an extended juvenile life.

Recently, Ross and Bras (1974) have shown that the frequency of a number of tumour types and several age-related diseases can be readily modified by dietary means. The rats under investigation were allowed a choice of three complete balanced diets differing only in the amount of protein and sugar they contained; each rat could eat as much or as little as it liked of each kind of food. The self-selection method (S-S), apart from representing more natural conditions, enabled each rat to have a diet related to its physiological needs. As a control, three other groups of rats were fed on low, intermediate or high protein diets.

The rats that were allowed to choose their diet grew more quickly than the others and reached higher body weights, but they had a far higher incidence of tumours and of kidney, heart and prostate gland diseases. Two-thirds of the S-S rats had three or more diseases at the time of death, while of the rats fed low, intermediate or high protein diets alone, only 9, 26 and 28 per cent respectively had multiple affections at the time of death. The high incidence of multiple pathology in S-S rats in old age resembles that found in the human elderly population for whom Williamson and his colleagues (1964) have demonstrated that men over 65 have a mean of 3.26 diseases and women 3.42.

In brief, the results of animal experiments indicate that overfeeding in earlier life hastens maturity and shortens life, and overfeeding after maturity

increases the incidence of certain diseases in old age. Moreover, there are other aspects in which experimental data from animals has direct relevance to the problems of human nutrition: for example, it has been shown (McCay, 1955) that rats fed from birth on a milk diet have denser bones with a higher calcium content when they die in old age than those fed on a mixed stock diet containing meat and many products commonly eaten by man. Thus, nutritional factors influence not only growth and development before maturity but also, in consequence, the ageing of the mature adult since certain attributes in old age depend on the status at the end of the period of growth. In old people it is often difficult to distinguish between the effects of nutritional factors that are operating for the first time in old age and those that may have influenced nutritional status many years previously and even in childhood. This difficulty is clearly seen in relation to the problem of bone rarefaction in old age. There is evidence (Garn *et al.*, 1967; Exton-Smith *et al.*, 1969) that the liability to osteoporosis in the elderly is determined at least in part by the skeletal development before maturity and by the loss of bone that appears to be a general phenomenon of ageing, but that might occur at varying rates in different individuals. When the duration of operative factors is prolonged over a period of twenty years, as seems likely in many cases before the clinical syndrome of osteoporosis develops, it is inevitable that the disease becomes more frequent with advancing age (Dallas and Nordin, 1962). In consequence, the process will appear as a manifestation of ageing, and our problem is to determine whether the changes we observe with age are a universal phenomenon or whether they can be influenced by nutritional or other factors.

NUTRIENT INTAKES OF THE ELDERLY

According to Durnin (1964) the nutritional requirements may change with age owing to alteration in the amount of physical activity, to change in the weight or composition of the body, and to decrease in muscular efficiency. He argues that these factors will cause little alteration in the body's gross metabolism, and his and other studies have shown that the intakes of nutrients and energy at the age of 60 or more for healthy people are similar to those at the age of thirty years.

RECOMMENDED INTAKES

In the report *Recommended Intakes of Nutrients for the United Kingdom* (D.H.S.S., 1969) it is considered that, although with increasing age there is a gradual decline in the metabolism at rest and, therefore, a reduced need for energy in the diet, a relatively greater reduction results from a decline in physical activity. The recommendations for energy intake for the elderly and the very

old were based on judgement of the rates at which most old people slow down in their activities. The recommended intakes, assuming a sedentary life, are 2,350 kcal (9.8 MJ) for men aged 65 to 75 and 2,100 kcal (8.8 MJ) for men aged 75 and over; for women the corresponding recommended intakes are 2,050 kcal (8.6 MJ) and 1,900 kcal (8.0 MJ). It is emphasised, however, that there are many people who retain their active habits of life until they are very old and they need more energy in their diet than these figures indicate.

Nutrition Surveys

In a survey sponsored by the King Edward's Hospital Fund, Exton-Smith and Stanton (1965) investigated the diets of elderly women living alone at home in two North London boroughs. The mean intakes of nutrients for the subjects, who were 70 to 80 years of age (with the exception of three who were aged 89, 90 and 94 years), were:

Calories	1,890 kcal	Calcium	860 mg
Protein	57 g	Iron	9.9 mg
Fat	74 g	Vitamin C	47 mg
Carbohydrate	221 g	Vitamin D	135 i.u.

The survey revealed a striking decrease in intakes of nutrients with age, and the percentage falls for subjects in their late seventies compared with those in their early seventies, as shown in Table 1.

TABLE 1. Cross-sectional study: fall in intakes of women in late seventies compared with those in early seventies

Calories and nutrients	Fall in intake %
Calories	19
Protein	24
Fat	30
Carbohydrate	8
Calcium	18
Iron	29
Vitamin C	31

As this was a cross-sectional study the results must be interpreted as revealing interesting age differences. It was considered that the most important cause for the reduction in intake in the older group was due to a rising incidence during the seventies of disease and physical disabilities that reduce appetite and energy expenditure in some of the subjects of the older group.

This suspicion was confirmed when the subjects who participated in the survey in 1962 were followed up 6½ years later to form a longitudinal study

(Stanton and Exton-Smith, 1970). It was found that for those women who maintained their health, as assessed by clinical examination and a scoring system recording physical capabilities, the intakes of nutrients during the 1962 and 1969 surveys were remarkably similar. On the other hand, for subjects whose health had declined during the years there was a considerable fall in intake amounting on average to 20 per cent for protein and 17 per cent for calories. Thus, it seems likely that nutrient intakes are maintained into extreme old age provided the person remains active and fit.

Further evidence that low intakes of nutrients are associated with impairment of health was obtained from a study of the nutrition of housebound old people (Exton-Smith *et al.*, 1972). The intakes of the housebound were compared with those of age-related active people, and for women the differences amounted to 15 per cent less for carbohydrate to 46 per cent less for vitamin C. For the housebound group as a whole there was no decline in intake with age; indeed, some of the youngest people had the lowest intakes. This is because, for the housebound, in contrast with the active group, disability was just as severe and as frequent in the younger as in the older people. Thus, disease or disability had a greater effect on nutrient intake than age alone. It is clearly necessary when making recommendations for nutrient intakes of older people, based on the results of dietary surveys, to include a medical examination of the subjects in order to distinguish those who are fit and active from those who suffer from a decline in intake due to some medical disorder that might otherwise pass unrecognised.

THE OCCURRENCE OF NUTRITIONAL DEFICIENCIES

Despite the fact that the individual dietary pattern in the majority of old people remains similar to that which has been acquired by habits established at a younger age, there are many factors that begin to operate more frequently with increasing age and these may lead to nutritional deficiencies. Some of these factors are related to decline in bodily health and difficulty in obtaining and preparing food; to changed economic circumstances resulting from retirement; to social isolation and loneliness; to depression following bereavement and to ignorance of what constitutes a balanced diet, especially in the widower who must often cater for himself for the first time. The primary and secondary causes of malnutrition are summarised in Table 2, and their importance has been discussed elsewhere (Exton-Smith, 1971).

These are common causes but, in the elderly, malnutrition is often multifactorial in origin, especially in the housebound individual who, in addition to physical ill-health, may suffer from social isolation, straitened financial circumstances and impairment of appetite due to inactivity.

TABLE 2. Primary and secondary causes of malnutrition

Primary	Secondary
Ignorance	Impaired appetite
Social isolation	Inefficient mastication
Physical disability	Intestinal malabsorption
Mental disorder	Alcoholism
Iatrogenic	Drugs
Poverty	Increased requirements

Recently, the results of a nutrition survey of the elderly population have been reported (*A Nutrition Survey of the Elderly*, D.H.S.S., 1972). The study was based on random samples of old people living at home in six areas of the United Kingdom. A diagnosis of malnutrition was made in 3 per cent of the elderly population surveyed and this included protein-calorie malnutrition, iron deficiency and specific vitamin deficiencies. Rarely, however, could a primary cause that was related to social and economic factors be discovered and, in the majority of cases, an underlying medical condition was responsible. Nevertheless, in the absence of overt malnutrition, socio-economic factors may be of importance since it was found that men aged 75 and over who were living alone fared worse than their fellows in respect of a large number of nutrients, and this was in some measure reflected in the numbers recorded as having biochemical values below certain arbitrary limits (for example, 30.8 per cent of those living alone had leucocyte ascorbic acid levels below $7.0 \mu\text{g}/10^8$ w.b.c. compared with 7.7 per cent of those living with a spouse). Again, both for men and women, there was a statistically significant higher incidence of anaemia in those living alone compared with other groups.

During the past ten years there have been numerous reports that the nutritional status of the elderly is often inferior to that of younger people. A few of these studies will be mentioned in order that the significance of the findings can be discussed.

B Group Vitamins

A high incidence of changes in the mucous membranes of the tongue and lips in elderly in-patients have been reported and these have been attributed to deficiency of B vitamins (Griffiths *et al.*, 1967; Brocklehurst *et al.*, 1968). Subsequently, Dymock and Brocklehurst (1972) repeated their earlier studies and showed that when single vitamin supplementation was given for one year, riboflavin produced an improvement in cheilosis and nicotinamide in the appearance of the dorsum of the tongue. Neither McLeod (1972) nor Berry and Darke (1972), using single vitamin supplementation for one year,

were able to confirm these findings. In the latter trial, 90 per cent of patients who had changes in the dorsal surface of the tongue were found to have a fungal infection and it was considered that this was the most likely cause of these changes. The commonest cause of angular stomatitis in the elderly is ill-fitting dentures.

In the study of accidental hypothermia in the elderly, based on a random sample of the elderly population of Camden (Fox *et al.*, 1973), limited nutritional investigations were carried out. Thurnham (1972) measured the erythrocyte glutathione reductase activity (EGR) and the percentage stimulation of EGR by flavine adenine dinucleotide (FAD) in 128 subjects. A stimulation of greater than 30 per cent (often regarded as an indication of deficiency) was found in 18 per cent of males and 19 per cent of females. Thus, marginal riboflavin deficiency could exist in the elderly population but the true significance of these biochemical levels is unknown. A similar uncertainty exists about the exact levels of folic acid in the serum and red cells that are considered to be adequate. Read and his colleagues (1965) in Bristol found that 80 per cent of 50 entrants to old people's homes had folate deficiency which was taken as a serum level of less than 6 ng/ml. Batata and his colleagues (1967) in Oxford, adopting a lower limit of normal of 2.1 ng/ml, found that 10 per cent of patients over the age of 60 admitted to hospital had deficiency. The folate levels tended to be lowest in those with severe disability and there was a significant correlation between organic brain disease and low folate levels.

In the Nutrition Survey of the Elderly (D.H.S.S., 1972) 15 per cent of the subjects had serum folate levels of less than 3 ng/ml and 3.7 per cent had red cell folate levels of less than 100 ng/ml. There was no relation between the haemoglobin concentration and the serum and red cell folate levels. Of the 22 subjects with low red cell folate, among the 629 people tested, only two women were mildly anaemic. In this study there was no significant relationship between folate levels and the clinician's assessment of mental state.

Vitamin C

Scurvy is now a rare disease in Britain but occasional cases are found among the elderly, especially in widowers. It seems likely, however, that the body stores of vitamin C in many old people are diminished and low levels of leucocyte ascorbic acid (LAA) have been reported by several observers: the levels are lower in the elderly than in younger subjects (Brook and Grimshaw, 1968), lower in winter than in summer (Andrews *et al.*, 1969), and lower in men than in women (Allen *et al.*, 1967). In a study in Edinburgh (Milne *et al.*, 1971) it was found that LAA levels were significantly higher in July to Decem-

ber compared with the rest of the year. Slightly more than half the subjects had intakes of less than 30 mg daily and a significantly greater proportion had low intakes in the months October to March compared with the months April to September. Vitamin C intake was correlated with LAA level and it was found that LAA levels increase in parallel with, but lag behind, seasonal increases in vitamin C intakes. Similar findings were reported in the Nutrition Survey of the Elderly (D.H.S.S., 1972) and there was a moderate correlation between vitamin C intake and LAA levels (Darke, 1972).

The Edinburgh study and other dietary surveys disclose that there is an appreciable number of old people who have an intake of less than 10 mg per day, which is known to be the amount required to prevent or cure scurvy (Bartley *et al.*, 1953). The recommended allowance of 30 mg daily (D.H.S.S., 1969) takes into account the considerable individual variations in requirements and the increased requirements due to stress. Although a high proportion of the elderly population are consuming less than 30 mg per day the majority will not suffer from any ill-effects, but our assessment is handicapped by lack of knowledge of the tissue levels required for health. Windsor and Williams (1970), by measuring total hydroxyproline excretion (THP) in response to vitamin C, found that THP increased when the initial LAA content was less than $15 \mu\text{g}/10^8$ w.b.c. Thurnham (1972), in an investigation of the old people who participated in the Camden survey of accidental hypothermia, found that 28 per cent of the men and 10 per cent of the women had LAA levels of less than $15 \mu\text{g}/10^8$ w.b.c. The higher proportion of men with deficiency is in keeping with the findings of the Edinburgh and other surveys and accords with clinical experience that scurvy is more prone to occur in men than in women.

Wilson and his colleagues (1972) in Cornwall have studied the relationship between LAA levels and mortality in the aged. The mortality was found to be 47 per cent within the first four weeks of admission for those whose initial LAA levels were less than $12 \mu\text{g}/10^8$ w.b.c. compared with 10 per cent when the LAA was greater than $25 \mu\text{g}/10^8$ w.b.c. ($p < 0.01$). Subsequent investigation, however, showed that mortality was not directly related to LAA levels but to the severity of the illness which, in turn, influenced the tissue stores of vitamin C.

Vitamin D

Inadequate dietary intake, lack of exposure to sunlight and minor degrees of intestinal malabsorption are probably the most important causes of vitamin D deficiency in the elderly. Dietary vitamin D deficiency may contribute to the skeletal rarefaction which is so common in old age (Exton-Smith *et al.*, 1966).

The vitamin D status of two groups of elderly women has been assessed by Smith and his colleagues (1964). For women living in Michigan (average age 60.6 years) the level of vitamin D in the blood (serum anti-rachitic activity) was significantly lower in those subjects with low bone density compared with those having normal bones; the level showed marked seasonal variation. By contrast, for a group of similar age living in Puerto Rico, where there is much greater exposure to sunlight and higher vitamin D content of the food, the incidence of skeletal rarefaction was much lower, the serum vitamin D levels were much higher, and there was no seasonal variation.

Using the more precise index of radio-stereo-assay of 25-OH-D levels, Stamp and Round (1974) have shown similar seasonal variations in both young and old subjects. They conclude that, at present, summer sunlight is an important and possibly the chief determinant of vitamin D nutrition in Britain. In this study, the older people who participated in the Camden nutrition survey had significantly lower levels of 25-OH-D than the younger subjects. Haddad (1973) has recently separated both 25-OH derivatives in the serum and found that 25 hydroxycholecalciferol is the major constituent, suggesting that in the United States skin synthesis plays a more important role than dietary ingestion. In this respect, housebound old people (Exton-Smith *et al.*, 1972) may be at the greatest disadvantage since they lack exposure to sunlight and often have very low dietary intakes; 48 per cent of housebound women aged 70 to 79 years had a dietary intake of less than 30 i.u. per day compared with 13 per cent of active women of similar age.

Clinical osteomalacia is not uncommon in certain sections of the elderly population. Anderson and his colleagues (1966) in Glasgow found 16 cases after investigation of 100 women admitted to a geriatric department when there was a possible clinical manifestation; subsequently, 100 admissions to the female wards were investigated and the incidence of osteomalacia was found to be 4 per cent of all elderly women. Aaron and his colleagues (1974a) in Leeds have shown by histological methods that 20 to 30 per cent of women with fractures of the proximal femur and about 40 per cent of men had osteomalacia. Later, they showed (Aaron *et al.*, 1974b) that the proportion with osteomalacia varied with the season. The highest frequency with abnormal calcification fronts (43 per cent) was observed in February to April and the lowest (15 per cent) in August to October. The highest frequency of abnormal osteoid covered surfaces (47 per cent) was observed in April to June and the lowest (13 per cent) in October to December. They concluded that variation in hours of sunshine is responsible for a seasonal variation in osteomalacia in femoral neck fractures and, possibly, in the elderly population as a whole.

SIGNIFICANCE OF LOW INTAKES AND TISSUE LEVELS OF NUTRIENTS

The results of the above studies have several features in common and some of them require further investigation—

1. A high proportion of older people have low dietary intakes and many of them are well below the recommended intakes for the United Kingdom. In some instances there is an association between low intakes and socio-economic factors (for example, living alone) and with physical disorders, especially when these make the individual housebound.
2. Many old people have tissue levels of nutrients that are below the arbitrarily defined limits adopted for younger people. The lowest levels are often found in those with physical disorders.
3. Only rarely are the low intakes and abnormal biochemical findings associated with a disturbance of form or function that is required for the clinical diagnosis of malnutrition. The significance of sub-clinical malnutrition and the extent to which the health of these old people would benefit from increased dietary intakes are unknown.
4. The relationship between health and nutrition in old age could best be determined by longitudinal studies. A five-year follow-up of the participants in the 1967/68 D.H.S.S. survey has recently been completed. Changes in nutritional status will be assessed and the extent to which the morbidity and mortality of those people with low intakes and tissue levels differ from the other groups will be investigated.
5. There is a need to establish 'running indices' in a small group of old people with continuous monitoring of the amount of money spent on food and dietary intakes, together with frequent assessments of the nutritional status by biochemical and clinical examinations (Whitehead, 1974). By this method it should be possible to establish in each individual the efficiency of homeostasis and the extent to which variations in biochemical values are a reflection of changes in nutrient intakes.

IMPROVING NUTRITION

In most forms of nutritional deficiency in the elderly the factors responsible can be identified. Although malnutrition can occur in isolation there are usually other unmet medical and social needs. Thus, the problem of improving nutrition is that of the early ascertainment and correction of needs in vulnerable groups of the elderly population.

Vulnerable Groups

Old people especially at risk are the socially isolated, those with physical

disability, and those with impairment of the special senses, the recently bereaved, very old men living alone, and those with mental disorders including depression. Unless these vulnerable groups can be identified, preventive measures would have to be applied to all old people irrespective of the fact that the majority will never suffer from malnutrition. The inefficiency and undesirability of employing such procedures can be overcome only by the recognition of those especially at risk. The application of preventive measures to these smaller groups rather than to the whole elderly population becomes a manageable proposition.

It is now believed that the housebound, who account for nearly 10 per cent of old people living in their own homes, form the largest single group at risk. Physical and mental disability in old age not only affects the mode of living and social relationships of those afflicted but also their dietary pattern and nutritional status. The nutrient intakes of the housebound are substantially lower than those for active old people of comparable age (Exton-Smith *et al.*, 1972). Since the majority of the housebound are already known to the social and health services, the prevention of malnutrition in this group should present less difficulty than for other vulnerable groups of old people who are not so readily identifiable.

Assessment of Nutritional Status

Having identified the groups of old people especially at risk, the prevention of malnutrition is the responsibility of the primary medical care team. The assessment of dietary intakes should ideally be made by dietitians but their skills are rarely available for old people at home. There are, however, simple scoring systems (Marr *et al.*, 1961) which are based on the number of main meals and the frequency of consumption of certain foods containing protein (meat, bread, eggs, cheese and milk). The system can be applied by a health visitor to give a rough guide to the quality of the diet. If dietary insufficiency is found, means must be sought for improving nutritional intake, and this may entail instruction by a dietitian or health visitor given either individually or in groups when old people attend clubs or day centres. When malnutrition is suspected, the diagnosis can sometimes be confirmed by the general practitioner using appropriate biochemical and haematological investigations, but in other instances—for example, in the diagnosis of osteomalacia—referral to hospital for more specialised investigations will be required.

Club and Domiciliary Meals

Means of improving the dietary intake of old people living at home have been discussed elsewhere (Exton-Smith, 1968). Those old people who are suf-

ficiently mobile but live alone should be encouraged to attend a club or day centre in order that they can eat in the company of others. For the less active, and especially for the housebound, the provision of an efficient Meals-on-Wheels service at least four or five days a week is often desirable. The recipients of Meals-on-Wheels and of club meals tend to regard them as the main meal of the day, hence they must be as nutritious as possible. The destruction of a considerable amount of vitamin C during the preparation of these meals must be borne in mind (Exton-Smith and Stanton, 1965). This occurs particularly in domiciliary meals, which may be kept hot for a long time before reaching the old person. Davies and her colleagues (1973) have shown by chemical assay that the vitamin C intake is often lower on those days when Meals-on-Wheels are supplied.

Supplementation

The most satisfactory means of promoting good nutrition is by improving the quality and, in some cases, the quantity of the diet. Thus, for those whose consumption of vitamin C is inadequate, intake should be improved by the addition to the diet of citrus fruit, blackcurrant juice, rose hip syrup, or tomatoes. The alternative of prescribing vitamin C tablets is satisfactory but less desirable. The very low intake of vitamin D by many old people must lead to a consideration of supplementation. This could be achieved by the fortification of milk, a procedure adopted in the United States. The distribution of fortified milk would best be restricted in the first instance to housebound old people who tend to have the lowest vitamin D intakes and lack exposure to sunlight.

It has already been emphasised (Exton-Smith, 1973) that the policy of supplementation should be introduced only after the results of carefully controlled experiments to assess the benefits of increased intakes are available. Once the practice of supplementation has become widespread it is difficult to prove the benefits and there is an understandable reluctance to withdraw a prophylactic measure on the basis of doubts about its value when it has been employed for several years.

This article is based on a paper read at the College Conference, 'Medical Problems in a Modern Environment', held in Bristol in September, 1974.

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