1
Diet and Nutrition Issues Relevant to Older Adults

1.1 Introduction

This Task Force Report aims to identify steps that can be taken from a nutritional perspective to help the older adults of tomorrow to lead healthier lives. Subsequent chapters will discuss:

- the basic biology of ageing;
- the effect of ageing on a range of different organ systems and how a life-course food and nutrition approach, together with regular physical activity, may minimise or delay these effects; and
- public health recommendations and approaches that should be undertaken to improve the health of future older adults.

This first chapter sets the scene. It provides some details of the demographics of ageing and describes current patterns of ageing and health. It highlights some of the diet and nutrition issues relevant to today's older adults, many of which will be expanded in subsequent chapters.

Within this Task Force Report, definitions from the World Health Organization (WHO) are used; that is 'older' refers to a person aged 65 years or over and the 'oldest old' refers to those aged 80 years or over. However, it is important to recognise that definitive categorisation of older people is difficult, as 'old' is an individual-, culture-, country- and gender-specific term. For example, in developing countries many people are functionally 'old' in their forties and fifties (World Health Organization 2001). This means that older adults are a very heterogeneous group.

1.1.1 Demographics

Over the past hundred years many changes have impacted on people's lives. In some parts of the world during this time, life expectancy has almost doubled, at the same time fertility rates have declined, leading to changes in the demographics of the population.

Population ageing (characterised by a decline in the proportion of children and young people and an increase in the proportion of older people) has, until recently, been associated with the more developed regions of the world. For example, nine out of the ten countries with more than 10 million inhabitants, and with the largest proportion of older people, are in Europe (World Health Organization 2002a). However, the number of older people living in less developed regions is expected to increase from ~400 million.

1.1.1.1 Worldwide

The number of older people is set to increase (Figure 1.1), although it is important to note that the proportion of older people within the total population varies widely among countries *e.g.* from about 4% in Cambodia to around 14% in Japan in 2004 (World Health Organization Regional Office for the Western Pacific Region). From 1970 to 2025, a 223% growth in older adults is expected worldwide, so by 2025 there will be ~1.2 billion people over the age of 60. Decreasing fertility rates and increasing longevity will ensure the continued 'greying' of the world's

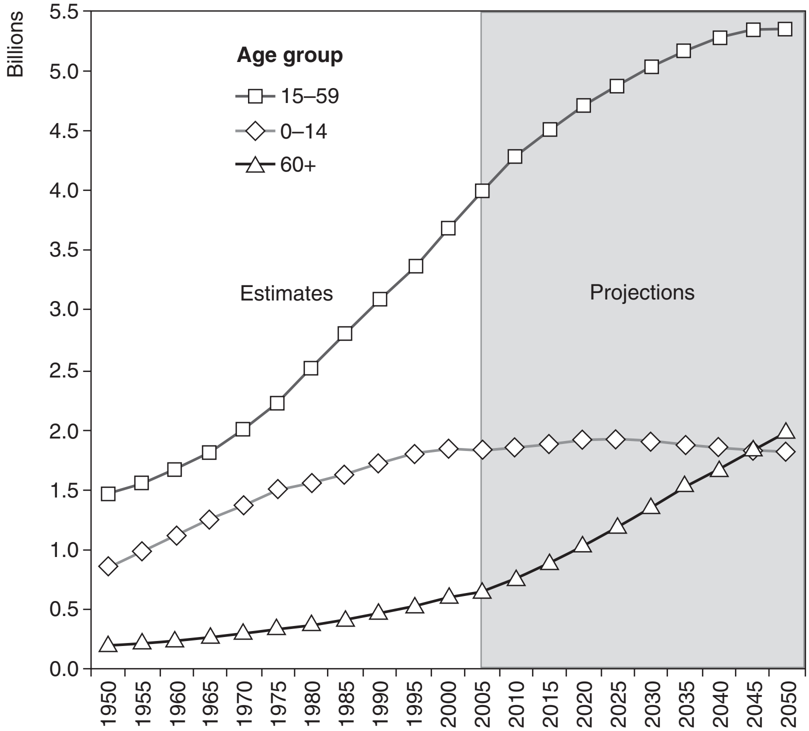


Figure 1.1: World population by age groups, 1950–2050. Source: United Nations Population Division, *World Population Prospects: The 2006 Revision.* Fact Sheet. Series A. New York: United Nations Department of Economic and Social Affairs, March 2007.

population, despite setbacks in life expectancies in some African countries (due to AIDS) and in some newly independent states (due, for example, to increased deaths caused by cardiovascular disease and by violence).

Over half the world's older people live in Asia and it is expected that Asia's share of the world's oldest people will continue to increase by the greatest amount. For example, it is projected that, by 2025, the proportion of older adults in Japan will increase to 26% of the population, and in China from 6.5% to 12% (World Health Organization Regional Office for the Western Pacific Region).

In 2002, globally, people over the age of 80 numbered ~69 million, the majority of whom lived in more developed regions of the world. This age group is the fastest growing segment of the older population (World Health Organization 2002a), owing to increased longevity, and is expected to increase with the post-Second World War baby-boom generation approaching their sixties (Ministry of Health 2002).

1.1.1.2 The UK

As in many other developed countries, life expectancy in the UK has continued to rise (Figure 1.2). In 1901, life expectancy at birth for females was 49 years and for males 45 years, whereas by 2002 life expectancy had risen to 81 and 76 years respectively. Consequently, the number of older people in the UK is increasing. The proportion of people aged 50 years or over has increased from 16 million in 1961 to 19.8 million people in 2002, a 24% increase. It is estimated that this number will continue to increase, with an estimated 27 million people aged 50 years or over by 2031 (National Statistics Online 2004) (see also Chapter 14, Section 14.1).

The proportion of people aged 85 and over will increase too. In 2001, this subgroup accounted for only 1.9% of the population; by 2031 it is estimated that it will make up 3.8% of the population. Currently, a very small proportion of older people in Great Britain are from non-white minority ethnic

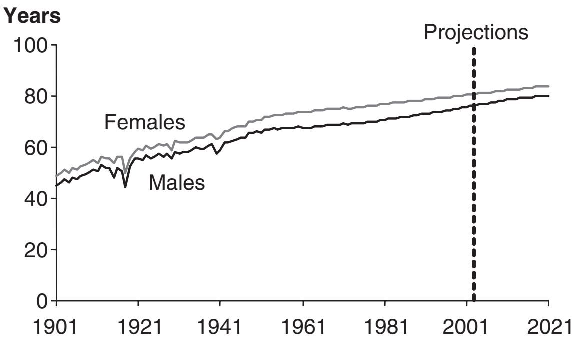


Figure 1.2: Life expectancy at birth in the UK. Source: Government Actuary's Department (www.gad.gov.uk); Babb *et al.* (2006).

groups (1%) but this will increase in the coming years.

1.1.1.3 Europe

Similar changes in demographics have been seen across Europe. Between 1960 and 2002 the proportion of older people in the EU-15 rose from 11% to 16%. Data for the EU-25 show a similar trend, although there is some variation between countries (*e.g.* 17.5% of Germany's population are aged 65 or over, while in Ireland and Liechtenstein it is closer to 11%). It is estimated that by 2010 there will be twice as many older people as in 1960 (69 million vs. 34 million), although as a proportion of the global population of older adults, Europe's share will decrease the most over the next two decades (World Health Organization 2002a).

Growth among those aged 80 or over is even more pronounced and it is estimated that between 2000 and 2010 the numbers of people in this age group will rise by 35%. Belgium, France, Italy and Luxembourg are expected to experience the largest increases (43–49%), while in Denmark and Sweden, growth of this age group will be negligible (Eurostat 2004).

1.1.1.4 The United States

In 2002 the older population of the US numbered 35.6 million, representing about 12.3% of the total population. It is expected that by 2030 the older population will have more than doubled to about 71.5 million; that the proportion of older people from ethnic minorities will increase (from 16% in 2000 to 26% in 2030) and that the 'oldest old' will increase (from 4.6 million in 2002 to 9.6 million in 2030) (Administration on Aging 2003).

1.1.1.5 Other regions and countries

Africa: It is projected that Africa will experience an increase in absolute numbers of older people. For example, in western and northern Africa the number of older adults is expected to increase nearly five-fold between 1980 and 2025. A feature of ageing in Africa is the number of older people who live and work in rural areas (World Health Organization Regional Office for Africa).

China: According to 2003 estimates, 7.5% of the Chinese population are 65 years old and over. With continuing ageing of the population, the proportion of the people who are over 65 is projected to increase to 8.3% by 2010, 12% in 2020 and 22.6% by 2040. In 1990, about 30% of the people over 65 years of age were above the age of 75 years; this proportion is projected to rise to 35% by 2020, and 50% by 2050.

New Zealand: As in other developed countries, the proportion of older adults in the New Zealand population has increased (Figure 1.3). It is estimated that from 2001 to 2051 it will increase from 12% of the total population to 26%. The number of people aged 85 and over is projected to increase by 485% between 2001 and 2051. In comparison, the total population aged 65 and over is estimated to increase by 158% and the New Zealand population by only 20% (Ministry of Health 2002).

1.2 Ageing and health

Although data increasingly indicate that old age itself may not necessarily be associated with increased health service expenditure, the number of people reporting long-standing illness increases with age. For example:

- Baseline data from the Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA) study of ~2,500 men and women from 17 towns in 11 countries across Europe, found the percentage of people suffering from a chronic

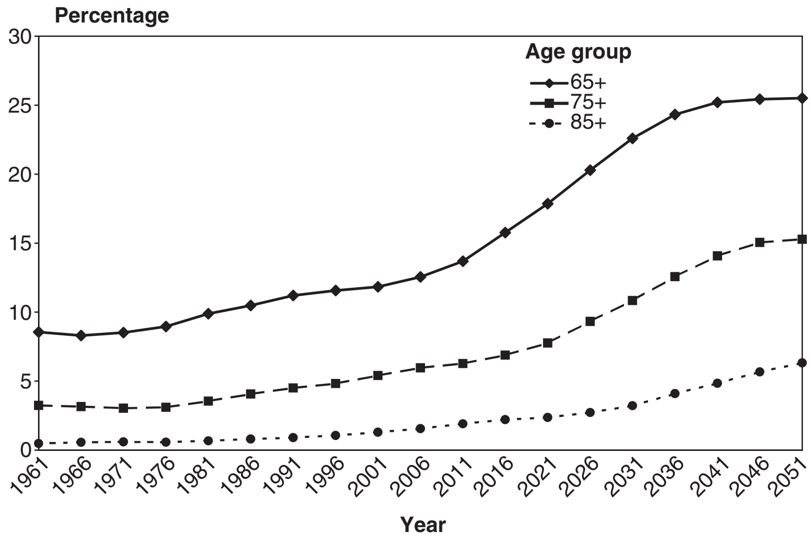


Figure 1.3: Changes in older adults – New Zealand population 65+, 75+ and 85+ as a percentage of the total population: 1961–2051. Source: Statistics New Zealand, *Census of Population and Dwellings 1961–1996 and Population Projections* (1999 base).

disease ranged from 59% (Yverdon, Switzerland) to 92% (Vila Franca de Xira, Portugal) (Schroll *et al.* 1991).

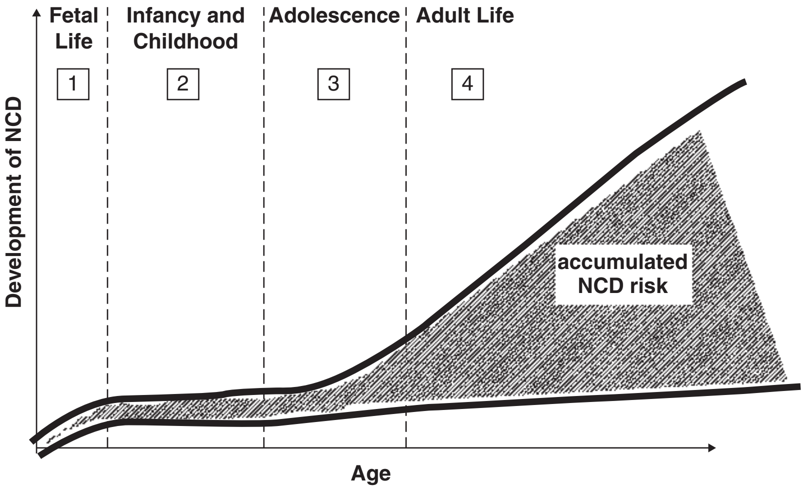
- Follow-up data from SENECA found that on average 68% of participating men and 78% of women aged 75–80 years had at least one chronic disease, with large variations between countries (*e.g.* 40% of Spanish men compared to 100% of Portuguese women have at least one chronic disease) (M. Schroll *et al.* 1996).
- In the US, 50% of older people had chronic diseases or some other form of disability (Blanc *et al.* 2004). The most frequently occurring conditions in 2000–1 were hypertension (49.2%), arthritic symptoms (36.1%), heart disease (31.4%), sinusitis (15%) and diabetes (15%) (Administration on Aging 2003).
- In Australia, survey data found that the prevalence of most conditions increased with age, to the extent that at least one long-term condition was reported for almost all (99%) of those aged 75 years and over. Among those aged 55 years or older, the most common long-term conditions included sight problems, arthritis, back and disc problems, hypertension and hearing loss (Australian Bureau of Statistics 2002).

Detailed statistics for the UK can be found in Chapter 14, Section 14.5.

Chronic or non-communicable diseases become the leading causes of morbidity, disability and mortality in all regions of the world as people age. A life-course approach to chronic disease has arisen against a background of increasing evidence that the risk of many chronic diseases is not just determined by risk factors in mid-adult life but begins in childhood or adolescence and potentially earlier during fetal development (Aboderin *et al.* 2002) (Figure 1.4).

The proportion of people reporting a disability tends to increase with age; additionally, the severity of disability increases with age. For example, data from New Zealand show that while 14% of women and 12% of men aged 15–44 years reported a disability; in those aged 75 years and above the proportion increased to 69% of women and 64% of men (Ministry of Health 2002). Similarly, the Health Survey for England 2001 indicates that while 66% of men and 68% of women aged 65–74 years reported no disability, less than a third of those aged 85 or older were disability-free. Among these age groups, prevalence of serious disability increases from 9% to 33% in men and from 9% to 42% in women (Figure 1.5) (Bajekal and Prescott 2003) (see Chapter 14, Section 14.5).

Older adults are disproportionately affected by sensory impairments (Desai *et al.* 2001). For example, in the US, although older people make up



The risk of non-communicable diseases accumulates with age and is influenced by factors acting at all stages of the life span. The main factors at different stages of life include the following:

1 Fetal Life
fetal growth, maternal nutritional status, socioeconomic position at birth

2 Infancy and Childhood
growth rate, breastfeeding, infectious diseases, unhealthy diet, lack of physical activity, obesity, socioeconomic position

3 Adolescence
unhealthy diet, lack of physical activity, obesity, tobacco and alcohol use

4 Adult Life
known adult behavioural and biological risk factors

NCD: Non-communicable disease.

Figure 1.4: Life-course approach to non-communicable disease prevention.
Source: Aboderin *et al.* (2002).

only 12.8% of the population, they account for approximately 37% of hearing-impaired individuals and 30% of all visually-impaired individuals. It is estimated that worldwide about 4% of persons aged 60 and over are blind (60% of whom live in Sub-Saharan Africa, China and India). The major age-related causes of blindness and visual disability include cataracts (nearly 50% of all blindness), glaucoma, macular degeneration and diabetic retinopathy (World Health Organization 2002a) (see Chapter 9, Section 9.1). The Health Survey for England 2001 found 3%, 7% and 21% of men aged 65–74, 75–84 and 85+ years and 4%, 10% and 19% of women aged 65–74, 75–84 and 85+ years had moderate or serious sight disability, defined as not being able to recognise a friend at a distance of 4 metres when wearing their glasses or contact lenses (Bajekal and Prescott 2003), and 62% of those aged 75 years and over reported more general eye complaints (see Chapter 14, Section 14.7). While globally over 50% of older people may have some degree of hearing loss (World Health Organization 2002a), in England lower levels have been found – 28% of men and 30% of women aged 85 years or older in the Health Survey for England had moderate or serious hearing disability (Bajekal and Prescott 2003). Both visual and hearing impairments can cause difficulties with communication; this can lead to frustration, low self-esteem, withdrawal and social isolation, increase vulnerability and limit quality of life (World Health Orga-

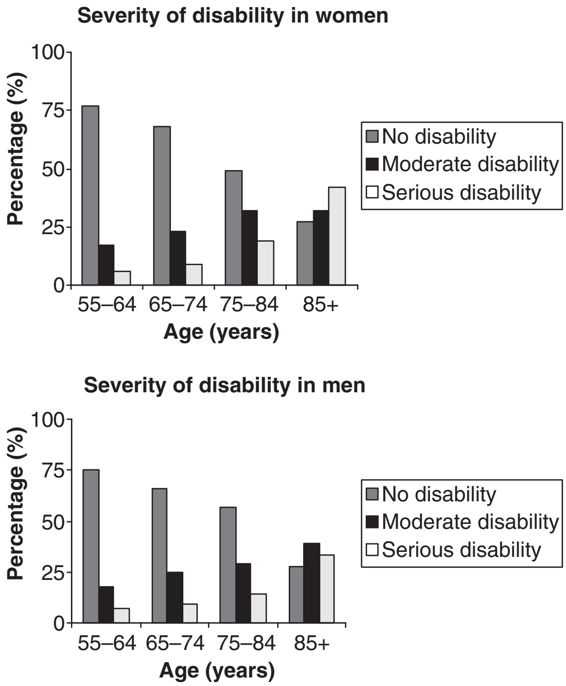


Figure 1.5: Severity of disability in women and men in England.
Source: Bajekal and Prescott (2003). Reproduced under the terms of the Click-Use Licence.

nization 2002a). Problems with locomotion (*e.g.* walking and climbing stairs), personal care (*e.g.* dressing and feeding oneself) and communication affect older adults more than younger adults (Bajekal and Prescott 2003).

Across Europe the number of older people free of any health problems, illness or disability has been shown to decrease with increasing age (Figure 1.6).

1.2.1 Causes of death

The main cause of death varies with age. For example, in 2002 the most common cause of death for people aged 50–65 years in the UK was cancer, while over the age of 65 circulatory diseases were the most common cause, with heart disease as a cause of death decreasing with increasing age and stroke increasing (National Statistics Online 2004).

Table 1.1 shows the leading causes of death in older people in a number of countries. However, the major causes of death can vary according to gender and race. For example, US data from 1997 show that diabetes was the third leading cause of death among older American Indian and Alaskan Native men and women, it was the fourth leading cause of death among older Hispanic men and women and ranked sixth among white men and women and older Asian and Pacific Islander men (Federal Interagency Forum on Ageing-Related Statistics 2004).

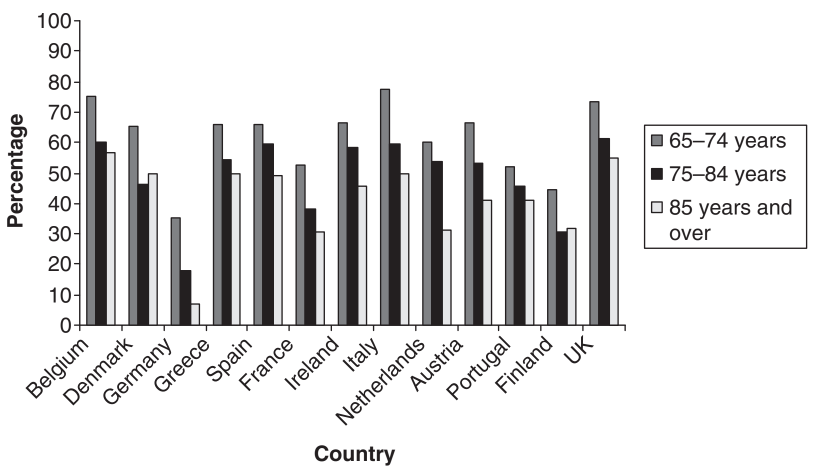


Figure 1.6: Percentage of older people free of any physical or mental health problem, illness or disability.
Source: ECHP UDB, EUROSTAT (06/2003).

Table 1.1: Leading causes of death among older people in selected countries

Country	Year	Leading causes of death (% of total deaths in older adults)	Reference
Australia	1999	Circulatory system (46%) Cancer (25%) Respiratory system (9%)	World Health Organization statistics
America	2001	Heart disease (32.4%) Cancer (21.7%) Cerebrovascular diseases (8.0%)	National Center for Health Statistics
Chile	1999	Circulatory system (34%) Cancer (22%) Respiratory system (17%)	World Health Organization Statistics
England and Wales	2002	Circulatory system (42%) Cancer (24%) Respiratory system (15%)	National Statistics Online (2004)
France	1999	Circulatory system (35%) Cancer (24%) Respiratory system (9%)	World Health Organization statistics
Germany	1999	Circulatory system (58%) Cancer (22%) Respiratory system (7%)	World Health Organization statistics
Ireland	1999	Circulatory system (45%) Cancer (21%) Respiratory system (19%)	World Health Organization statistics
Japan	1999	Circulatory system (34%) Cancer (27%) Respiratory system (16%)	World Health Organization statistics
New Zealand	1996–98 combined	Ischaemic heart disease (25.8%) Cancers (19.55%) Other circulatory disease (13.5%) Respiratory diseases (13.98%) Stroke (10%)	Ministry of Health 2002

1.2.2 Quality of life

Quality of life (QoL) issues in ageing also need to be recognised and addressed because the term ‘health’ encompasses more than just the absence of disease. For example, the WHO (2001) defines health as the state of complete physical, mental and social wellbeing.

The factors important in QoL may differ from person to person, but independence, self-esteem and socio-economic security are typically key factors. It is important to recognise that, as some foods have symbolic meaning and particular food habits are influenced by religious, cultural, social and emotional experiences, some dietary interventions may not lessen disability or extend life expectancy but may still be worthwhile if they enhance the individual’s QoL (Wahlqvist and Saviage 2000). Equally, in some older adults, traditional food will be preferred even if it is known that these foods are not nutritionally ideal. Control of food choice and/or preparation may improve self-esteem in some older adults.

1.3 Ageing, gender and ethnicity

As mentioned above, there are gender differences with respect to ageing. Women outlive men in virtually all societies, so that there are more older women than men (World Health Organization 2002a). Men are more likely to engage in behaviours known to lead to health problems and premature mortality such as poor diet, smoking and excessive consumption of alcohol and other substances harmful to health. This means that women generally have a longer life expectancy and in developed countries men's life expectancy is at least five years lower than women's (Payne 2004). But it appears that this gender inequality is slowly changing, in some countries at least. For example, in Great Britain, death rates for men have fallen faster than for women over the last 30 years and are expected to continue. There were 28% more women than men aged 50 and over in 1961 but only 18% more in 2002, and by 2031 the number is expected to have reduced further, to 14% (National Statistics Online 2004).

Health inequalities have been noted among people of different ethnic groups, for example life expectancy varies by race. In New Zealand, the life expectancy of Maori and Pacific people is lower than that of the general population due to higher mortality rates, particularly for circulatory diseases and cancers, at earlier ages. In the 65–74 age group, the Maori mortality rate is 104% higher than that of European/other New Zealanders. The mortality rate for Pacific peoples aged 65 and over is also much higher than for European and other groups of the same age (77% higher) (Ministry of Health 2002).

Some ethnic groups are more susceptible to certain chronic diseases. In the UK the risk of stroke is higher among men from African-Caribbean and South Asian communities (Department of Health 2001). *The Health Survey for England 1999 – The Health of Minority Ethnic Groups* found higher rates of cardiovascular disease among South Asian groups compared with the general population, and Black Caribbean men and women had a higher prevalence of diabetes (Erens *et al.* 2001).

Nationally representative data from the US have also shown differences in nutritional intakes and status between different ethnic groups. The Third National Health and Nutritional Examination Survey (NHANES III, 1988–94) found that, compared to non-Hispanic whites, older non-Hispanic blacks and Mexican Americans generally had lower mean dietary intakes and a higher prevalence of inadequate iron and zinc intakes, or intakes below the recommendation for calcium (Ervin and Kennedy-Stephenson 2002).

The British National Diet and Nutrition Survey (NDNS) for older people does not provide information according to ethnic group. However, the *Health Survey for England 1999 – The Health of Minority Ethnic Groups* specifically focused on ethnicity and found differences in eating habits among minority ethnic groups (Erens *et al.* 2001). For example, the proportion of Chinese men and women who consumed fruit and vegetables six or more times a week (46% and 53% of men and 60% and 69% of women, for fruit and vegetables respectively) was higher than corresponding proportions of all other minority ethnic groups, and a higher proportion of Bangladeshi men (13%) and women (11%) than of other minority ethnic groups consumed red meat six or more times a week (Erens *et al.* 2001).The participants (adults over 16 years) in this survey were not segmented by age and no comparisons were made with the general population (also see Chapter 14, Section 14.5.1).

A series of smaller studies have also noted differences in nutrient intakes between ethnic groups:

- A study of 2655 older adults found that, compared to whites, African-Americans were more likely to have inadequate intakes for most nutrients (American Dietetic Association 2000).
- The San Luis Valley Health and Aging Study found Hispanic participants were more likely than non-Hispanic whites to report inadequate intakes of vegetables, problems with teeth or dentures, difficulty preparing meals and lack of money to buy food (Marshall *et al.* 1999).
- An American study found that Hispanic older adults consumed fewer saturates and simple sugars and more complex carbohydrates than did non-Hispanic whites, although those Hispanics who had been living in the US for a longer period of time tended to have macronutrient profiles more like those of the non-Hispanic whites (Bermudez *et al.* 2000).
- A UK study of men and women aged 25–79 years from Pakistani, European and African-Caribbean communities found iron intakes were low among the African-Caribbean group (Table 1.2).

As the proportion of older people from ethnic minorities is projected to increase in many countries, and because of the health inequalities described above, it is important that robust data are collected on these groups of older adults.

Table 1.2: Nutrient intake per day (means)

Nutrient	Men			Women		
	White European (n = 38)	African-Caribbean (n = 99)	Pakistani (n = 34)	White European (n = 48)	African-Caribbean (n = 147)	Pakistani (n = 50)
Iron (mg)*	15.5	12.1	14.8	14.8	10.1	14.1
Calcium (mg)*	1133	939	605	1063	828	601

*Reference nutrient intake (RNI): iron 8.7 mg/day for men and 14.7 mg/day for women; calcium 700 mg/day for adults.
Source: Vyas *et al.* (2003).

1.4 Costs of an ageing population

A large proportion of public health funds are spent on older adults, that is to say, although older people account for only 16% of the UK population, just over a third of hospital and community health service spending can be attributed to them (Wanless 2004). Additionally, in England almost two-thirds of general and acute hospital beds are occupied by people over 65 (Department of Health 2001).

As well as impacting on health care spending, an increase in the average age of the population has consequences in relation to the workforce and pensions. The changing age composition of the population will reduce the proportion of workers and increase the number of dependent older adults, but several factors may influence these changes. For example, the increase in experience associated with an older workforce will typically raise average earnings and productivity per worker (Rogers *et al.* 2000). 'Savings' may be made from the decreased per capita expenditure on school education as the proportion of the population of school age will be reduced.

1.5 Nutritional requirements of older people and current recommendations

1.5.1 Energy

Energy is needed by the body for a number of different functions (FAO/WHO/UNU 2004). The largest component of energy expenditure is that required to maintain physiological equilibrium and is referred to as basal metabolic rate (BMR). BMR is influenced by fat-free mass, age, sex, thyroid hormones and protein turnover. Energy is also required to digest and absorb food and for the regulation of body temperature (thermogenesis), as well as for physical activity. In addition, energy is required for growth, pregnancy and lactation. Energy requirements are estimated from measures of energy expenditure and revised values for the UK population are expected to be published in 2008. Recommendations are also being reviewed from a European perspective by the European Food Safety Authority (EFSA).

There is much interest in how the components of total energy expenditure (TEE) change with age. Generally, among healthy people living in developed countries, TEE decreases with age (Elia *et al.* 2000). A decrease in BMR with age has been reported by the Food and Agriculture Organization (FAO), with estimates of decreases of 2.9% and 2% per decade for normal weight men and women, respectively (FAO/WHO/UNU 2004). However, this decrease is not linear. Ageing is associated with quantitative changes in body composition, with body mass tending to increase from adulthood to 70–75 years (and thereafter decrease), while fat-free mass increases (Kendrick *et al.* 1994; Ritz 2001). This means that, for a given bodyweight, older people tend to have less muscle and more fat, leading to a decrease in the BMR.

The effect of ageing on thermogenesis is not clear. Several studies have investigated the effect of ageing on the diet-induced thermogenesis (DIT) component of energy expenditure (summarised by Elia *et al.* 2000) but results are inconsistent, with some studies showing no difference in DIT between young and older adults, and others reporting a greater DIT in younger individuals compared to older ones. However, as DIT is affected by a number of factors including the composition and consistency of food intake, body composition, visceral fat accumulation in women, physical activity level and heredity factors, more studies controlling for these factors are required to better understand the contribution of DIT to TEE in older adults.

As people age they often become more sedentary, leading to a decrease in energy expenditure (National Academy of Sciences 2002). But this is not always the case. For example, a prospective study in the US found that on retirement people tended to increase their sport and physical activity participation (Evenson *et al.* 2002). In the UK, energy requirements in older people are based on assumed physical activity levels (PALs) relative to basal metabolic rate (*i.e.* 1.5 × BMR). However, the number of older adults used in formulating these predictive equations is usually small (*e.g.* 50 men and 38 women in Scholfield 1985) and typically they include small numbers of people from ethnic minorities, limiting the generalisability of the equations. A recent study of ~280 older adults found that metabolic requirements were overestimated by predictive equations, while physical activity levels were underestimated compared to empirical measurements (Blanc *et al.* 2004). Several smaller studies have found energy requirements to be underestimated in older men and older women (Roberts *et al.* 1992; Reilly *et al.* 1993). Another small study by Fuller *et al.* found that although the mean daily energy requirement equalled 1.5 times the BMR, there was substantial variation between a random sample of 23 older men (standard deviation 0.2 times the BMR), with significant differences between those living in their own home and those in sheltered accommodation (Fuller *et al.* 1996).

In the UK (as in other countries) the estimated average requirements (EAR) for energy for older adults have been set at lower levels than for younger adults (see Table 1.3). This lower value is to take into account the changes described above. The FAO/WHO/UNU Report concluded that energy requirements for older adults should be calculated based on physical activity levels, placing great importance on accurately estimating the BMR of older adults. Although the FAO/WHO/UNU Report continued to use Scholfield's (1985) equations for estimating BMR from bodyweight (FAO/WHO/UNU 2004), as more information becomes available on the BMR of older adults with differing lifestyles, ethnicity and body composition, the predictive equations may need to be revised. As noted, expert committees are in the process of considering whether current energy recommendations for people in the UK and also across the EU are appropriate.

Table 1.3: Estimated average requirements (EAR) for energy

	EAR	
Age	MJ/d	Kcal/d
Men		
19–50	10.60	2550
51–59	10.60	2550
60–64	9.93	2380
65–74	9.71	2330
75+	8.77	2100
Women		
19–50	8.10	1940
51–59	8.00	1900
60–64	7.99	1900
65–74	7.96	1900
75+	7.61	1810

Source: Department of Health (1991).

Chronic diseases can affect energy balance in many different ways. BMR can be increased (*e.g.* during metabolic stress and with fever) or decreased (*e.g.* because of reduced body mass). With many diseases energy expenditure due to physical activity is decreased, but in some instances may be increased (*e.g.* in patients with severe muscular spasms) (Elia *et al.* 2000). Medication may also change energy expenditure (Ritz 2001). Elia *et al.* (2000) detailed a limited number of studies of TEE in older adults with disease but concluded from the available information that a significant rise in TEE is generally not observed in chronic disease because increases in BMR are balanced by reductions in physical activity (Table 1.4).

1.5.2 Bodyweight

Recommendations to maintain a healthy bodyweight are relevant to all sections of the population, including older adults. Malnutrition predisposes to disease, delays recovery from illness and adversely affects body function, wellbeing and clinical outcome (Malnutrition Advisory Group 2003), while being obese increases the risk of many chronic diseases (British Nutrition Foundation 1999). Body mass index (BMI, a measure of weight and height) is used to identify individuals who are underweight (BMI <18.5 kg/m^2), and those who are overweight (25–

Table 1.4: Energy expenditure in free-living, 'healthy' subjects and patients with selected diseases

	No. of subjects (gender)	Age (y) and SD	BMR measured (MJ/day) and SD	TEE (MJ/day) and SD	Physical activity energy expended	
					(MJ/day) and SD	(MJ/kg/day) and SD
Healthy subjects	150 (M)	72 ± 8	6.44 ± 0.89	10.79 ± 2.09	3.27 ± 1.61	0.044 ± 0.021
	100 (F)	68 ± 6	5.53 ± 0.08	8.85 ± 1.49	2.22 ± 1.2	0.033 ± 0.019
Parkinson's disease	16 (M)	62 ± 8	6.92 ± 1.18	9.26 ± 1.95	1.42 ± 1.53	0.018
Alzheimer's disease	30 (13 M/17 F)	73 ± 8	5.38 ± 0.95	7.95 ± 2.16	1.78 ± 1.32	0.028
Lung cancer	8 (5 M/13 F)	68 ± 12	6.39 ± 1.04	8.73 ± 2.38	1.34 ± 1.35	0.019

BMR: basal metabolic rate; F: female; M: male; SD: standard deviation; TEE: total energy expenditure.
Source: *European Journal of Clinical Nutrition*, **54 (Suppl 3)**, S92–S103; Elia *et al.* (2000).

29.9 kg/m^2) or obese (>30 kg/m^2). While BMI is an important component of many malnutrition screening tools (*e.g.* the UK malnutrition universal nutrition tool; MUST), it has been suggested that BMI is not a good marker of body composition in older people because height and lean body mass decrease with ageing (Beck and Ovesen 1998; Visscher *et al.* 2001) (see also Chapter 10, Section 10.6.2). There may also be difficulties in obtaining accurate height measurements in some older adults (*e.g.* some may be unable to stand straight or may be unsteady on their feet). Surrogate measures such as using demi-span (the distance from the middle of the sternal notch to the tip of the middle finger when the arm is stretched out laterally) can and have been used. For example, the British National Diet and Nutrition Survey obtained reliable measures of demi-span for around 1000 free-living older people and around 200 older people in institutions. The ratio of height to demi-span was 2.11 for free-living men and 2.15 for free-living women. There was no significant association between this measure and age, which suggests that any height differences observed in the survey were cohort effects rather than age-related spinal shrinkage.

As highlighted by the American Dietetic Association (2000), the appropriate range of healthy BMIs for older adults is controversial. For example, the US Longitudinal Study of Ageing, a prospective cohort study of over 7000 people, found that a relatively high BMI (30–35 kg/m^2 for women and 27–30 kg/m^2 for men) was associated with minimal risk for mortality in adults older than 70 years of age (Allison *et al.* 1997). Similarly, the Cardiovascular Health Study (a cohort study of over 4000 non-smoking men and women aged 65–100 years) found that the association seen between higher BMI and mortality in middle age did not appear to be a risk factor for five-year mortality in older American adults (American Dietetic Association 2000). In their review, Beck and Ovesen (1998) concluded that different cut-off points should be used for older adults, *i.e.* BMI < 24 kg/m^2 in older adults may be associated with health problems in some older adults, while a BMI of 24–29 is a healthy weight for most older adults.

There are also questions about the applicability of reference data for a range of anthropometric measurements for older adults, including BMI (Chumlea and Sun 2004), with Bannerman *et al.* (1997) identifying a need for contemporary reference data.

1.5.3 Macronutrients

In the UK, dietary recommendations for fat, carbohydrate and dietary fibre are the same for older people as for the rest of the adult population (Department of Health 1991). A similar situation exists in many other countries although, in the US and Canada, recommendations for fibre vary with age and gender to take into account the median energy intake of the different groups (National Academy of Sciences 2002. See Lunn and Buttriss 2007).

Protein recommendations for adults in some countries change with age. In the UK, the reference nutrient intake (RNI) for protein was set in 1991 and was based on the 1985 recommendations from the FAO/WHO/UNU (Department of Health 1991). It assumed that older people had the same

Table 1.5: Reference nutrient intake (RNI) for vitamins and minerals for adults (50+ years)

Nutrient	RNI
Calcium (mg/d)	700
Phosphorus (mg/d)	550
Magnesium (mg/d)	270 women, 300 men
Sodium (mg/d)	1600
Potassium (mg/d)	3500
Chloride (mg/d)	2500
Iron (mg/d)	8.7
Zinc (mg/d)	7.0 women, 9.5 men
Copper (mg/d)	1.2
Selenium (μg/d)	60 women, 75 men
Iodine (μg/d)	140
Thiamin (mg/d)	0.8 women, 0.9 men
Riboflavin (mg/d)	1.1 women, 1.3 men
Niacin (mg/d)	12 women, 16 men
Vitamin B_6 (mg/d)	1.2 women, 1.4 men
Vitamin B_{12} (μg/d)	1.5
Folate (μg/d)	200
Vitamin C (mg/d)	40
Vitamin A (μg/d)	600 women, 700 men
Vitamin D (μg/d)	(10 μg/d after age of 65 years)

Source: Department of Health (1991).

requirements for protein as younger adults (0.75 g protein/kg/day). As older adults have less lean body mass per kg bodyweight, the RNI for younger adults is slightly higher (see Section 1.6.2 for details of protein intakes in Great Britain). In a report by the Committee on Medical Aspects of Foods (COMA), guidance was given for the UK population as a whole to avoid high protein intakes (defined as intakes of more than twice the RNI; *i.e.* over 1.5 g protein/kg/day) (Department of Health 1991). This may be of particular importance to older adults, as the report suggested that high intake of dietary protein increases glomerular filtration rate, which may be related to the age-related decline in renal function. In the US and Canada recommendations exist regarding the amount of amino acids that should be consumed (reported as mg/g protein for the different amino acids), but recommendations for older adults in these countries are the same as for other age groups (National Academy of Sciences 2002).

There are ongoing discussions about the validity of protein requirements based on the FAO/WHO/UNU report, with various researchers concluding that protein requirements may be higher in older adults. For example, an American study found net nitrogen balance was negative among older adults consuming 0.8 g protein/kg/day and positive for those consuming 1.62 g protein/kg/day (more than twice the UK RNI) (Campbell *et al.* 1994). The authors estimated that the intake required for nitrogen balance was 1 g/kg/day. Similarly, Evans and Cyr-Campbell (1997) suggested a safe protein intake for older adults of 1.25 g/kg/day and that the recommendations should be set at 1–1.25 g/kg/day. A review on protein requirements by Millward and Jackson (2004) highlighted some of the problems encountered when establishing protein recommendations, for example the lack of consideration given to the potential influence of metabolic adaptation on dietary requirements. The authors calculated protein requirements in relation to energy requirements (predicted for different physical activity levels), to generate reference ratios for protein energy/total energy (reference P/E ratio) as a function of age, bodyweight, gender and physical activity level. Reference P/E ratios were adjusted using the proposed values for amino acid requirements and from these calculations the authors concluded that a number of sub-groups could be at risk of inadequate protein intakes, including large, older sedentary women. This conclusion is in contrast to those reached by other researchers (see Chapter 6, Section 6.8).

Protein requirements may be increased by illness, surgery, infection, trauma and pressure ulcers, and long-term inadequate protein intake may result in further loss of muscle mass, impaired immune function and poor wound healing (Chicago Dietetic Association 2000).

1.5.4 Micronutrients

Recommendations for intakes of micronutrients among UK adults aged 50 years or older are shown in Table 1.5. As can be seen, the only change in recommendations for older adults is for vitamin D. It is assumed that individuals aged 4–64 years will obtain adequate amounts of vitamin D through the action of sunlight; however, this conclusion has been challenged recently (see Chapter 4, Section 4.2.3 and Chapter 14, Section 14.3.2). Older adults typically go out of doors less than younger age groups and are less efficient at producing vitamin D from sunlight. Therefore, an RNI of 10 mg/day for older adults was set, with the expectation that the majority of older people would need vitamin D supplementation to achieve this level (Department of Health

1998a). Micronutrient intakes among older adults are discussed in Section 1.6.3.

In the US, Dietary Reference Intakes (DRIs) are provided for older adults in two life-stage brackets: 51–70 years and older than 70 years. To date, recommendations are the same for both groups, with the exception of vitamin D, which is higher in the older group, and sodium, which is lower in the older age group (National Academy of Sciences 2004; www.iom.edu/Object.File/Master/21/372/0.pdf, accessed 13 April 2007).

1.5.5 Fluid

Fluid requirements in adults are about 1 ml/kcal (30 ml/kg bodyweight), *i.e.* approximately 6–8 cups, mugs or glasses of fluid per day, although this intake level may not be sufficient to meet the fluid needs of underweight adults (World Health Organization 2002b). In the US, adequate intakes of fluids from drinks are estimated to be 3 L/day, in addition to water provided by food, which is estimated as just under 900 ml/d on average (National Academy of Sciences 2004) (see Chapter 14, Section 14.5.4). Fluid needs increase with environmental temperature, fever, vomiting, diarrhoea and drug- and caffeine-induced fluid losses (Chicago Dietetic Association 2000).

The prevalence of dehydration is controversial but it is thought to be a potential problem in older adults, especially in the oldest old and those living in institutions. According to the WHO (2002b), increased risk of dehydration in older adults is due to:

1. Reduced fluid intake, with evidence that even healthy older adults feel less thirst in response to water deprivation. Other factors such as delirium, dementia, diuretic use, swallowing problems, laxative abuse, incontinence (with urinary incontinence reportedly affecting about half of older adults living in institutions and 15–30% of those living in the community; Williams and Pannill, 1982; Resnick 1996) and problems with dexterity or mobility can also increase the tendency towards dehydration in some older adults.
2. Increased fluid loss. A reduction in renal concentrating capacity in response to dehydration and decreases in plasma rennin activity and aldosterone secretion mean that older adults are less able to concentrate urine compared to younger individuals and therefore have a higher minimum urine output.

1.5.6 Physical activity

Physical activity has been demonstrated to benefit all people regardless of age, stage of life, gender or socio-economic status. The benefits of physical activity for older adults in relation to specific organ systems are covered in subsequent chapters (see Chapter 4, Section 4.2.4.1; Chapter 8, Sections 8.2.2 and 8.3.8; Chapter 10, Section 10.8; Chapter 12, Section 12.5.2.1; Chapter 13, Section 13.4.1 and Chapter 14, Section 14.4 for a summary). However, more generally, strength training can increase muscle size (see Chapter 6, Section 6.10), which may stimulate more aerobic activity. It may also have an important impact on energy balance because of an increased resting metabolic rate and an increase in energy expenditure (Evans and Cyr-Campbell 1997). Additionally, depending on the type of physical activity, participation may provide social interaction which can have a positive impact on quality of life.

Recommendations for physical activity among adults in the UK (Department of Health 2004a) (at least 30 minutes' moderate activity at least five times a week) are applicable to older adults. In addition, older people should aim to maintain mobility through daily activity; activities that promote and improve balance, strength and coordination are encouraged. The importance of physical activity in the prevention and treatment of diabetes and coronary heart disease has been highlighted in the Department of Health's National Service Framework (NSF) reports. For example, the NSF for diabetes highlights that physical activity and weight loss should be the first intervention for people with newly diagnosed type 2 diabetes (Department of Health 2001), while the NSF on coronary heart disease highlights the role that regular physical activity plays in reducing the risk of developing cardiovascular disease (Department of Health 2000b) (see Chapter 14, Section 14.6).

The American Agency for Healthcare, Research and Quality suggests at least 30 minutes of physical activity on most days of the week for older people, but *The Guidelines for Americans* recommend approximately 60 minutes of moderate to vigorous intensity activity on most days of the week to obtain greater health benefits (Department of Health and Human Services). These guidelines also recommend at least 60–90 minutes of daily moderate-intensity physical activity to sustain weight loss in adulthood.

The WHO's (2003a) global strategy on diet, physical activity and health recommends that all people should engage in adequate levels throughout their lives, and recognises that different types and amounts of physical activity are required for different health outcomes: at least 30 minutes of regular, moderate-intensity physical activity on most days reduces the risk of cardiovascular disease and diabetes, colon cancer and breast cancer. More activity may be required for weight control. Evidence exists that it is never too late to start and that all age groups can benefit (Buttriss and Hardman 2005; Blair 2007) (see Chapter 14, Section 14.6).

1.6 Food patterns, nutrient intakes and nutritional status of older people

1.6.1 Food patterns

Differences in food patterns have been observed among people of different ages. National cross-sectional survey data suggest that the diets of older UK adults (50–64 years) are typically closer to the dietary recommendations than those of younger adults (under 35 years) (see Chapter 14, Section 14.5).

Older adults consume more fruit and vegetables than younger adults, *e.g.* the average daily intake for men aged 19–24 years was 1.3 portions compared with 3.6 portions in men aged 50–64 years. Similarly, women in the youngest age group consumed considerably less fruit and vegetables than those women in the oldest age group on average (1.8 portions vs. 3.8 portions). For nearly half of the types of fruits and vegetables, a significantly lower proportion of men and women aged 19–24 years consumed the item compared with the oldest age group, *e.g.* 30% of men and 43% of women in the youngest age group ate leafy green vegetables compared with 64% of men and 70% of women in the oldest age group. Other foods less likely to have been consumed by the youngest group of men and women compared with the oldest group are shown in Table 1.6 (see also Chapter 14, Section 14.5.5).

Results from the British survey for older adults (65+ years) indicated that men generally ate larger quantities than women (Finch *et al.* 1998). No significant differences in the types of food eaten were observed between men and women in institutions, but in the free-living group men were more likely than women to consume meat and meat products, eggs, table sugar and alcoholic drinks, while women were more likely to consume cottage cheese, yogurt and fromage frais. A more traditional eating pattern was observed in the group resident in institutions and for older free-living participants, *e.g.* these groups were more likely than younger free-living age groups (aged 65+) to eat cereal-based milk puddings (Finch *et al.* 1998). Using data from this survey, Pryer *et al.* (2001) divided the free-living older adults into clusters (traditional, mixed diet and healthy diet), based on consumption of different foods, and found that men and women in the traditional and mixed-diet groups were more likely to be smokers and from the manual social class; they were more likely to be in receipt of a state benefit and to be on a lower income compared to those individuals in the healthy diet group. An age effect was seen, with a higher proportion of younger individuals being categorised in the healthy diet group and more of the oldest old group in the traditional or mixed diet groups.

Much effort has been directed towards identifying food patterns associated with health in older populations. Trichopoulou *et al.* (1995) found that among a sample of older Greek adults, a one unit increase in diet score (based on eight component characteristics of the traditional diet common in the Mediterranean region) was associated with a 17% reduction in overall mortality (9% confidence interval, 1% to 31%). Similarly, The Healthy Ageing: a Longitudinal Study in Europe (HALE) reported that individuals aged 70–90 years following a Mediterranean-type diet and lifestyle had a more than 50% lower rate of all-cause and cause-specific mortality (Knoops *et al.* 2004). The benefit of a Mediterranean-type diet has been demonstrated in other settings. Kouris-Blazos *et al.* (1999) found mortality reduction increased with diet score among Greek-Australians and Anglo-Celts living in Melbourne, Australia. A cross-sectional analysis of food patterns of participants of the SENECA follow-up study found that north and south European eating patterns emerged (Schroll *et al.* 1996). The southern food pattern seemed more in line with guidelines for healthy eating, being rich in grains, vegetables, fruit, lean meat and olive oil.

Table 1.6: Main differences in the eating behaviour of British respondents by age group*

Men aged 19–24 years more likely to eat	Men aged 50–64 years more likely to eat
Pasta	Wholemeal bread
Pizza	Whole-grain and high-fibre breakfast cereals
Coated chicken and turkey	Fruit pies
Burgers and kebabs	Other cereal-based puddings
Potato chips	Whole milk
Savoury snacks	Skimmed milk
Carbonated soft drinks (not low calorie)	Cottage cheese
Alcopops	Eggs
	Pork and dishes
	Liver, liver products and dishes
	Oily fish
	Raw carrots
	Peas
	Green beans
	Leafy green vegetables
	Tomatoes – not raw
	Other potatoes and potato dishes
	Apples and pears
	Citrus fruits
	Bananas
	Canned fruit in juice
	Other fruit
	Preserves
	Wine
	Low alcohol and alcohol-free beer and lager
	Coffee
Women aged 19–24 years more likely to eat	**Women aged 50–64 years more likely to eat**
Coated chicken and turkey	Wholemeal bread
Burgers and kebabs	Whole-grain and high-fibre breakfast cereals
Savoury snacks	Fruit pies
Carbonated drinks (not low calorie)	Buns, cakes and pastries
Concentrated soft drinks (not low calorie)	Cream
Concentrated soft drinks (low calorie)	Eggs
Beer and lager	Egg dishes
Alcopops	Coated and/or fried white fish
	Other white fish dishes
	Oily fish
	Raw tomatoes
	Peas
	Leafy green vegetables
	Carrots – not raw
	Tomatoes – not raw
	Apples and pears
	Citrus fruits
	Bananas
	Canned fruit in juice
	Canned fruit in syrup
	Other fruit
	Preserves
	Fortified wine
	Low alcohol and alcohol-free beer and lager
	Coffee
	Soup

*Dietary patterns change with age.
Source: Finch *et al.* (1998).

1.6.2 Nutrient intakes

A number of dietary surveys and studies have been undertaken in older adults in a range of different locations. Examples of some of these studies are shown in Table 1.7, along with average values. While these studies show that older people are generally well-nourished, they have highlighted low intakes of fibre and a range of micronutrients, especially in some sub-groups of older adults (see Chapter 14, Section 14.5).

1.6.2.1 Great Britain

The most recent NDNS of older adults was published in 1998. Two nationally representative samples

Table 1.7: Selected dietary surveys and studies showing low intakes of various nutrients in older populations

Country	Nutrients and proportion of study population with low* intake (%)	Age range of subjects	Reference
Australia	Vitamin A Magnesium Potassium Calcium (12–24% men and 14–61% women)	>65 years	Bannerman *et al.* (2001)
Germany	Fibre (38%) Vitamin D (75%) Folate (37%) Calcium (35%)	≥65 years	Volkert *et al.* (2004)
Great Britain	(Results given for free-living men, free-living-women, men and women living in institutions, respectively) Vitamin A (5, 4, 1, 1%) Riboflavin (5, 10, 3, 3%) Vitamin B6 (2, 3, 1, 2%) Folate (1, 6, 4, 5%) Vitamin C (2, 2, 0, 0%) Iron (1, 6, 5, 6%) Calcium (5, 9, 1 >0.5%) Magnesium (21, 23, 39, 22%) Potassium (17, 39, 28, 42%) Zinc (8, 5, 13, 4%)	≥65 years	Finch *et al.* (1998)
Spain**	Vitamin A (14–65%) Vitamin D (47–97%) Vitamin E (54–95%) Thiamin (0–50%) Riboflavin (0–53%) Vitamin B6 (12–89%) Vitamin B12 (1–23%) Folate (2–88%) Vitamin C (0–48%) (At blood levels, deficiencies of vitamins B_{12}, A and E were infrequent, but for all other vitamins prevalence of deficiency varied within a wide range)	All ages included in analysis	Ortega *et al.* (2001)
US**	Calcium (males 70–75%, females 87%) Zinc (males 35–41%, females 36–45%) Vitamin D (up to 90%)	≥60 years	Ervin and Kennedy-Stephenson (2002) C. Moore *et al.* (2004)

*Low has been defined differently in various countries.
**Details on a limited number of nutrients available.

Table 1.8: UK dietary reference values (DRVs) for fat and carbohydrate as a percentage of food energy, and intakes of older adults (aged 65 years and above)

% of food energy unless otherwise stated	Population average	Free-living		Living in institutions	
		Men	Women	Men	Women
Saturated fatty acids	11				
Cis polyunsaturated fatty acids	6.5				
Cis monounsaturated fatty acids	13	11.0	11.0	10.5	10.5
Trans fatty acids	2	1.5	1.5	1.8	1.8
Total fat	35	35.7	36.1	35.1	34.8
Non-milk extrinsic sugars	11	13.2	11.5	17.9	18.5
Intrinsic and milk sugars and starch	39	35	36	32.9	32.8
Total carbohydrate	50				
Non-starch polysaccharide (g/d)	18	13.5	11.0	11.0	9.5

Source: Finch *et al.* (1998).

were drawn from older adults: one of free-living individuals and one of individuals living in institutions (Finch *et al.* 1998). The free-living sample generally had 230 people for each category (age groups 65–74, 75–84 and 85 and over), but there were low numbers of men in the oldest age group so it was agreed that the target for this group would be 100. The survey included an interview to provide general information; a four-day weighed dietary record of food and drinks consumed; physical measurements and requests for blood and urine, and an interview to provide information on oral health (see Section 1.6.1 for information on dietary patterns).

Average daily energy intakes in the free-living population were 8.02 MJ (1909 kcal) for men and 5.98 MJ (1422 kcal) for women aged 65–74 years, while for those men and women living in institutions the mean daily intake was 8.14 MJ (1935 kcal) and 6.94 MJ (1650 kcal) respectively. These intakes were below the estimated average requirements (EAR) of 9.71 MJ and 7.96 MJ, for men and women respectively. The largest contribution to recorded energy intake was made by cereals and cereal products (providing 34% of energy intake in the free-living group and 38% in the institution group).

Average intakes of macronutrients and fibre are shown in Table 1.8. Briefly, protein intakes were above the estimated requirements, but there was a large variation in intakes (from 33.7 g in men and 30.8 g in women up to 96.7 g in men and 85.2 g in women) and a decrease was seen with age. The main sources of protein were meat and meat products (32% of average daily intake for free-living participants and 26% for those in institutions), cereals and cereal products (24% for the free-living and 29% in institutions) and milk and milk products (19% for the free-living and 22% in institutions).

The average daily intake of total carbohydrate was slightly lower than the current UK DRV. Cereals and cereal products were the main source of carbohydrates, followed by vegetables, including potatoes. The average daily intake of non-milk extrinsic sugars (NEMS) was above the DRV of 11%, particularly in those older adults living in institutions where there was a high intake of NMES and a relatively low intake of other carbohydrates.

With regard to fat, intakes for all groups were close to the DRV of 35% of food energy, while average intakes of saturated fatty acids were above the recommended 11% of food energy in all older adults (with average intakes representing ~15% of food energy), with milk, fat spreads, meat and cereal products being the main sources. Intakes of *trans* fatty acids were below the recommended upper limit of 2% of energy (1.5% of food energy in free-living older adults and 1.8% in those living in institutions) (see Chapter 14, Section 14.5.2).

Average fibre intakes (measured in the UK as non-starch polysaccharides, NSP) among older adults were well below the 18 g recommendation in all groups. Intakes of fibre were found to decrease with age among the free-living participants, but not within institutions.

More free-living older adults consumed alcohol than those participants in institutions (85% of free-living men and 70% of women vs. 30% of those living in institutions). Free-living men had a higher average daily intake than women; a similar pattern was seen among those in the institution group, although intakes were far lower.

Table 1.9 shows the average intake of a range of vitamins and minerals as a proportion of the RNIs, the amounts believed to cover the needs of 97.5% of the population. Vitamin D intakes were particularly low, and average folate intake (in women living in institutions) was close to the RNI. For the minerals, average intakes of potassium and magnesium were well below the RNIs, zinc was close to the RNI and the average iron intakes of both groups of women were also close to the RNI, as were average calcium intakes in free-living women. It is interesting to note that, with one or two exceptions, the intakes of vitamins and minerals in the participants living in institutions were lower than those of free-living participants (though they were generally above the RNI). However, for several nutrients, namely calcium, riboflavin and vitamin A, those in institutions fared better. These three nutrients are provided by milk, and milk intake was higher than in the free-living subjects.

Although the average intakes of most nutrients were well above the RNI, a small proportion of subjects had intakes below the lower reference nutrient intake (LRNI) (the quantity sufficient for only 2.5% of the population). There is no LRNI for vitamin D; however, virtually all the subjects had intakes below the RNI (Table 1.10). A substantial proportion of subjects had intakes of magnesium and potassium below the LRNI. There was evidence that the situation worsened in the older age group for some micronutrients (riboflavin, vitamin B_6, vitamin C, iron, magnesium, potassium and zinc).

Table 1.9: Intakes of vitamins and minerals from food in older people (% RNI)

	Free-living		Living in institutions	
	Men	Women	Men	Women
Vitamin A	168	161	151	160
Thiamin	166	148	149	142
Riboflavin	134	130	138	147
Niacin	200	206	170	194
Vitamin B_6	168	160	154	158
Vitamin B_{12}	404	298	329	304
Folate	135	103	117	99
Vitamin C	167	152	124	119
Vitamin D	41	29	38	33
Iron	127	99	111	94
Calcium	119	99	136	123
Phosphorous	225	180	218	192
Magnesium	85	73	72	70
Sodium	168	128	170	138
Potassium	78	63	69	61
Zinc	93	98	88	101
Iodine	134	106	138	125

Source: Finch *et al.* (1998).

1.6.3 Nutritional status

1.6.3.1 Bodyweight

Involuntary weight loss predicts morbidity and mortality. It is estimated that, in the general population, one in seven older adults has a medium or high risk of malnutrition. The prevalence is higher in subjects who are living in institutions (Malnutrition Advisory Group 2003). The NDNS identified more older adults with a BMI ≤20 within institutions than free-living (16% of men and 15% of women living in institutions vs. 3% free-living men and 6% women). Risks to health are associated with excess bodyweight, and although there is some uncertainty

Table 1.10: Proportion of older people with micronutrient intakes from food below the LRNI (%)

	Free-living (%)		Living in institutions (%)	
	Men	Women	Men	Women
Vitamin A	5	4	1	1
Thiamin	>0.5	>0.5	1	>0.5
Riboflavin*	5	10	3	3
Niacin	>0.5	>0.5	>0.5	>0.5
Vitamin B_6*	2	3	1	2
Vitamin B_{12}	>0.5	1	nil	Nil
Folate*	1	6	4	5
Vitamin C*	2	2	1	Nil
Vitamin D	97% below RNI		99% below RNI	
Iron*	1	6	5	6
Calcium	5	9	1	>0.5
Magnesium*	21	23	39	22
Sodium	nil	nil	nil	Nil
Potassium*	17	39	28	42
Zinc*	8	5	13	4
Iodine	2	6	1	1

*Proportion increases with age.
LRNI: lower reference nutrient intake; RNI: reference nutrient intake.
Source: Finch *et al.* (1998).

about whether the cut-offs used are appropriate for all older adults (see Section 1.5.2 and Chapter 10, Section 10.6.2), a large proportion of older adults in the NDNS were found to be obese or overweight when using these cut-offs (67% of free-living men and 63% of free-living women; 46% of men and 47% of women living in institutions).

1.6.3.2 Micronutrient status

In contrast to the NDNS findings regarding micronutrient intakes, the results on nutritional status highlighted larger proportions of older British adults with low status (Table 1.11). The situation was typically worse among those in institutions; additionally those in institutions had lower vitamin E, beta-carotene and retinol indices (not shown). Indices of magnesium and potassium were not included but may have also been low on the basis of the intake data. Vitamin C status was particularly low in those living in institutions without their own teeth (Table 1.12) and the data suggested that half the subjects had an intake below the level regarded as signifying biochemical depletion.

Of particular concern is the number of older adults with low status of vitamin D (see below), and

Table 1.11: Proportion with a low status of selected nutrients

	Free-living (%)		Living in institutions (%)	
	Men	Women	Men	Women
Iron (Hb)*	11	9	52	39
Vitamin C*	14	13	44	38
Folate	15	15	39	39
Vitamin B_{12}	6	6	9	9
Thiamin	8	9	11	15
Riboflavin	41	41	41	32
Vitamin D*	6	10	38	37

*Proportion increases with age.
Source: Finch *et al.* (1998).

Table 1.12: Mean vitamin C status

	Plasma vitamin C* (µmol/L)
Free-living, own teeth	49.1
Free-living, without teeth	39.4
Institutional care, own teeth	24.6
Institutional care, without teeth	21.1 (median 11.4)

*Below 11 µmol/L indicates biochemical depletion.
Source: Steele *et al.* (1998).

Table 1.13: Prevalence of iron deficiency anaemia (%) among older adults

	SENECA baseline (Lesourd *et al.* 1996) (excluding those in psychogeriatric nursing homes)		SENECA follow-up (Lesourd *et al.* 1996) (excluding those in psychogeriatric nursing homes)		NHANES II (Looker *et al.* 2002) (free-living)		NDNS (Finch *et al.* 1998) (free-living/living in institutions)	
	Men (n = 975)	Women (n = 946)	Men (n = 570)	Women (n = 594)	Men	Women	Men	Women
WHO criteria*	4.6	5.5	6.0	5.0	4.5	3.5	11/52	9/39
NHANES II criteria**	4.1	4.2	4.0	3.5	4.5	3.5	–	–

*Men Hb < 130 g/L; women Hb < 120 g/L.
**Men Hb < 126 g/L; women Hb < 117 g/L.
NDNS: National Diet and Nutrition Study; NHANES: National Health and Nutritional Examination Survey, SENECA: Survey in Europe on Nutrition and Elderly, a Concerted Action; WHO: World Health Organization.

of iron, folate and vitamin B_{12}. In the US NHANES III, there was evidence of anaemia due to nutrient deficiency in one third of older adults (Guralnik *et al.* 2004). Table 1.13 shows the prevalence of iron deficiency anaemia in several studies, including the NDNS, where the highest prevalence in the free-living group of low haemoglobin concentrations was among those aged 85 years and over, although among those in institutions there was little variation with age (Finch *et al.* 1998).

Plasma 25 hydroxyvitamin D (25 OHD) is used as a measure of vitamin D status, with the lower level of the normal range for plasma 25 OHD usually considered to be 25 nmol/L (see Chapter 4). As can be seen from Table 1.11, a proportion of older adults had low vitamin D status and this was considerably greater in those living in institutions (Finch *et al.* 1998) (see Chapter 4, Section 4.2.3 and Chapter 14, Section 14.3.2).

It is worth highlighting that many of the reference values used for determining micronutrient status were not determined for use specifically with older adults. So while these figures are useful, it is likely that a limited number of older adults were used in setting such values, making their relevance for older adults questionable (Brachet *et al.* 2004). It may be useful to identify specific reference values for older adults.

1.6.3.3 Physical activity

Although the NDNS of older adults did not collect data on physical activity levels, there is some information on self-reported levels of physical activity among older adults living in England from the 2003 Health Survey for England report, which highlighted an increase in the proportion of men and women meeting the physical activity target in all age groups, except for those aged 75 and over (Sproston and Primatesta 2004).

An earlier report found that the majority of older adults in care homes were classed as inactive, with significantly more women (86%) than men (78%) in this category. Inactivity levels were highest in nursing homes, with about nine in ten residents not having done a continuous walk of 15 minutes or more in the past month, and lowest in private residential homes (seven in ten men; eight in ten women) (Bajekal 2002) (see Chapter 14, Section 14.6).

1.7 Determinants of food and nutrient intake and status in older people

Many factors influence food and nutrient intake and therefore status. A sufficient energy intake may be important for an adequate nutrient intake because those older adults with a low energy intake may not compensate for the low micronutrient intake by eating foods with a higher nutrient density (K. Schroll *et al.* 1996; Bannerman *et al.* 2001). However, a high energy intake does not guarantee an adequate nutrient intake (De Groot *et al.* 2000). Several nutritional surveys have shown a gradual decrease in energy intake as people progress into old age, along with increasing numbers with low micronutrient intakes and/or status amongst the oldest (*e.g.* Finch *et al.* 1998).

1.7.1 Ill health, disease and disability

Physical and mental health problems, illness and disability can affect people of different ages. However, as people get older their daily activities are more likely to be hampered by such problems, so that within Europe among those aged 85 or over, from 43% (Belgium) to 93% (Germany) of the population may be affected (Figure 1.6).

Ill health and disease may affect nutrient intake/status in various ways. For example, periods of ill health can lead to weight loss because of decreased intakes (*e.g.* loss of appetite) and/or increased requirements (*e.g.* metabolic stress and fever increase energy requirements) (De Groot *et al.* 2000; Ritz 2001). Depression (see Chapter 8, Section 8.4) has been shown to be a major cause of weight loss, and this may be an important factor for some older adults: the SENECA study (1996) found 12% of men and 28% of women were depressed. More recently, it was found among a sample of 1800 older adults that depression severity made a larger independent contribution to three out of four general health indicators (mental functional status, disability and quality of life) than medical co-morbidities, highlighting the importance of recognising and treating depression (Noel *et al.* 2004).

Disability can affect the activities of daily life, such as shopping, preparing and cooking food and eating. Researchers in Italy found that from a sample of ~1500 older adults, those reporting difficulties in three or more nutrition-related activities had a significantly increased risk of an inadequate intake of energy and vitamin C (Bartali *et al.* 2003). Similarly, a smaller American study of housebound older adults (n = 123) found better calcium, vitamin D, magnesium and phosphorus intake among those with less disability. Greater BMI was directly associated with worse lower extremity performance and indirectly with greater severity of disability (Sharkey *et al.* 2004).

Those older adults who took part in the NDNS and were unwell were, on average, found to have lower intakes of protein, total carbohydrate and starch, although there was no significant effect on energy intake. Free-living men who were unwell and whose eating was affected had lower intakes of vitamins A, D, pantothetic acid and riboflavin, and lower intakes per unit energy of retinol, vitamin B_{12} and vitamin D. These differences were not seen in free-living women and there were few differences among older adults living in institutions (Finch *et al.* 1998).

1.7.2 Poor dentition

Although few relationships have been observed between dentition and macronutrient intake (De Groot *et al.* 2000), data do suggest that poor dentition may impact on micronutrient intake. For example, the NDNS found an association between oral function and nutrient intake. Those older adults with no or few natural teeth ate a more restricted range of foods, influenced by their perceived inability to chew. For example, they were less likely to choose foods that need chewing, such as apples, raw carrots, toast, nuts and oranges. An association was also found between oral function and status (iron, vitamin C, vitamin E and retinol status was lower in those without teeth or with few teeth) (Steele *et al.* 1998). For more on the NDNS and dental status, see Chapter 3, Section 3.3. Similarly, the American NHANES III survey found that among adults aged 50 years or over, those with impaired dentition had consistently lower healthy eating scores (a measure of dietary quality), consumed fewer servings of fruit and had lower serum values of β-carotene and ascorbic acid (Sahyoun *et al.* 2003).

1.7.3 Living in institutions

There is wide variation between countries in the proportion of older adults living in a care home or institution. Table 1.14 shows the use of residential and home care services across a selected number of European countries. In England and Wales, 2.6% of men and 5.9% of women live in a residential or nursing home (National Statistics Online 2004), while in the US and New Zealand, about 4% and 5% of older men and women, respectively, live in a nursing home (Ministry of Health 2002; National Center for Health Statistics 2005).

The Health Survey for England 2000 found that the proportion of men and women in care homes eating fruit and red meat six or more times a week was about half that in private households (Bajekal *et al.* 2003) and, as highlighted in Section 1.6.2, although there were few differences in macronutri-

Table 1.14: Use of residential and home care services across a selected number of European countries

Country	Estimated % of older adults		Reference
	Living in institutions	Receiving formal help at home	
France	6.5	6.1	Jacobzone (1999)
Greece	1.0	N/A	Mestheneos and Triantafillou (1999)
Italy	3.9	2.8	Jacobzone (1999)
Poland	0.7	1.0	Bieň *et al.* (1999)
Sweden	8.7	11.2	Jacobzone (1999)
UK	5.1	5.5	

Table 1.15: Intakes of selected nutrients by social class, free-living subjects

	Non-manual		Manual		RNI
	Men	Women	Men	Women	
Riboflavin, mg	1.96	2.17	1.68	1.46	1.3/1.1*
Folate, µg	295	239	266	209	200
Vitamin C, mg	85.6	85.2	60.3	54.2	40
Vitamin E, mg	11.8	11.9	8.8	7.0	–
Iron, mg	12.4	9.5	10.9	8.4	8.7
Magnesium, mg	278	217	237	184	300/270*
Potassium, mg	2933	2409	2550	2076	3500
Zinc, mg	9.3	7.5	8.5	6.6	9.5/7.0*

*RNIs for men and women.
RNI: reference nutrient intake.
Source: Finch *et al.* (1998).

ent intake, data from Great Britain generally found lower micronutrient intakes among those older adults living in institutions compared to those free-living individuals. Similarly, biochemical and haematological indices of nutritional status were generally poorer among those in institutions (Table 1.14). This may be in part due to ill health and drug–nutrient interactions, which may be higher in those in care homes compared to the free-living population (see Sections 1.7.1 and 1.7.5).

1.7.4 Socio-economic status, poverty and economic uncertainty

The NDNS found lower intakes of a range of nutrients among those free-living subjects from manual households compared with those in non-manual households. In some cases (*e.g.* magnesium and potassium), intakes were quite low in comparison with the RNI, particularly among women (Table 1.15). Additionally, associations between socio-economic status (SES) and low nutrient status among older British adults have been seen, *e.g.* lower plasma selenium among those receiving state benefits (Bates *et al.* 2002) and variations in methylmalonic acid concentrations (a measure of vitamin B_{12} status) and receipt of state income benefits, social class of head of household and education (Bates *et al.* 2003). Data from the US found that older adults from food-insufficient families were more likely to have diets that might compromise their health, *e.g.* lower intakes of energy, vitamin B_6, magnesium, iron and zinc and lower serum concentrations of vitamin A and vitamin E (Dixon *et al.* 2001).

Poverty can be a barrier to adequate food intake and therefore can influence nutritional status. Data from the US show that a substantial proportion of older people live in poverty or near poverty (~17% in 1998), with older women experiencing twice the rate of poverty of men. In addition, those older adults living alone or with non-relatives are also more at risk of poverty than those living with families (American Dietetic Association 2000). Data for Great Britain show that over 30% of those classified as living on a persistent low income were pensioners, and were less likely to move out of poverty (Babb *et al.* 2006).

Even if older people are not living in poverty, most live on a fixed income. As expenses increase (*e.g.* cost of utilities), they may result in reduced food intake, thereby increasing the risk of malnutrition.

1.7.5 Drug–nutrient interactions

It is estimated that over 30% of all prescription drugs are taken by older adults, and older adults are the highest users of over-the-counter drugs too (McCabe 2004). It is not surprising, therefore, that older adults are at high risk of experiencing drug–nutrient interactions (Chan 2002).

In England, older adults living in care homes are more likely to be on prescribed medication (92% of men and 97% of women) than those living in private households (77% of men and 80% of women) (Bajekal 2002). Polypharmacy (taking four or more prescribed medicines) was also more common in care homes, where 71% of both men and women were on four or more drugs compared with about a third of men and women in private households (Bajekal 2002).

Four types of drug–nutrient interactions have been defined (Chan 2002):

- *ex-vivo* bio-inactivation (interaction through biochemical or physical reaction);
- interactions affecting absorption;
- interactions affecting systemic/physiologic disposition; and
- interactions affecting the elimination or clearance of drugs or nutrients.

In particular, a healthy gut is important for the metabolism of many drugs (McCabe 2004) (see Chapter 12).

While interactions may be quickly recognised when a food or a nutrient interferes with the action of a drug in a hospital setting, it is less likely that a drug interfering with nutritional status will be recognised, monitored or diagnosed elsewhere, particularly in outpatient or nursing home settings.

Herbal medicines and dietary supplements are commonly used by older people – the NDNS found 19% and 26% of free-living men and women, respectively, took supplements. Among men and women living in institutions 18% and 19% respectively took supplements (Finch *et al.* 1998). As some of these supplements can interact with drugs (*e.g.* gingko biloba and aspirin interact), doctors and health professionals need to be aware of these interactions and monitor their patients accordingly (Dergal *et al.* 2002).

1.7.6 Taste and smell

Chemosensory impairment in older people has been indicated in a number of laboratory studies (*e.g.* Schiffman *et al.* 1994; Nordin *et al.* 2003). A number of medical conditions (Table 1.16), as well as a range of medications including drugs to lower cholesterol and blood lipids, drugs for arthritis and pain, drugs

Table 1.16: Examples of medical conditions that may alter taste or smell

Nervous	Alzheimer's disease Bell's palsy Multiple sclerosis Parkinson's disease
Nutritional	Cancer Chronic renal failure Liver disease Niacin, vitamin B_{12} and zinc deficiency
Endocrine	Adrenal cortical insufficiency Diabetes mellitus Hypothyroidism
Local	Allergic rhinitis, atopy and bronchial asthma Sinusitis and polyposis
Viral infections	Acute viral hepatitis Influenza-like infections

Source: *European Journal of Clinical Nutrition,* **50 (Suppl 3)**, S54–S63; Schiffman and Graham (2000).

for hypertension and heart disease and antihistamines, can alter taste or smell (Schiffman and Graham 2000). However, according to Mattes (2002), data on the prevalence of chemosensory shifts over the lifecycle are rare (see Chapter 3).

1.8 Conclusions

As people are now generally living longer, the number of older adults is increasing. Unfortunately, these extra years are not always spent in good health as there tends to be an increase in the presence and number of chronic conditions with older age. This provides a number of challenges, including economic ones especially with regard to health care costs, pensions and the workforce. Compared to other life-stages, comparatively little is known about nutritional requirements of older adults. Food patterns and nutritional intake and therefore nutritional status are influenced by a range of factors which need to be considered with all sub-groups, but especially the older age group. While older adults have generally been found to be well nourished, low intakes of fibre and a range of micronutrients have been found, especially among some sub-groups. Considering the important role diet plays in health and disease prevention as well as treatment, it is important that the diets of older adults as well as younger adults are improved to reduce the burden of disease and increase quality of life.

1.9 Key points

- The trend of an increasing proportion of older adults and a decreasing proportion of children will continue in developed countries while spreading to less developed countries. The fastest growing segment of the older population is among the oldest old – those aged 80 years and older – and in Great Britain there will be a growing proportion of older adults from non-white minority ethnic groups in this segment.
- While old age *per se* is not necessarily associated with poor health, the number of people reporting long-term illness and disability increases with age. Older adults are also disproportionately affected by sensory impairments.
- Women tend to have a longer life expectancy than men, although in some countries this is changing. Life expectancy also varies by race; some ethnic groups are more susceptible to some chronic diseases.
- An ageing population impacts on health care spending and also has consequences in relation to the workforce and pensions.
- The energy, macronutrient and micronutrient requirements of older adults are not yet fully understood. The relevance of using a range of anthropometrical and biochemical measurements for older adults is unclear; much of the reference data for these measurements included few older adults.
- A number of surveys and studies in a range of countries have found that while older adults are generally well nourished, low intakes of fibre and a range of micronutrients have been found, especially in some sub-groups. Of particular concern is the number of older adults with low status of vitamin D, and of iron, folate and vitamin B_{12}.
- Food and nutritional intake (and therefore status) is influenced by a range of factors, including ill health, disease and disability, poor dentition, institutionalisation, socio-economic status, poverty and economic uncertainty.

1.10 Recommendations for future research

- Most of the reference data used to establish energy and other nutrient requirements have used limited numbers of healthy older adults and very little representation from different ethnic groups. The UK DRVs for older adults could be reviewed taking into account the research findings accumulated since the early 1990s.
- More work could be undertaken to increase understanding of the particular nutritional needs of the oldest old, the fastest growing age group of the population, and those with disabilities and diseases, which are common among older adults.

1.11 Key references

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