Chapter 30

Assessment of nutritional status

IAN DARNTON-HILL, E.TERRY COYNE and MARK L.WAHLQVIST

Introduction

Health, nutrition and ageing

Many of the diseases acquired with age appear to have been preprogrammed many years previously. The hypothesis that the non-communicable, chronic diseases of adulthood, such as some heart diseases, hypertension and diabetes, are more likely to occur in people who were undernourished *in utero*, and possibly in infancy, is increasingly accepted. This is of course a good argument for ensuring adequate antenatal care and nutrition for expectant mothers, and especially in developing countries where the burden of both undernutrition and overnutrition is the most significant.

Attention to diet, exercise and health towards the end of the life cycle will improve the quality of life and lessen both the occurrence and the impact of diseases. Thus there are still benefits to maximising health behaviours. However, the earlier people adopt healthier lifestyles, the more likely they are to have relatively healthy and active lives in their later years.

Age-related changes in the elderly

Most physiological functions in the elderly are affected by the actual ageing process itself only to a minor extent. However, some functions do appear to decline progressively throughout adult life, such as mineralisation of the skeleton, host immunity and food intake in general. Most of these lead to a decrease in body weight due to their effect on systemic energy balance. Table 30.1 summarises age-related changes in body composition and physiological functions and the resulting impact on requirements for certain nutrients. Changes in body composition occur throughout adult life and can lead to a continuous decline in lean body mass, which tends to accelerate later in life and is greater in males. In addition to loss of active tissue mass, there is some reduction of function in many organs and tissues: for example, cellular enzymes for men fall on average by 15% over the 50 years to age 80; resting cardiac output by 30% and renal blood flow by 50%. However, even the magnitude of these changes is likely to be a result of reduced exercise and diet in later years as much as the inevitable effects of ageing in itself.

Table 30.1 Age-related changes that impact on nutritional needs

Change in body composition or physiological function	Impact on nutrient requirement
⇓ Muscle mass (sarcopenia)	⇓ Need for energy
⇓ Taste and olfactory acuity	⇑ Need for energy
⇓ Bone density (osteopenia)	⇑ Need for calcium, vitamin D
⇓ Gastric acid (atrophic gastritis)	⇑ Need for vitamin B_{12}, folic acid, calcium, iron, zinc
⇓ Skin capacity for cholecalciferol synthesis	⇑ Need for vitamin D
⇓ Calcium bioavailability	⇑ Need for calcium, vitamin D
⇓ Hepatic uptake of retinol	⇓ Need for vitamin A
⇓ Efficiency in metabolic utilisation of pyridoxal	⇑ Need for vitamin B_6
⇓ Immune function	⇑ Need for vitamin B_6
⇑ Oxidative stress status	⇑ Need for carotenoids, vitamin C, vitamin E and food polyphenolics
⇑ Levels of homocysteine	⇑ Need for folate, vitamin B_6, vitamin B_{12}

Source: Adapted from National Health and Medical Research Council (1999), *Dietary Guidelines for Older Australians*, Australian Government Printing Service, Canberra.

As the above metabolic functions progressively alter with ageing, nutrient needs change (Table 30.1). The rate of synthesis and breakdown of protein, expressed as per kilogram body weight, is significantly lower in older people of both sexes. Total body protein synthesis, body mass and bone mineralisation decreases, while the proportion of body fat increases. Tissue avidity for some nutrients (e.g. folate, zinc) appears to be reduced by ageing, and nutrient uptake may decrease. The relationship between physical activity, satiety and nutritional status is complex. A diminished ability to regulate food intake is an important subtle change that may affect dietary intake and hence nutritional status.

Immunological function is depressed by both ageing and by malnutrition, although the actual relationship is unclear and differs from one individual to the next. Although 25% of older individuals have immune responses as vigorous as those of young adults, elderly patients can develop deficiencies in host defences that may predispose to infections such as infectious diarrhoea. Nevertheless, the above changes can be relatively easily managed, and with small behavioural changes, older individuals can be healthy, and demonstrate adequate nutritional status.

Factors which influence nutritional status of the elderly

Specific risk factors can help identify elderly individuals who are especially likely to be malnourished or suffer other nutritional concerns. The factors leading to poor nutritional status can be broadly categorised as (Box 30.1):

1. social, such as inadequate dietary intake, isolation and poverty
2. physical/medical, including physiological reduction in utilisation of nutrients and reduced absorption, disease states, as well as difficulties with eating and dental problems
3. psychological and emotional factors, including depression, Alzheimer's disease and anorexia.

1. Social factors

Social isolation and poverty are major contributors to poor quantity and quality of food intake. Persons living alone and living in poverty may have limited access to food shopping and to transportation, limiting, among other things, their ability to attend meal programs. They may also lack adequate food preparation skills and food storage facilities. For the elderly living in the community, the degree of dependence is important. The more dependent the elderly are on being fed by others, the greater the risk of malnutrition. Living alone is related to decreased food intake among men, but not among women, and this has been reported in Australian, US and other studies. At all ages, people tend to eat more when eating with others.

Box 30.1 Major risk factors for nutritional conditions among the elderly

Social factors

- Poverty
- Isolation (living alone)
- Poor nutrition, food preparation or food safety knowledge
- Institutional factors
- Abuse of the elderly

Physical/medical factors

- Feeding or swallowing difficulties
- Poor dentition
- Diminished sense of smell or taste or xerostomia
- Dysphagia
- Drugs
- Malabsorption
- Increased metabolism
- Chronic disease or chronic infection
- Need assistance with feeding
- Need assistance with food shopping and meal preparation
- Severe visual deficit
- Physical disabilities/impaired basic activities of daily living

Psychological and emotional factors

- Widowed
- Depression
- Loneliness
- Dementia
- Alcoholism
- Eating disorders or diet phobias: choking, fat, salt, etc.
- Anorexia

Source: Adapted from J. E. Morley (1997), 'Anorexia of aging: Physiologic and pathologic', *The American Journal of Clinical Nutrition*, 66, pp. 760–73.

Dietetic assessment is needed to review appropriate choice and consistency of food to allow easier eating (although the latter is not an important issue with the majority of the elderly). Availability of fresh foods, sufficient variety, appropriate cooking and the attractive presentation of food are all factors which promote nutritious diets. Particularly for some older men living alone, knowledge of diet and food preparation may be important. Other aspects of diet that need to be assessed are food contamination or improper food handling, especially for those living alone and preparing food under less than ideal conditions, which may lead to infectious diarrhoea and which especially in the elderly lead to malnutrition.

2. Physical/medical factors

Most physiological functions in the elderly are affected by the ageing process per se only to a minor extent. However, there is a wide variation in the correlation between chronological and physiological ages among different persons. Underprivileged individuals often appear much older than their years, this variation being due more to socioeconomic conditions than to physiological processes. Physiologic changes that affect nutritional status and are directly associated with ageing are summarised in Table 30.1.

The decrease in energy intake common in elderly persons reflects, among other factors, a decline in basal metabolic rate, which is essentially due to a decrease in lean body mass. Some recent studies suggest that the early satiety in older persons may be caused by a nitric oxide deficiency, which decreases the adaptive relaxation of the fundus of the stomach in response to food. It has been observed that older men have a substantial reduction in their ability to maintain a constant energy balance compared with younger men and that age-related changes in food intake are observed in healthy older men and women, even when they do not report any problem with appetite. This may be due to diminished metabolic signals that drive adaptive variations in energy intake. A decrease in taste acuity and olfaction, as well as a variety of oral health problems, contribute to a declining energy intake in some elderly people.

Decreased energy intake may also accompany a decline in physical activity, which is sometimes a result of disabilities that limit movement. Usually, however, there are social and psychological factors that are responsible for loss of weight that accompanies the declining energy intake, and these are often amenable to modification.

The function of the gastrointestinal tract is essentially well preserved in ageing. One major change is in gastric function due to the prevalence of atrophic gastritis (20–50%) in elderly people. Atrophic gastritis causes a decrease in acid and intrinsic factor secretion and can cause vitamin B_{12} deficiency. Decreased gastric function is also associated with decreased absorption of folate, iron and zinc and reduced calcium bioavailability. The most important causal factor in the development of atrophic gastritis and ulcers is infection with *Helicobacter pylori*. If *H. pylori* infection is controlled, the prevalence of atrophic gastritis can be reduced.

Vitamin D deficiency is common in the elderly as sun exposure may decrease with age, especially in institutionalised or home-bound individuals, and there is a decreased ability of the ageing skin to convert 7-dehydrocholesterol to vitamin D_3. A reduction in kidney function can be responsible for a decrease in active vitamin D and thus reduced calcium absorption. There is also a reduced ability to secrete insulin in response to glucose challenges.

Eating and swallowing problems may occur at any age, but especially with ageing. The prevalence of eating disorders in nursing home residents may be as high as 50%, and are likely to be due to both physical and psychological factors. Common oral health problems that affect food intake in the elderly are summarised in Table 30.2. The lubricatory factors in saliva that soften and bind food material may decline with age. Saliva also affects taste, dissolving the parts of foods that taste and bringing them in contact with taste buds. The result of decreased olfactory and taste sensitivity often leads to decreased appetite, aggravated by any problems with the gums, teeth or dentures, particularly those that cause pain. The orofacial musculature atrophies with ageing, resulting in decreased biting force, slower chewing and denture problems.

Inflammation or burning of the tongue is often a complaint of elderly patients and may be secondary to nutritional diseases such as anaemia, or due to drug reactions, systemic infections or psychosomatic syndromes. Infections of the mucous membranes of the oral cavity, including burning mouth syndrome, candidiasis, contact stomatitis or ulcers can all cause pain and decrease the pleasure of eating. Dysphagia, which is most common in older adults, is often secondary to other conditions such as stroke, cancer, multiple sclerosis, parkinsonism and brain/spinal cord injuries.

Table 30.2 Oral health problems that affect the eating process

Oral function	Problem
Salivary glands	Reduction in secretion
Teeth	Attrition Dental caries Tooth hypersensitivity Tooth loss
Periodontium	Gingivitis Periodontitis
Alveolar bone	Bone loss/resorption
Temporomandibular joint (TMJ)	Dysfunction
Orofacial musculature	Atrophy
Tongue	Glossitis Glossodynia
Mucous membranes	Atrophy Burning mouth syndrome Candidiasis Contact stomatitis Oral cancer Traumatic ulcers
Dentures	Poor hygiene Stomatitis Ulceration Wearing

Source: Adapted from W. E. Martin (1995), 'The oral cavity and nutrition', in J. E. Morley, Z. Glick & L. Z. Rubenstein (eds), *Geriatric Nutrition: A Comprehensive Review*, 2nd edn, Raven Press, New York.

Some disease states can in themselves markedly affect nutritional status and these include wasting disorders such as cachexia, chronic obstructive pulmonary disease (COPD) and neoplastic disease. Attention to nutrition and diet in the management of these diseases will improve quality of life and may help slow the progression of the disease.

A further important cause of malnutrition in the elderly is the use of pharmaceuticals. A thorough history of current drug use, both prescribed and over-the-counter, is an important part of initial patient analysis and care. Hypertensive drugs adversely influence potassium and magnesium

status, antibiotics affect intestinal absorption and hypnotics affect nutritional intake. More specifically, medication can produce:

- anorexia (e.g. digoxin, fluoxetine, hydralazine, psychotropics, quinidine, vitamin A)
- nausea (e.g. antibiotics, aspirin, theophylline)
- increased energy metabolism (e.g. theophylline, thyroxine)
- malabsorption (see below).

Withdrawal from certain drugs (e.g. alcohol, anxiolytics and psychotropics) may also be associated with weight loss.

3. Psychological and emotional factors

Psychological factors, such as recent loss of a spouse, depression, dementia, alcoholism and anorexia nervosa, have considerable impact on nutritional status in the aged. Bereavement, which is more common in women, is often associated with loss of interest in eating due to the loss of socialisation at meal times. It is estimated that approximately 5–10% of elderly persons living in the community suffer some form of depression. In elderly persons with depression, approximately 90% suffer weight loss, compared with 60% of young adults with depression. A common symptom of depression is a loss of desire to eat. Widowed, elderly men who live alone without a good support system are at risk of alcohol abuse, which in later life is often associated with weight loss, squalor syndrome and depression.

Persons with dementia or Alzheimer's disease are particularly at risk of malnutrition as they may forget to eat, make poor food choices, or become too disabled to be able to purchase or prepare food. Some patients with Alzheimer's disease develop constant wandering that may increase energy needs. Anorexia nervosa has been reported in older persons who were previously weight restrictors, and can lead to inadequate dietary intake, even in the face of normal energy requirements.

At all ages, the healthiest diet is one with enough variety to provide adequate micronutrients, and the appropriate amounts of energy, protein, carbohydrate and essential fatty acids (both omega-3 and omega-6). Although our knowledge of the exact requirements is imperfect, the approximate quantities are known, and there is some flexibility because of the range of the recommended intakes, and because of individual variation. The limited variety of foods in many geriatric diets has been identified as a factor in reduced nutrient intake.

Malnutrition

The term 'malnutrition' covers the three main areas of concern in the nutrition of elderly people: undernutrition, overnutrition and eating disorders. Although the last does appear to be of more significance in the older age group than usually thought (and should therefore be routinely sought out), only the first two will be considered in detail.

Undernutrition

Protein-energy malnutrition

While malnutrition in the elderly has often been described in the hospitalised and institutionalised elderly and those living in poor social circumstances, data on free-living, active elderly individuals has been less available. A recent study from Germany identified minimal changes in this population. However, a study in the US of institutionalised but ambulatory elderly patients concluded that malnutrition, both with and without accompanying disease, is relatively frequent, although a specific nutritional diagnosis is not made in many cases. While as many as 30–50% of institutionalised patients reportedly suffer from protein-energy malnutrition, even in non-institutionalised elderly individuals, significant unexplained weight loss becomes increasingly common after 65 years of age.

As noted previously, with advancing age there is generally a progressive decrease in energy intake as well as probably energy requirements. One study showed a progressive decrease in average daily intake from 11 300 kJ (2700 kcal) at 20–34 years to 8800 kJ (2100 kcal) at 75–90 years. One-third of this fall (840 kJ or 200 kcal) was accounted for by the reduction in basal energy metabolism consequent to reduced body cell mass, while the remaining 1680 kJ or 400 kcal were identified as the result of reduced activity. The sharp decline in the energy

intake of the very old is often related to disability and chronic disease.

In most diets, as energy intakes fall, there is a very strong likelihood that the intake of other nutrients will also decrease. Protein inadequacy is frequently found in the diets of the elderly and contributes to increased susceptibility to infection. In the elderly, protein and energy status can go in opposite directions (unlike in young children). Box 30.1 lists the underlying causes of protein-energy malnutrition in the elderly.

Assessment/diagnosis

No screening battery has been shown to have both good sensitivity and specificity for identifying persons at risk for undernutrition. Weight loss remains the single best factor for predicting persons at risk for malnutrition. A body mass index (BMI): weight/height^2 of less than 20 kg/m^2 may suggest a problem. Mid-arm circumference or arm muscle circumference (which corrects for triceps skinfold thickness) can be useful in following muscle mass changes in persons with a fluid retention problem, whereas skin-fold thickness measurements have little diagnostic value in the elderly. In isolated communities, assessment can be done without biochemical tests and a manual has recently been published (by the London School of Hygiene and Tropical Medicine and HelpAge International) to this end.

However, in the absence of obvious malnutrition or obesity, in most cases a small battery of tests, such as a self-administered history (see Box 30.4), biochemical tests (see Table 30.4) and a simple combination of both (e.g. the SCALES protocol in Table 30.3) will be helpful. A simple check list may also help to ensure that nutritional status and undernutrition is actively considered in the analysis of every geriatric patient (Box 30.2).

In persons with wasting, serum albumin and haemoglobin levels, total iron-binding capacity, and tests of cell mediated immune function are usually normal. When hypoalbuminaemic protein-energy malnutrition occurs, anergy (failure to respond to common antigens) and oedema are often present. Serum albumin levels are generally < 35 g/L, and anaemia, lymphocytopenia and hypotransferrinaemia (as evidenced by a total iron-binding capacity < 45 mol/L) are likely. Albumin, which has a 21 day half-life, is a good measure of protein status. Healthy, ambulatory elderly people should have a serum albumin level > 40 g/L, while albumin levels < 32 g/L in hospitalised geriatric patients are highly predictive of subsequent mortality. Cholesterol levels < 4.0 mmol/L in residents of nursing homes have been reported to predict mortality, presumably because such levels reflect malnutrition (although acute disease associated with cytokine release can also lower cholesterol levels).

Table 30.3 'SCALES' protocol for evaluating risk of malnutrition in the elderly

Item evaluated	Assign 1 point	Assign 2 points
Sadness		
Yesavage Geriatric Depression Scale[a]	10–14	≥ 15
Clinical impression[b]	Moderate	Severe
Cholesterol level	< 4 mmol/L	
Albumin level	3.5–4g/dL	< 3.5g/dL
Loss of weight	1 kg (or 0.5 cm mid-arm circ.) in 1 month	3 kg (or 1 cm) in 6 months
Eating problems	Patient needs assistance	
Shopping and food preparation problems	Patient needs assistance	

(a) Yesavage, J.A., (1988), 'Geriatric depression scale', *Psychopharmacology Bulletin*, 24, p. 709.
(b) Has not been validated.
Note: A total score ≥ 3 indicates that the patient is at risk, and needs further assessment.
Source: *The Merck Manual of Geriatrics*, 2, Nutrition, 1999 (modified from J. E. Morley & D. K. Miller (1992), 'Malnutrition in the elderly', *Hospital Practice*, 27, pp. 95–116).

Box 30.2 History and quick check list

1. Weight change
   Current height _____cm Weight _____kg
   BMI _____ $\frac{\text{wt (kg)}}{\text{ht (m)}^2}$
   Overall weight loss or weight gain in past 6 months _____

2. Dietary intake change (relative to usual intake) or no change
   Type of change:
   - Suboptimal solid food
   - Hypocaloric liquids
   - Starvation
   - Supplement vitamin, mineral, energy

3. Gastrointestinal symptoms that persisted for more than 2 weeks
   None
   Nausea
   Vomiting
   Diarrhoea
   Pain at rest only on eating

4. Functional capacity
   No dysfunction
   Dysfunction Duration _____days
   Type:
   - Working suboptimally
   - Ambulatory but not working
   - Bedridden

5. Disease and its relation to nutritional requirements
   Primary diagnosis _____
   Metabolic demand (stress)
   - No stress
   - Moderate stress
   - High stress (burns, sepsis, severe trauma)

6. Physical status
   Loss of subcutaneous fat
   - Muscle wasting
   - Oedema
   - Ascites
   - Mucosal lesions
   - Cutaneous/hair changes

Source: Adapted from K. N. Jeejeebhoy (1998), 'Nutritional assessment', *Gastroenterology Clinics of North America*, 27, pp. 347–69.

Treatment

The intensity of intervention clearly depends on the severity of the malnutrition and the cause. It may require no more than correcting the social isolation of the person by putting him in touch with a local support group through a social worker. With moderate malnutrition, a dietitian should analyse the diet and feeding patterns in detail and guide the nutritional intervention. In severe cases, aggressive intervention is required but would generally be in a hospital setting.

Some evidence indicates that the mortality rate for all hospitalised elderly patients would decrease if energy (kilojoule) supplements were given (e.g. hip fracture patients recovering; or in short-term tube-feeding patients when their serum albumin level drops below 30 g/L). Total parenteral nutrition should be reserved for severely undernourished persons (serum albumin < 20 g/L), and for those who cannot tolerate enteral feeding. The use of specific types of nutrient supplements has little scientific basis. In most cases, the choice of supplement should be based on the patient's preference. For tube feeding it should be the most cost effective.

When a malnourished elderly person is fed, food may induce side effects, including electrolyte abnormalities, hyperglycaemia and aspiration pneumonia, and can sometimes cause a significant drop in blood pressure, which can be associated with falls. Nevertheless, active food supplementation can save lives and is an important intervention. Identifying poor dietary habits or physical and social impediments is the most important first step in treatment. Correcting or modifying these is the next step.

Micronutrients

As indicated, many people eat less as they get older due to a combination of decreased activity and decreased lean body mass and decreased basal metabolic rate (BMR). The reduced food and energy consumption increases the risk of inadequate intake of micronutrients. If aggravated by disease, medications and economic, psychological and physical problems, the intake may be even lower. Tissue uptake of some nutrients (e.g. zinc) is reduced by ageing. Micronutrients identified as being particularly at risk include iron, thiamine, riboflavin and nicotinic acid. The most common deficiency in the elderly in both developing and industrialised countries is iron, important in resistance to infection and cognition.

Vitamin deficiencies

Vitamin deficiencies are common in institutionalised older persons. The deficiencies most commonly seen include riboflavin (B_2) and pyridoxine (B_6). There is no evidence that the absorption of B vitamins, other than folate, is affected by ageing. There is evidence of a decrease in the utilisation of polyglutamate forms of folacin from foods, although synthetic folic acid is well absorbed at all ages. Signs of vitamin B_2 deficiency include cheilosis, glossitis, angular stomatitis, seborrhoeic dermatitis and a magenta tongue. Evidence of vitamin B_6 deficiency include the sideroblastic anaemias. Thiamine deficiency occurs mainly in industrialised countries in people who have consumed excessive amounts of alcohol over a long period of time, often while consuming inadequate diets. The resulting Wernicke-Korsakoff syndrome, of which Australia has one of the highest prevalences in the world, is now seen more commonly in developing or transitional economies, as is niacin deficiency. Niacin deficiency can also occur in either patients receiving isoniazid or patients with the carcinoid syndrome. Characteristically the patient develops pellagra, comprising dermatitis (on areas exposed to the sun), dementia and diarrhoea.

Vitamin B_{12} deficiency can lead to dementia, megaloblastic anaemia, incontinence, orthostatic hypotension or posterior column disease (leading to loss of position and vibration sense). Up to 5% of persons over 80 years have vitamin B_{12} deficiency. The most common cause is pernicious anaemia, caused by a lack of intrinsic factor.

Vitamin C deficiency can be associated with increased bruising, poor wound healing and the development of pressure sores. It should be remembered that taking vitamin C at any dose can result in false-negative faecal and urinary occult blood tests. Ingesting megadoses can interfere with serum and urine glucose tests and may result in oxalate kidney stones, increased serum salicylate levels and rebound scurvy (bleeding after withdrawal). A British study reported that low intakes of vitamin

C in elderly men and low serum pyridoxine levels in elderly women were predictive of early mortality.

Mineral deficiencies

There is relatively little information on the non-institutionalised ambulatory population, although iron is consistently reported to be the micronutrient most at risk. Iron deficiency leads to tiredness, feelings of reduced 'energy', reduced productivity and a decrease in immune function.

Zinc deficiency occurs in institutionalised, closed in and ambulatory elderly persons. Zinc is lost in the urine of patients with diabetes, cirrhosis and alcoholism and in those using a diuretic, and can be associated with poor wound healing, impaired immune function, night blindness and hypogonadism. High doses of zinc have been reported to slow the progress of age-related macular degeneration. However, the taking of high doses is not recommended until further research has been done, partly due to caution being required to avoid secondary copper deficiency. Other food components, such as the carotenoids (pro-vitamin A), lutein and zeaxanthin, may be relevant to macular degeneration, although there are currently no clinical recommendations regarding these.

Antihypertensive drugs can influence potassium and magnesium status. The clinical picture of magnesium deficiency is often coloured by superimposed hypocalcaemia and/or hypokalaemia. This can be aggravated by a poor intake of potassium and magnesium due to anorexia and loop diuretics causing urinary magnesium loss. Magnesium depletion can be the result of severe diarrhoea, as is the case for potassium. Faecal magnesium excretion is related to the total water content of the stool. Much less commonly, selenium deficiency reportedly occurs in patients receiving long-term tube feeding and causes muscle weakness and pain. Copper deficiency is associated with anaemia and possibly mild glucose intolerance.

Other important nutrient and non-nutrient components in foods

Phytochemical deficiencies

Given the current interest in antioxidants and ageing, it is worth remembering that only a few of the food antioxidants available to humans are necessarily vitamins or minerals. Those that are vitamins or minerals are usually acting in metalloenzymes, such as glutathione peroxidase and superoxide dismutase. It is therefore a consideration that older people taking an inadequate diet may not be obtaining the antioxidants that would be beneficial. Phytochemicals, like the phytoestrogens, are usually multifunctional compounds with important health implications for older people, particularly their immune systems, and possibly have antimutagenic and anti-angiogenic properties. There is now good evidence that some sensory disorders characteristic of the elderly, such as maculopathy, can be ameliorated by the ingestion of carotenoids.

Essential fatty acids

In the aged, it is important to ensure adequate amounts of both omega-3 and omega-6 essential fatty acids are consumed because of their effects as anti-inflammatory and immunomodulatory nutrients; and in relation to central nervous functions they have a beneficial effect on mood and cognitive function. There is some evidence that omega-3 fatty acid deficiency can contribute to depression in some individuals and that exercise can alleviate the depressed mood.

Biochemical assessment

The biochemical tests useful in assessing nutritional status are shown in Table 30.4. It is rarely necessary to do an extensive assessment of the biochemical status of the micronutrients (or the other food components mentioned). Generally any treatment, apart from purely iron/folate interventions, is likely to be a multimicronutrient supplement. Thus precise baseline knowledge is not necessary, except where there are clinical signs or some aspect of the dietary history that might point to a particular problem. Exceptions would be iron, folate, vitamin B_{12} and occasionally vitamin B_6.

Iron deficiency, being the most commonly recognised deficiency, should be tested for routinely. In the aged, iron deficiency anaemia is more commonly due to blood loss—notably large bowel disease (haemorrhoids, diverticular disease, tumour or angiodysplasia)—and therefore requires active

Table 30.4 Biochemical tests used to assess nutritional status

Test	Nutritional problem	Normal range[a]	Levels considered to be high risk or require further investigation
Indicators of undernutrition or nutritional deficiencies			
Haemoglobin (g/L)	Anaemia	120–140	< 120 in males < 115 in females
Lymphocytopenia ($\times 10^9$/L)	Weight loss/PEM[b]	1.0–4.0	< 1.0
Serum iron (μmol/L)	Anaemia/iron deficiency	11–32	< 11
Serum ferritin (μg/L)	Anaemia/iron deficiency	18–30	< 20
Plasma zinc (μmol/L)	Poor wound healing	11.5–18.6	< 12
Total iron-binding capacity (μmol/L)	Weight loss/PEM	45–82	< 45
Vitamin B_{12} (pmol/L)	Anaemia ('pernicious')	220–660	< 200
Red cell folate (nmol/L)	Anaemia, elevated homocysteine	450–1300	< 360
Plasma vitamin B_6 (μmol/L) (P5'P[c] nmol/L)	Sideroblastic anaemia	> 20 (> 30)	< 10 (< 20)
Serum albumin (g/L)	Weight loss/PEM	> 40	< 35
Serum cholesterol (mmol/L)	Weight loss/PEM	4.0–5.2	< 4.0
Indicators of overnutrition			
Homocysteine (μmol/L)	Risk factor for vascular disease	5–15	> 15
Fasting blood glucose (mmol/L)	Risk factor for diabetes mellitus	2.5–5.8	> 6.0
Serum cholesterol (total) (mmol/L)	Risk factor for heart disease	< 5.2	> 5.5
Serum high-density lipoprotein cholesterol (mmol/L)	Risk factor for heart disease	> 1.2	< 1.0

(a) Normal ranges can vary according to laboratory method, gender, age, etc.
(b) PEM = Protein-energy malnutrition.
(c) P5'P = is pyridoxal 5 phosphate.

investigation and not simply supplementation. As a first step, anaemia needs to be detected by measuring haemoglobin levels. In addition to measuring haemoglobin, in microcytic anaemia, measures of actual iron stores such as ferritin and serum iron should be tested to clarify the cause of low haemoglobin levels. Ferritin levels are affected by concomitant infection.

The presence of macrocytosis warrants the measurement of folate and B_{12} concentrations. The diagnosis of vitamin B_{12} deficiency is made by documenting a serum level < 200 pmol/L. However, 25% of persons with levels 200–300 pmol/L are also deficient, as demonstrated by elevated methylmalonic acid and homocysteine levels in the urine. These levels should be tested in those suspected clinically of having vitamin B_{12} deficiency. The Schilling test is not useful in diagnosing pernicious anaemia.

If there is apparent clinical evidence of other trace elements (which will be rare) then the clinical

suspicion needs to be confirmed. Zinc is also likely to be a problem but the difficulties in measuring this trace element complicate the diagnosis; however, levels below 12 μmol/L are usually considered to indicate risk.

Elevated homocysteine

A wealth of epidemiological data now suggests that an increase in the serum homocysteine level is an important independent risk factor for vascular disease—specifically of the coronary arteries, cerebrovascular disease and peripheral vascular disease. A recent meta-analysis study estimated that 10% of coronary artery disease in the general population is associated with an elevation in homocysteine. High levels of homocysteine have been shown to be associated with decreased levels of folate, vitamin B_6 and vitamin B_{12}, and supplementation with these vitamins has resulted in decreased homocysteine levels. It is still unclear, however, whether interventions with these nutrients are effective in decreasing the risk of vascular disease. To date, only one randomised controlled clinical trial has shown a decrease in vascular disease outcome.

Evidence is now emerging that suggests that there may also be a link between elevated homocysteine levels, low levels of folate, vitamin B_{12} and Alzheimer's disease. The ranges for normal total homocysteine levels are shown in Table 30.4.

Treatment

Generally, treatment (excluding with vitamin B_{12}) and certainly prevention include increasing the dietary variety or introducing a multimicronutrient formulation. Any such supplement should include adequate levels of zinc (10–15 mg/day) and folate. Although vitamin deficiencies are common in institutionalised older persons, especially those having any degree of protein-energy malnutrition, most vitamin replacement studies have failed to show any major benefits, except for a decreased hip fracture rate with vitamin D replacement. Nevertheless, non-institutionalised persons in Newfoundland who took daily vitamin and mineral supplements had improved immune function compared to a control group. As with undernutrition in general, one needs to examine the elderly patient's socio-economic circumstances and diet, and modify these as appropriate. Concomitant disease that may be affecting absorption or utilisation of micronutrients, including side effects of prescribed drugs, should be excluded as possible causes, and corrected accordingly.

The elderly patient showing nutritional vulnerability should be given a multimicronutrient supplement that covers 100% of the recommended dietary intake (RDI) of the most common vitamins and minerals. As the dietary, non-nutrient constituents of food have other beneficial qualities (e.g. fibre, protection against some cancers, etc.) an aggressive attempt to improve the variety and quality of the diet should also be made. Given the relatively recent recognition of the phytochemicals and fatty acids, attention to improving dietary quality has become even more important.

Older persons who develop gastric achlorhydria may be able to absorb vitamin B_{12} that is not bound to food. Although oral vitamin B_{12} has been used to treat this deficiency, it is recommended that vitamin B_{12} 1000 μg be given intramuscularly (IM) monthly.

Increasing evidence indicates that free radical damage may play a role in the pathogenesis of many diseases in older persons, including atherosclerosis, cancer, arthritis and Parkinson's disease. This has re-opened the question of the pharmacological use of free radical scavengers (vitamins and minerals) to prevent a diverse group of degenerative diseases. However, there is presently inadequate information or scientific evidence to make recommendations, and pharmacological doses are not currently recommended for the elderly.

Overnutrition/obesity

Overweight and obesity in older adults appear to result from a decrease in physical activity, a decline in growth hormone, and for women, the loss of oestrogens. The major cause of overweight in the elderly, however, is an energy intake which exceeds energy output. Less common disorders, such as hypothyroidism, Cushing's syndrome and tumours of the ventromedial hypothalamus, should be excluded.

Obesity has been clearly associated in both the young and the elderly with a myriad of morbid conditions such as decreased longevity, coronary artery disease, hypertension, type II diabetes ('mature onset'), certain types of cancers, sleep apnoea, osteoarthritis, gall bladder disease, gout and poor wound healing and bed sores.

Assessment/diagnosis (WHO criteria)

The ranges of body mass index (BMI) classify underweight, overweight and obesity in most adults. These ranges indicate the higher risk of type II diabetes, hypertension and cardiovascular disease associated with higher BMI ranges, particularly when accompanied by increased waist circumference. However, with increasing age these ranges are less certain. Several large studies have shown that above the age of 74 years, higher body weight may be protective. A BMI range of 22–26 is acceptable for older Australians. It is generally agreed that for the obese elderly person, a reduction in BMI to 30 or below affords the healthiest long-term option. In terms of survival, older people can tolerate higher BMIs than their younger counterparts. However, quality of life in terms of movement, independence and proneness to chronic non-communicable disease is affected by total and abdominal obesity, and therefore requires some prevention, monitoring and management.

It is important to measure height as accurately as possible. Because loss of height in the elderly is commonly due to bone loss, stooped posture, etc., using 'usual height' to assess BMI will not be accurate. If height measurement in an upright position cannot be performed, there are several other alternatives: total arm span, half-arm span and mid-upper arm circumference are all possibilities but charts are needed for diagnosing risk (as, for example, in the London School of Hygiene and Tropical Medicine/HelpAge manual). Knee height can be measured in a recumbent position, but a knee height calliper is required. This instrument has two blades set at right angles to a measuring stick, and measures the distance between the base of the heel and the top of the thigh on a bended knee. The formula used to compute stature from knee height is:

$$\text{Stature for women} = (1.83 \times \text{knee height}) - (0.24 \times \text{age}) + 84.88 \text{ cm}$$

$$\text{Stature for men} = (2.02 \times \text{knee height}) - (0.24 \times \text{age}) + 64.19 \text{ cm}$$

Abdominal fat tends to increase with age. In women, this trend occurs after menopause. In men, there may be an increase in intra-abdominal fat with a decrease in subcutaneous abdominal fat compared with younger males. In both genders, increased waist circumference accounts for about 40% of the insulin resistance associated with ageing. Increased waist measurement is a sign easily recognised by both patient and doctor as indicative of overnutrition.

Food intake is an important part of any assessment of malnutrition (over-, under- or disordered). If at all possible, this assessment is best made by a trained dietitian or nutritionist. A good dietary assessment is essential for diagnosis, treatment and prevention.

Treatment

Weight management should be initiated in elderly persons whose BMI is > 30 kg/m^2 and in patients with diabetes whose BMI is > 27. Recommendations for appropriate weight management strategies in the elderly are summarised in Table 30.5. A weight management program that begins with increasing exercise is logical because decreased physical activity is the major aetiological factor in obesity for most older individuals. A walking program, beginning with 3–5 km per day 4 times a week and 1–2 km on the other days of the week, is attainable. Other types of physical activity, such as gardening, dancing, low impact aerobics, yoga or Tai Chi, can also be encouraged. Swimming or water aerobics are popular with older individuals, especially those with arthritis or conditions that affect movement of the lower extremities.

Strength (or resistance) training, which involves lifting a heavy load in rapid succession, will strengthen muscles and reduce muscle loss, and is also recommended for elderly individuals. Recent studies in older people have demonstrated that resistance training can result in a decline in the progress of sarcopenia, as well as decreased problems associated with type II diabetes, coronary

Table 30.5 Appropriate weight management techniques

Weight management technique	Appropriateness for elderly
Exercise	Yes
Diet: moderate energy restriction	Yes (if BMI greater than 27, or weight associated with diabetes mellitus)
Behaviour modification	Yes
Low and very low kilojoule diets	Potentially dangerous
Drugs (anorectic or thermogenic agents)	Rarely indicated
Gastric balloon	Not useful
Surgery: gastric restriction	Only when massive obesity is associated with sleep apnoea
Surgery: jejuno-ileal bypass	Never used

Source: Adapted from J. E. Morley & Z. Glick (1995), 'Obesity', in J. E. Morley, Z. Glick & L. Z. Rubenstein (eds), *Geriatric Nutrition: A Comprehensive Review*, 2nd edn, Raven Press, New York.

artery disease, hypertension, osteoporosis and obesity. Close follow-up or monitoring of the exercise program by a physician or therapist will result in greater long-term success.

Appropriate dietary recommendations for weight management in the elderly are outlined in the National Health and Medical Research Council's *Dietary Guidelines for Older Australians* (Box 30.3). Emphasis should be placed on increasing the consumption of nutrient dense foods, such as: vegetables; fruit; whole grain cereal; bread and pasta; low-fat dairy products; low-fat protein sources, such as dried beans and legumes; fish; poultry and lean meat. Elderly persons should be encouraged to limit (but not completely eliminate) food high in saturated fat and sugar. A moderate amount of alcohol (1–2 glasses per day) can help stimulate the appetite and provide a social and pleasant mealtime environment. It is vitally important that older people continue to enjoy meal times and not be overly restricted in their diet to the point of getting little satisfaction from eating.

Behaviour modification techniques such as self-monitoring and lifestyle changes have been used successfully with elderly persons. With the help of a skilled intervention team that includes a dietitian and a psychologist, elderly persons can learn techniques to limit the temptation to overeat and focus on positive outcomes, such as improved mobility and general wellbeing. Some successful weight management programs focus on improved eating habits and reduction of waist circumference rather than on weight loss alone. It is worth remembering that although through middle age there is a doubling of body fat, it is more typical for body fat to decrease after the age of 65 years, even in healthy individuals.

Low-energy diets (3350–4200 kJ or 800–1000 kcal/day) are not appropriate for weight management in the elderly. At this level of energy intake, micronutrient status is likely to be compromised. The use of pharmacological agents should be avoided, as there are few data on the effectiveness and safety of anorectic and thermogenic agents in the elderly.

Box 30.3 National Health and Medical Research Council Guidelines

Dietary guidelines for older Australians

1. Enjoy a wide variety of nutritious foods.
2. Keep active to maintain muscle strength and a healthy body weight.
3. Eat at least three meals every day.
4. Care for your food: prepare and store it correctly.
5. Eat plenty of vegetables (including legumes) and fruit.
6. Eat plenty of cereal, breads and pastas.
7. Eat a diet low in saturated fat.
8. Drink adequate amounts of water and/or other fluids.
9. If you drink alcohol, limit your intake.
10. Choose foods low in salt and use salt sparingly.
11. Include foods high in calcium.
12. Use added sugars in moderation.

Conclusion

At all ages, the healthiest diet is one that, through variety, provides adequate micronutrients and appropriate amounts of energy, protein and carbohydrate. The treatment goal is to empower the elderly person to develop a healthy lifestyle to reduce the risk of chronic diseases.

Studies have shown that the quality of life for the elderly is very much a subjective feeling and may be relatively unrelated to a more objective assessment. An ideal assessment scale would cover activities of daily living (including eating), communication, visual and hearing disability, cognitive function, depression, quality of life and assessment of social status. The family physician is suited to assessing his elderly patient's 'nutritional vulnerability', which covers physical health, food intake, socioeconomic status, disability, functional ability, family and social life, and psychological and emotional wellbeing.

The checklist in Box 30.4 is an outline for assessing the warning signs of poor nutritional health. Accurate nutritional assessment of the elderly is difficult, but should be kept as simple as possible to ensure it is actually done. The assessment involves taking a medical, dietary and social history; basic biochemical assessment; and further investigation when indicated. The most important factor in the nutritional assessment of the older patient is that the practitioner remains alert to the possibility of some degree of malnutrition (both under- and over-). As undernutrition, in particular, can be very subtle and develop over many years, a high degree of suspicion needs to be maintained.

Many countries have developed dietary guidelines specifically related to the elderly population. In Australia, the National Health and Research Council has published *Dietary Guidelines for Older Australians* (Box 30.3). These guidelines were designed to be used as a whole. The first four guidelines deal with general aspects of nutrition and lifestyle, while the remaining guidelines address issues related to specific foods and nutrients, and are ranked in approximate order of importance. Older persons should be encouraged to seek the advice of their physician, dietitian or other health or social service professional. There are a number of programs in most communities which provide nutritious meals in a social setting, a recognised positive factor in encouraging greater variety and quantity in the diet. Other programs, such as Meals-on-Wheels, offer meals delivered to the home by community volunteers.

Regular physical exercise, improving muscle strength and maintaining a healthy body weight, have all been shown to reduce the risk of several chronic diseases and premature death. Moderate physical activity has also been shown to promote a positive mental attitude and to promote stronger, healthier muscles, bones and joints. Research indicates that eating a wide variety of foods offers protection against major chronic diseases, such as coronary heart disease, hypertension, type II diabetes and some cancers. Eating a wide variety of foods also increases the likelihood of obtaining most of the essential nutrients.

It is encouraging that a national nutrition survey in Australia found that on average, older people actually eat better than their younger countrymen and women. Regular nutritional assessment and the awareness that this is needed will help maintain nutritional health and wellbeing as our society continues to age. The year 1999 was designated as the International Year of Older Persons. The UN Secretary-General described a society for all ages as 'one that does not caricature older persons as patients and pensioners', and one that 'seeks a balance between supporting dependency and investing in lifelong development'.

Editor's note

Box 30.4 is a mini-nutritional assessment (MNA), which is an 18 item instrument requiring only 20 minutes to complete. It incorporates anthropometric measures, data entry questions and health and functional status questions. The developers used discriminate analysis techniques applied to several cross-sectional samples to establish cut-off points for being 'at risk' of malnutrition and being undernourished. The instrument has been validated against the clinical judgment of nutritional status, dietary intake and biochemical measures. More importantly, predictive validity for weight loss, the occurrence of acute disease and the need for assistance has been documented.

Box 30.4 Mini-Nutritional Assessment

Last name: _____ First name _____ M.I. _____ Sex: _____ Date: _____

Age: _____ Weight (kg:) _____ Height (cm): _____ Knee height (cm): _____

Complete the form by writing the numbers in the boxes. Add the numbers in the boxes and compare the total assessment to the Malnutrition Indicator Score.

Anthropometric Assessment

Points

1. Body Mass Index (BMI) (weight in kg)/(height in m^2)
   a. BMI < 19 = 0 points
   b. BMI 19 to < 21 = 1 point
   c. BMI 21 to < 23 = 2 points
   d. BMI > 23 = 3 points

2. Mid-arm circumference (MAC) in cm
   a. MAC < 21 = 0.0 points
   b. MAC 21 ≤ 22 = 0.5 points
   c. MAC > 22 = 1.0 point

3. Calf circumference (CC) in cm
   a. CC < 31 = 0 points
   b. CC ≥ 31 = 1 point

4. Weight loss during last 3 months
   a. weight loss greater than 3 kg (6.6 lb) = 0 points
   b. does not know = 1 point
   c. weight ooss between 1 and 3 kg = 2 points
   d. no weight loss = 3 points

General Assessment

5. Lives independently (not in a nursing home or hospital)
   a. no = 0 points b. yes = 1 point

6. Takes more than 3 prescription drugs per day
   a. yes = 0 points b. no = 1 point

7. Has suffered psychological stress or acute disease in the past 3 months
   a. yes = 0 points b. no = 2 points

8. Mobility
   a. bed or chair bound = 0 points
   b. able to get out of bed/chair but does not go out = 1 point
   c. goes out = 2 points

9. Neuropsychological problems
   a. severe dementia or depression = 0 points
   b. mild dementia = 1 point
   c. no psychological problems = 2 points

10. Pressure sores or skin ulcers
    a. yes = 0 points b. no = 1 point

Dietary Assessment

Points

11. How many full meals does the patient eat daily?
    a. 1 meal = 0 points
    b. 2 meals = 1 point
    c. 3 meals = 2 points

12. Selected consumption markers for protein intake
    - At least one serving of dairy products (milk, cheese, yogurt) per day ☐ Yes ☐ No
    - Two or more servings of legumes or eggs per week ☐ Yes ☐ No
    - Meat, fish, or poultry every day ☐ Yes ☐ No

    a. 0 or 1 yes = 0.0 points
    b. 2 yes = 0.5 points
    c. 3 yes = 1.0 point

13. Consumes two or more servings of fruits or vegetables per day
    a. no = 0 points b. yes = 1 point

14. Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
    a. severe loss of appetite = 0 points
    b. moderate loss of appetite = 1 point
    c. no loss of appetite = 2 points

15. How much fluid (e.g., water, juice, coffee, tea, milk) is consumed per day? 1 cup = 220g)
    a. less than 3 cups = 0.0 points
    b. 3 to 5 cups = 0.5 points
    c. more than 5 cups = 1.0 point

16. Mode of feeding
    a. unable to eat without assistance = 0 points
    b. self-fed with some difficulty = 1 point
    c. self-fed without any problem = 2 points

Self-Assessment

17. Do they view themselves as having nutritional problems?
    a. major malnutrition = 0 points
    b. do not know or moderate malnutrition = 1 point
    c. no nutritional problem = 2 points

continued

18. In comparison with other people of the same age, how do they consider their health status?
    a. not as good = 0.0 points
    b. do not know = 0.5 points
    c. as good = 1.0 point
    d. better = 2.0 points

Assessment Total (max. 30 points)

MALNUTRITION INDICATOR SCORE

≥ 24 points = well-nourished | 17 to 23.5 points = at risk of malnutrition | < 17 points = malnourished

Source: B. Vellas, Y. Guigoz, P. J. Garry et al. (1999), 'The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients', *Nutrition*, 15(2), pp. 116–22.

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PRACTICAL GUIDE TO GERIATRIC MEDICINE

EDITED BY
RANJIT N RATNAIKE

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