

## Review Article

# Eating your way to a successful old age, with special reference to older women

Caroline Horwath<sup>1</sup> BSc, PGradDip Nutr&Diet, PhD, Antigone Kouris-Blazos<sup>2</sup> BSc (Hons), GradDip Diet, PhD, Gayle S Savige<sup>2</sup> BSc, GradDip Diet, PhD, Mark L Wahlqvist<sup>2</sup> BMedSc, MBBS, MD, FRACP, FAIFST, FACN, FAFPHM

<sup>1</sup>Department of Human Nutrition, University of Otago, Dunedin, New Zealand

<sup>2</sup>International Health & Development Unit, Faculty of Medicine, Monash University, Clayton, Victoria, Australia

A comprehensive definition of successful ageing would combine the elements of survival (longevity), health (lack of disability), and life satisfaction (happiness). Predictors of longevity include being female, being physically active, not smoking, having good cognitive functioning, higher socio-economic status and greater life satisfaction. Predictors of life satisfaction include being healthy (which is in part influenced by nutrition and physical activity), being socially active, having work satisfaction, having a high happiness rating and enjoying sexual activity. To age successfully is therefore the ultimate challenge. This paper cannot address all variables in the equation to successful ageing, but will focus on the value of food and physical activity in later life.

**Key words:** successful ageing, older women, food variety, dietary recommendations, dietary supplements, physical activity.

## What happens to our bodies as we age?

The elderly today are living almost 20 years more than their ancestors did at the turn of the century. They are achieving older age in better health and the majority will live independently. Life expectancy is increasing for both men and women; between 1981 and 2001 the number of older people will have increased by 50%, with an even greater increase in those aged over 70. In the year 2020, at birth men will be able to expect to live to 79, and women to 87.<sup>1</sup> Socio-economic progress and advances in medical care have apparently underpinned this increase in longevity,<sup>2</sup> but it is also likely that it has been facilitated, in part, through food availability and quality.<sup>3</sup>

If we live long enough, changes in body composition, physical function and performance will occur in all of us. Many of these changes, as well as health problems, which become more common in old age, have long been attributed to the 'normal ageing process' — whatever that may be! However, as can be observed when looking at those around us, people vary enormously in the degree to which changes occur with ageing. Indeed, the older people become, the more dissimilar they become from their contemporaries of the same chronological age. Some of this variability may reflect heterogeneity in true rates of ageing; however, other factors, which accompany ageing seem to be of major importance. These include lifestyle factors such as poor eating habits, a sedentary lifestyle and smoking, and the development of disease.<sup>4</sup> Each of these factors can contribute to deterioration in cardiovascular, lung or endocrine functions, thereby accelerating one's apparent 'rate of ageing'. For example, declining cardiovascular function has been observed in the Baltimore Longitudinal Study of Ageing. However, after careful exclusion of those with heart disease, no consistent declines in function with age remained. Thus the apparent declines in the

study group members as they aged were due to the inclusion of people with defined disease rather than to the ageing process *per se*. The accumulated effects of years of poor eating habits can increase the risk of many health conditions as one grows older; yet, it is never too late to change!

As people grow older, a decline in muscle mass and increase in body fat tends to occur.<sup>5</sup> However, what is often not appreciated is that these also cannot be blamed on the ageing process *per se*. A major contributor to these changes is the increasingly sedentary nature of people's lifestyles as they grow older in Western countries. Reduced physical activity leads to loss of muscle (i.e. 'use it or lose it!'), and as a direct consequence basal metabolic rate falls. A lower metabolic rate means that we need to eat less in order to maintain the same body weight. If one does indeed eat less in order to avoid weight gain, rather than remaining (or becoming) active, the problem, particularly for women, is that it becomes increasingly difficult to meet our needs for essential nutrients. Without doubt, it is preferable to keep physically active, maintain muscle mass, and continue to enjoy eating.

In Western society, advancing age often brings an increase in blood pressure and a reduced ability to metabolise glucose from food. Diabetes also becomes more prevalent. Once again, these changes are linked to a lack of physical activity, increasing levels of obesity and an increased tendency for body fat to distribute around the abdomen.

**Correspondence address:** Dr Antigone Kouris-Blazos, International Health & Development Unit, Faculty of Medicine, Monash University, Wellington Road, Clayton, VIC 3168, Australia.

Tel: 61 3 03 9905 8145; Fax: 61 3 9905 8146

Email: antigone.blazos@med.monash.edu.au

Accepted 1 February 1999

Thus, although ageing appears to be an inevitable, natural process programmed into our genes, many of the changes that occur in our bodies as we grow older are at least partly the result of lifestyle or environmental factors. Therefore, the good news is that they may be amenable to modification.<sup>6</sup> In other words, we can adopt lifestyle habits such as regular exercise and healthy eating that will slow functional declines and compositional changes within the limits set by genetics. Healthy eating habits can, by delaying or slowing disease processes, help us to reach our maximum life-span potential.

### The special nutritional needs of older women

Let us now examine the ways in which the nutritional needs of post-menopausal women differ from those of younger women.<sup>7</sup> Reflecting the usual reduction in physical activity levels and the resultant loss of muscle, a lower level of energy (or kilojoule) intake is recommended for older women. Neither of these changes, however, are inevitable. Indeed, it can be argued that morbidity and mortality could be lowered if activity and muscles were maintained rather than diminished in old age. Certainly, the greater amount of food that can be eaten without putting on weight when older women are more active is more likely to ensure adequate intakes of essential nutrients.

The next most obvious change in nutritional needs among post-menopausal women is the lower need for iron. This is the result of the cessation of menstrual blood loss. Consequently, after menopause iron deficiency is unlikely to reflect a lack of iron in the diet. Other causes are more likely at this time. For example, chronic blood loss from ulcers or other disease conditions, poor iron absorption due to reduced stomach acid secretion, or medications such as aspirin that can cause blood loss.

One area that has attracted a great deal of attention is the higher calcium needs of post-menopausal women not on hormone replacement therapy. The importance of an abundant calcium intake in protecting against osteoporosis is discussed in more detail later, but here we will briefly mention the levels of calcium needed. Many women do not meet the current Australian recommended calcium intake for post-menopausal women (1000 mg/day). They are even further from meeting more recent consensus recommendations, which take into account the latest studies on the calcium intake–bone health link.<sup>8</sup> For example, the 1995 US National Institutes of Health Consensus Development Conference on Optimal Calcium Intake recommended 1000 mg per day for women aged 25–50 years and post-menopausal women on hormone replacement therapy;<sup>8</sup> 1500 mg per day for women over 50 years not on hormone replacement therapy and all women over 65 years; and 1200–1500 mg per day for pregnant or lactating women. In light of recent studies, there have been suggestions that the Australian recommended dietary intake for post-menopausal women be increased to 1500 mg calcium per day.<sup>9</sup>

Older women and men also appear to have greater needs for vitamin D, vitamin B12 and vitamin B6, and lower needs for vitamin A, than do younger people.<sup>7</sup> The main contributor to vitamin D deficiency in old age is reduced sun exposure, usually due to declining mobility levels. It appears that in the USA and Great Britain, some 30–40% of older patients with hip fractures are vitamin D deficient. However, even

during old age, improving vitamin D status can have profound benefits for the health of one's bones. A number of carefully conducted studies in this area are worthy of specific mention. In a double-blind placebo-controlled trial, a 10 µg/day vitamin D supplement over a 1-year period significantly reduced winter-time bone loss and improved spinal bone density in healthy post-menopausal women.<sup>10</sup> In a Finnish study of out-patients over the age of 85 years and municipal home residents aged 75–84 years, those randomly assigned to receive an annual vitamin D injection had significantly fewer fractures over a 5-year follow-up period.<sup>11</sup> Probably the most striking and impressive study is the one undertaken by Chapuy *et al.* of a nursing home population of 3270 women with an average age of 84 years.<sup>12</sup> In a randomized controlled trial of vitamin D (20 µg/day) and calcium (1200 mg/day), those receiving the supplement experienced 43% fewer hip fractures and 32% fewer non-vertebral fractures over an 18-month period. Thus, clearly the message is that it is never too late to care for your bones.

We need to be aware not only of the high risk of vitamin D deficiency among older people living in institutions but also among those living in their own homes who have low mobility levels. The solution is straightforward: preferably 15–30 min of daily sun exposure on the hands and face (the amount of exposure required need not raise concerns about skin cancer), or alternatively a daily 10 µg vitamin D supplement (halibut or cod liver oil capsules are fine).<sup>10</sup> Greater attention needs to be drawn to this widespread nutritional problem given the serious health implications involved.

Two studies which have added greatly to our knowledge of the nutrition of older adults are the 'Survey in Europe on Nutrition and the Elderly, a Concerted Action' (SENECA) study<sup>13</sup> and the 'Boston Nutritional Status Survey'.<sup>14</sup> In the SENECA study, 23% of older people had biochemical levels suggesting subclinical vitamin B6 deficiency. Over half of the people over 60 years of age in the Boston survey had vitamin B6 intakes below two-thirds of the recommended level. This is of great concern for a number of reasons. Most importantly, vitamin B6 deficiency adversely affects immune function and also appears to be linked with an increased risk of vascular disease.

Probably the most important change in the digestive system as we grow older is the reduction in stomach acid production in a subgroup of older people who have 'atrophic gastritis'.<sup>15</sup> This atrophy of the stomach mucosa becomes more common with ageing and appears to affect approximately one third of those over 60 years of age. This can reduce the availability for absorption of vitamin B12, calcium, iron and folate.

So it can be seen that overall, older women need to reach at least the same levels (and in some cases, higher levels) of intake as young women for most vitamins and minerals. However, since this usually needs to be obtained in substantially lower overall food intakes, a nutrient-dense diet becomes a high priority in later life. In other words, given the tendency for activity levels to decline and total food intakes to fall with advancing years, there is less room for those high-kilojoule foods (particularly high-fat or high-sugar foods) which supply few of the essential nutrients which our bodies to continue to need.

### Health conditions in old age that are influenced by diet

Many chronic conditions associated with ageing such as coronary heart disease, diabetes, osteoporosis and cancer are, in part, attributable to the cumulative effect of poor dietary habits and other less desirable lifestyle factors throughout life such as smoking and low levels of physical activity. Nutrition can play a useful role in reducing the risk of developing these diseases even at an older age and, if disease does occur, nutrition can play an important role in the management of these conditions. For example, as people age their bodies become less effective at utilizing their blood sugars (glucose). This condition is known as glucose intolerance and may develop into diabetes. Certain foods like legumes (baked beans, lentils), spaghetti and some fruits and vegetables appear to assist in normalizing blood sugars.

In women, coronary heart disease and stroke have become the major causes of death and disability with ageing. Cholesterol is one risk factor for coronary heart disease; however, not everyone with a high level of cholesterol will develop premature heart disease, and having a low level of cholesterol does not necessarily protect you from premature heart disease. Furthermore, the relationship between cholesterol and heart disease in older adults has not been investigated fully especially in adults over 70 years of age. There are a number of dietary factors that are likely to be protective and these include limiting saturated fat as well as including a variety of fats from different food sources. For instance, fish (a good source of omega-3 fats) appears to be protective against coronary heart disease and, in women, its regular consumption (more than once a week) has been associated with a reduced incidence of stroke.<sup>16,17</sup> Vitamin E, an antioxidant found predominantly in vegetable oils and nuts, may also play a protective role in coronary heart disease.<sup>18</sup>

Three vitamins that may be important in the prevention of coronary heart disease and stroke include folate, vitamin B6 and vitamin B12. Low intakes of these vitamins can lead to a build up of an amino acid, known as homocysteine, which is toxic to blood vessels. High blood levels of homocysteine appear to increase the risk of coronary heart disease<sup>19</sup> and have been associated with a narrowing of the carotid artery.<sup>20</sup> Good food sources of folate include soybeans, liver, leafy green vegetables and berries, while vitamin B6 is found predominantly in bananas, wholemeal breads, cereals and yeast. Vitamin B12 is found in foods of animal origin; the B12 found in mushrooms is not biologically active.

Factors that occur early in life may affect the risk of breast cancer in later life. For instance, rapid early growth, greater adult height<sup>21</sup> and the commencement of menstruation at a younger age are associated with an increased risk of breast cancer.<sup>22</sup> Although it is unlikely that appropriate interventions could be undertaken to avoid these factors, there are other nutritional and lifestyle factors that are amenable to change and may reduce the risk of breast cancer. These include consuming diets high in vegetables and fruits, avoiding alcohol, maintaining a healthy body weight and remaining physically active throughout life.<sup>21</sup> There is some evidence that phytoestrogens (compounds found in plants that possess mild oestrogenic properties) may reduce the risk of breast cancer.<sup>23</sup> Soy and linseed are two excellent sources of phytoestrogens and recently Australian food manufactur-

ers have been adding soy and linseed to a variety of breads and cereals.

Women are more prone to osteoporosis than men for two reasons. First, bone loss is accelerated after menopause and women have a lower bone mineral density compared with men. A large study of elderly men and women conducted in Australia found that after the age of 60 years approximately 60% of women and 30% of men sustained an osteoporotic fracture.<sup>24</sup> In post-menopausal women, a high intake of calcium appears to prevent or reduce bone loss.<sup>24</sup> While adequate intakes of calcium appear to be protective against osteoporosis, other potentially protective factors include vitamin D,<sup>12</sup> vitamin K,<sup>25</sup> certain trace elements such as boron,<sup>26</sup> and possibly phytoestrogens.<sup>27</sup>

Carrying extra weight when we are older appears to be reasonably well-tolerated. In fact, several studies have shown that older adults with a higher body weight tend to survive longer than their thinner counterparts.<sup>28</sup> Having a higher body weight, however, increases the risk of developing non-insulin dependent (or Type II) diabetes, especially if there is a family history of diabetes. Interestingly, in some older adults there may be an inappropriate sense of need for weight change and this could lead to disordered eating behaviour.<sup>29</sup> This type of behaviour might include the prolongation of a minor eating disorder from earlier life, a preoccupation with the major morbidities and mortalities associated with later life, social isolation, physical handicaps, emotional difficulties and impaired cognitive function.<sup>29</sup>

### Food habits of older adults

In early colonial times in Australia different food patterns were imposed on men and women. Female convicts were given smaller rations of meat and flour but unlike the males, they were also issued with vegetables and tea.<sup>30</sup> In fact, females became extravagant tea drinkers, consuming more tea per head than that consumed in the United Kingdom.<sup>31</sup> Traditionally, women have usually been responsible for planning, buying and preparing food for the family and as such the food habits of infants and children have been largely influenced by women rather than by men.<sup>32</sup> Women are perceived to be good mothers if their young children are well-nourished. In recent years, two random population surveys completed in South Australia and Victoria found that women, compared with men, were more concerned with nutrition and health, more fussy over their food, and more accepting of novel foods. Furthermore, those over 60 years of age were found to be the most health conscious and the least weight conscious.<sup>33</sup>

Contrary to the popular 'tea and toast' myth, it appears that many older adults outside institutions eat 'reasonably' well.<sup>34-37</sup> The dietary patterns of older adults have generally been found to be similar to or healthier than those of their younger counterparts (see Tables 1, 2).<sup>38</sup> Nevertheless, their intakes of cereals, fruit, vegetables and milk products are still below the recommended amounts. A news-poll conducted nationally in September 1998 reported that nine out of 10 Australians over the age of 60 years were not eating the recommended dietary intake of fruit and vegetables and that more than one in five (22%) women in this age group lacked the motivation to prepare a meal, especially if living alone.<sup>38,39</sup>

**Table 1.** Mean daily food (g/day) intake of older Australians compared with their middle-aged counterparts in 1995\*

	65 years and over		25–44 years		Recommended intake g/day**
	M n = 3337	F n = 2926	M n = 4189	F n = 3321	
Cereals (e.g. rice, bread)	200	150	230	170	> 210 g
Fruit (not juice)	179	176	127	132	300 g
Vegetables (not juice)	282	244	275	220	300–375 g
Legumes (+ tofu)	9	3.6	11	8.4	> 30 g <sup>a</sup>
Nuts/seeds (e.g. peanut butter)	3	2	7	4	> 10 g <sup>a</sup>
Milk products	340	300	390	300	450 g
Meat/poultry	146	95	212	121	85 g <sup>b</sup>
Fish and seafood	26	20	28	20	40 g <sup>a</sup>
Egg products	14	10	16	12	30 g or 2–4 eggs/week
Snack foods (e.g. crisps)	0.8	0.4	4	4.4	
Sugar products (jam, sorbet)	28	17	22	14	
Confectionery (e.g. chocolate)	4	4	11	10	
Fats/oils	17	12	14	9	1–2 tablespoons (30 g)
Soup	77	69	40	53	
Savoury sauces	25	20	37	27	
Non-alcoholic beverages (e.g. tea, juice, water)	1644	1714	2162	2004	
Alcohol (pure)	15	5	20	8	Men 20 g; women 10 g

Source: \*, Reference 53; \*\*, References 54, 55. Foods were converted to equivalents in core food groups as follows: 30 g bread is equivalent to 90 g cooked rice/pasta or 20 g breakfast cereal; 150 g fruit is equivalent to one medium fruit (apple, orange, banana, two apricots, one cup diced pieces, edible portion); 75 g cooked vegetables is equivalent to ½ cup or one cup salad vegetables; 250 mL milk is equivalent to ½ cup evaporated milk or 40 g cheese or small tub (200 g) yoghurt. <sup>a</sup>Based on epidemiological studies of long-lived populations e.g. Greeks in Greece (Crete) in 1960s, Greek Australians, Japanese, vegetarians. <sup>b</sup>In core food groups 85 g/day of meat and meat equivalents is recommended. This includes red and white meat, eggs and legumes (note: 35 g cooked meat is equivalent to 40 g cooked fish fillet or ¼ cup cooked beans or ½ cup nuts).

**Table 2.** Mean daily nutrient intake of older Australians compared with their middle-aged counterparts in 1995\*

Nutrients	65 years and over		25–44 years		Recommended intake**	
	M n = 3337	F n = 2926	M n = 4189	F n = 3321	M, F 65+	M, F 19–64 years
Energy						
kJ	8510	6370	11 725	7875		
kcal	2000	1500	2800	1900		
Protein (%E)	17	17.6	17	17	10–15	10–15
Total fat (%E)	32	32	33	33	30–35	30–35
Saturated (%E)	12	12	13	13	< 10	< 10
Monounsaturated (%E)	11	11	12	12	> 15	> 15
Polyunsaturated (%E) <sup>a</sup>						
Omega 6 linoleic (%E)	5	5	5	5	3–5	3–5
Omega 3 linolenic (%E)	< 0.2	< 0.2	< 0.2	< 0.2	1–2	1–2
Omega 3 EPA/DHAg	< 0.2	< 0.2	< 0.2	< 0.2	0.4	0.4
Carbohydrate (%E)	46	47	45	47	> 55	> 55
Total sugars	21	22	19	20	< 15%	< 15%
Total starch	25	26	26	26	> 40%	> 40%
Dietary fibre g	24	20	26	20	> 30 g	> 30 g
Ethanol (%E)	5	2	5	3	< 3	< 3
Vitamin A RE (mcg)	1310	1064	1334	1038	750	750
Thiamin (mg)	1.6	1.2	2.1	1.4	0.9, 0.7	1.1, 0.8
Riboflavin (mg)	2.0	1.6	2.5	1.8	1.3, 1.0	1.7, 1.2
Niacin equivalent	39	29	54	35	16, 11	19, 13
Folate (mg)	280	225	311	227	200	200
Vitamin C (mg)	127	111	133	108	40, 30	40, 30
Calcium (mg)	796	686	990	762	800, 1000	800
Phosphorus (mg)	1420	1132	1867	1300	1000	1000
Magnesium (mg)	334	268	392	284	320	320
Iron (mg)	14	11	17	12	7, 5–7	7, 12–6
Zinc (mg)	11	9	15	10	12	12
Potassium (mg)	3232	2626	3818	2816	1950–5460	1950–5460

Source: \*, Reference 53; \*\*, References 85; <sup>a</sup>, Reference 56; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid.

Energy intakes fall with advancing age (from 2800 kcal to 2000 kcal for men and from 1900 kcal to 1500 kcal for women) but average intakes of protein, total fat, polyunsaturated omega 6 linoleic acid, vitamin A, thiamin, riboflavin, niacin, vitamin C, iron, and phosphorus remain adequate in the 65-plus age group. Saturated fat and refined carbohydrates (high sugar content) continue to be consumed in excess of the recommended and monounsaturated fats; omega 3 fatty acids (from plants and fish), unrefined carbohydrates, fibre, folate, vitamin B6, calcium, magnesium and zinc tend to be below the recommended intakes. These intakes may not result in the appearance of any diagnostic features or symptoms of true deficiency but may result in 'subtle' or 'subclinical' nutrient deficiencies which may still significantly increase the risk of stroke, susceptibility to infections and neurological disorders.<sup>40</sup> There are some subgroups within older populations who appear more likely to be consuming inadequate diets (e.g. less regular consumption of cooked meals) such as older men living alone, low socio-economic status groups, the socially isolated, the institutionalized, the recently bereaved, the physically and socially inactive and the lonely.<sup>34,41-43</sup> Participation in fewer activities outside the home has also been linked with higher mortality in old age.<sup>44</sup> Nutrients at greater risk of inadequate intakes in these subgroups include calcium, zinc, magnesium, vitamin B6 and folate.<sup>35,42,45,46</sup> Low intakes of these nutrients have important implications for bone health (calcium), wound healing (zinc), impaired immune response (zinc, vitamin B6) and vascular disease via elevated homocysteine levels (folate, vitamin B6).<sup>40</sup> Other negative influences on dietary intake include physical disability, problems with chewing (loss of teeth and poorly fitting dentures), shopping difficulties and depression.<sup>41</sup>

### Is it too late to make dietary changes in later life?

Sometimes the assumption is made that after the age of 65 or 70 years is reached, lifestyle changes will perhaps no longer confer significant benefits. Are the remaining years sufficient to reap the benefits of modifications to food choice or exercise patterns? In fact, many recent intervention studies reveal that improvements in nutrition and regular exercise can benefit health even in advanced old age. For example, older muscles are just as responsive to strength-training exercises as are young muscles.<sup>47</sup> Nonagenarians have shown impressive increases in muscle mass, muscle strength, and walking speed with weight-training programs. As mentioned earlier, improvements in calcium or vitamin D nutrition can dramatically reduce fracture risk even in very old institutionalized people.<sup>11,12</sup> Chronological age is, in itself, clearly no justification for deciding whether it is worthwhile pursuing lifestyle change. Behavioural risk factors (e.g. not regularly eating breakfast, lack of regular physical activity, overweight, smoking) have been shown to remain predictors of 17-year mortality even at older ages (i.e. 70-plus).<sup>48</sup>

Furthermore, many older adults do make positive changes to their food patterns, often for health reasons, thus challenging the stereotyped view of this group as being resistant to change.<sup>34</sup> Studies which have described the food habits of elderly people in their 70s and then followed them up 5-6 years later to ascertain survival status, concluded that 'food

patterns', even as late as 70 years and onwards, could reduce the risk of death by more than 50%.<sup>49-52</sup>

The 'food patterns' which were reported to confer longevity were defined as follows: (i) a high vegetable intake (approximately 300 g/day); (ii) a high legume intake (approximately 50 g/day); (iii) a high fruit intake (approximately 200 g/day); (iv) a high cereal intake (250 g/day); (v) a moderate dairy product intake (approximately 300 g of milk/day or equivalent in cheese/yoghurt); (vi) a moderate meat and meat products intake (approximately 100 g/day); (vii) a moderate alcohol intake (< 10 g/day); and (viii) a high monounsaturated : saturated fat ratio (> 1).

This food pattern was consistent with the traditional Greek food pattern of the 1960s and was basically high in plant foods (approximately 70% of total food intake) and low in animal foods (30% of total food intake). What was particularly interesting was that subjects achieved greater mortality advantage if they followed the entire food pattern as opposed to just achieving the required amount for one or two of the food groups. This suggests that there may be synergy between the food groups and that we need to follow dietary recommendations as a whole rather than focusing on just one food group or nutrient. Nevertheless, this 'food pattern' definition does have limitations. It does not differentiate between meat and fish, milk and yoghurt, fruit and nuts, different types of vegetables, the source of the monounsaturated fats (which can be derived from olive/rape seed oils, avocados, nuts and dairy products) or the mode of food preparation (e.g. olive oil, herbs and lemon juice added to Greek vegetable dishes vs melted margarine on Anglo-Celtic vegetable dishes). Therefore, these mortality studies, although interesting, leave us with some unanswered questions.

Studies have shown that consuming a wide variety of foods, especially plant foods,<sup>57</sup> and having a proportionately higher intake of plant foods relative to animal foods is associated with longevity.<sup>49,51,58</sup> The main concern for people eating meat-rich diets is that they tend to eat less plant foods and may not gain as many benefits of the protective substances found in plant foods. However, an omnivore diet that is low in saturated fat and contains plenty of fruits, vegetables, cereals and legumes may be just as effective as a vegetarian diet in terms of reducing cardiovascular disease risk (Diet & Heart Disease Advisory Committee, National Heart Foundation, 1997).<sup>59</sup> Also, the cooking technique used to prepare meat and fish is important. Charred and burnt meat/fish juices, grilling in direct flame, or cured and smoked meats have been linked with cancer due to the formation of carcinogenic compounds.<sup>21</sup>

A high intake of fish,<sup>16</sup> seeds and nuts,<sup>18</sup> soy products and other legumes,<sup>60</sup> olive oil and olives,<sup>59,61</sup> rape seed oil,<sup>62</sup> red wine, dark green vegetables, onions and garlic, apples and berries, green and black tea,<sup>63</sup> tomatoes, carrots,<sup>64</sup> citrus fruits, fermented milk products,<sup>65</sup> and herbs and spices (Kouris-Blazos *et al.* unpubl. data, 1998) have also been reported to protect against several chronic diseases associated with ageing and may result in lower overall mortality rates in later life. The protective components in these foods include the anti-oxidant vitamins (e.g. vitamins E, C, A) phytochemicals (e.g. polyphenols, flavonoids), phytoestrogens (e.g. isoflavones, lignans), omega 9 (monounsaturated) fatty acids, and omega 3 (polyunsaturated) fatty acids from plants

(alpha-linolenic acid) and fish (eicosapentaenoic and docosahexaenoic acids).<sup>66,67</sup> For example, extra virgin olive oil contains between 30 and 40 different anti-oxidant compounds (including vitamin E) which may protect against cancer and heart disease.<sup>68</sup>

So what dietary changes can we make, even in later life, which will translate into improved health and longevity and, hopefully, successful ageing:

1. Increase food variety — eat a little bit of everything. Aim to eat at least 20 biologically distinct foods a week drawing from all food groups (fruits, vegetables, grains, nuts, meats, dairy, fish, oils, herbs, spices) (Table 3). An easy way to increase food variety is to include healthy dishes from other cuisines (e.g. tofu and leafy greens from Asia, tomato/legume dishes from the Mediterranean).
2. Vegetables — eat at least two cups per day and include three different colours. Choose a variety of brightly coloured vegetables, especially dark green leafy vegetables. Experiment with vegetables from Asia (e.g. bok choy) and the

Mediterranean (e.g. purslane, chicory, endive) which are high in omega 3 fatty acids). Try to include onion and garlic in your daily meals.

3. Fruit — eat at least two daily; fruit juice should count for no more than one serve per day as it does not contain everything you would get from whole fruit.
4. Cereals such as bread, pasta, rice — eat approximately five serves daily. Reduced salt bread and wholegrain products are preferred. Bread is the major source of salt in the diet.
5. In order to increase the intake of phytoestrogens, any of the following should be eaten on a regular basis: two to four slices of soy enriched bread, two 200 mL soy drinks, one tablespoon of linseed and one tablespoon of soy grits on cereal, one to two tofu burgers, a bowl of chickpea soup, or a snack of roasted chickpeas with sultanas.
6. Milk and milk products — eat at least two serves of low-fat products daily and eat fermented milk/yoghurt regularly. Non-milk sources of calcium include calcium fortified soy milk, fish with soft bones (e.g. sardines, salmon, pilchards)

**Table 3.** Weekly food variety score<sup>84</sup>

Biologically distinct food groups	Score	Biologically distinct food groups	Score
1. Eggs (all variety)		30. Water (including mineral)	
Dairy		31. Tea, coffee, herbal teas, wine, beer, spirits	
2. Milk, ice-cream, cheese		Fermented foods	
Live cultures		32. Miso, tempeh, soy sauce	
3. Yoghurt (e.g. acidophilus, bifidobacteria)		33. Sauerkraut	
Yeast		34. All other varieties	
4. Vegemite		Sugar/confectionery	
Fish (+ canned)		35. All varieties (including soft drinks)	
5. Fatty fish (tuna, anchovies, salmon, sardines, herring, mackerel, kipper)		Vegetables(canned, frozen)	
6. Saltwater fish		36. Root (potato, carrot, sweet potato, beetroot, parsnip, bamboo shoot, ginger, radish, water chestnut)	
7. Freshwater fish		37. Flowers (broccoli, cauliflower)	
8. Fish roe (caviar salad)		38. Stalks (celery, asparagus)	
9. Shellfish (mussels, oysters, squid)		39. Onion (spring, garlic, leeks)	
10. Crustaceans (prawns, lobster)		40. Tomatoes, okra	
Meat		41. Beans (green, snow peas)	
11. Ruminants (lamb, beef, veal)		42. Leafy greens (spinach, silverbeet, endive, kale, chicory, parsley, lettuce)	
12. Monogastric (pork, ham, bacon)		43. Peppers (capsicum, chillies)	
13. Poultry (chicken, duck, turkey)		44. Marrow (zucchini, squash, cucumber, turnip, eggplant, swede, pumpkin)	
14. Game (quail, wild duck, pigeon)		45. Fungi (e.g. mushrooms)	
15. Game (kangaroo, rabbit)		46. Herbs/spices	
16. Liver		Nuts and seeds	
17. Brain		47. Almond, cashew, chestnut, coconut, hazelnut, peanut, peanut butter, pine nut, pistachio, pumpkin seed, sesame seed, tahini, walnut	
18. All other organ meats		Fruit	
Legumes (+ canned)		48. Stone (peach, cherry, plums, apricot, avocado, olive, prune)	
19. Peas (fresh, dried, split peas); chickpeas (dried, roasted); beans (haricot, kidney, lima, broad); lentils (red, brown, green); soy products (tofu, milk).		49. Apples	
Cereals		50. Pears, nashi	
20. Wheat (bread, pasta, ready-to-eat)		51. Berries (strawberries)	
21. Corn (cornflakes, polenta)		52. Grapes (and raisins, sultanas)	
22. Barley (bread, barley, cereal)		53. Bananas	
23. Oats (porridge, cereal, bread)		54. Citrus (orange, lemon)	
24. Rye (bread; ready-to-eat)		55. Melon (honeydew, watermelon)	
26. Rice (grain, ready-to-eat)		56. Kiwi, date, passionfruit	
27. Other grains (millet, linseed)		57. Tropical (mango, pineapple)	
Fats and oils		Total weekly variety score = 1–57	
28. Oils			
29. Hard/soft spreads			
Beverages			

Instructions: A score of one is given to each food only once if consumed (> two tablespoons) over a 7-day period. Score of biologically different foods consumed in a week: < 20 marginal; 20–24 fair; 25–29 good; ≥ 30 very good.

unhulled sesame seed paste, almonds, pistachio nuts, soy beans, dried figs and apricots, pumpkin and dark green vegetables (e.g. broccoli, bok choy).

7. If eating red meat, use as a condiment (e.g. Asian style dishes). Choose lean cuts and limit these to less than 80 g/day or larger serves to approximately two times per week. Game meats and other non-domesticated (lean) animals are preferable. When cooking, use relatively low temperature methods, such as steaming, boiling, poaching, stewing, braising, baking, microwaving or roasting. Limit the use of grilling, pan frying and barbecuing to avoid formation of carcinogenic compounds.

8. Include meals high in plant proteins (e.g. legume, tofu or nut-based meals) on a regular basis, that is, approximately two times per week.

9. Include fish and seafood meals one to three times per week, especially fatty fish (e.g. fresh tuna, salmon, sardines, mackerel).

10. Include unroasted nuts as a snack — eat a handful of nuts (especially walnuts, pecans, almonds) at least a few times a week or spread pure nut pastes on bread instead of butter or margarine.

11. Avoid animal fats — choose low fat milk products and lean meats, and avoid high-fat fast food and commercial cakes and biscuits.

12. Use margarine sparingly on bread; reserve added fats (preferably a variety of unrefined liquid oils such as cold pressed canola or the flavoursome extra virgin olive oil) for your cooked meals, vegetables and salads. A little oil (one to two tablespoons/day) will improve the flavour of plant foods and will also aid the absorption of fat soluble vitamins (vitamin A and E,  $\beta$ -carotene) and phytochemicals (e.g. lycopene) from the vegetables.<sup>64</sup> Use herbs such as parsley, mint, basil, dill and paprika to provide more flavour to vegetables and meats.

13. Limit the consumption of table sugar or sugar-rich products. A high (as opposed to moderate) intake of sugar has been linked with lower intakes of nutrients, particularly in 'small eaters' or when diets are limited in calories. Sugar also increases the excretion of chromium, which may contribute to the onset of diabetes.<sup>69</sup> Dietary sources of chromium includes nuts, raisins, mushrooms, blackstrap molasses, brewer's yeast, egg yolk, cheese, liver, barley and other wholegrain cereals, meat, apple peel, some beer and wine. Dark honey is now thought to contain anti-oxidant phytochemicals and therefore it may be desirable to replace some table sugar with pure honey.<sup>70</sup>

14. Limit alcoholic beverages to one to two standard drinks per day and preferably consume with meals. However, since many adverse effects of alcohol consumption clearly exist (especially with breast/upper gastrointestinal cancers and stroke), a moderate alcohol intake is considered an optional rather than an essential component of the diet.<sup>59</sup>

15. The consumption of several small non-fatty meals daily (five to six episodes of eating) appears to be associated with greater food variety and with lower body fat, blood glucose and blood lipids, especially if food intake is curtailed in the evening hours (i.e. it is preferable to have the main meal for lunch and a light snack for dinner rather than the reverse).<sup>71</sup>

16. Remain physically active (e.g. 30–60 min of walking daily) and include strength exercises 2–3 times a week in

order to achieve an adequate intake of nutrients and phytochemicals and to maintain muscle strength and balance.

17. Last but not least is the need for an adequate fluid intake. As we age there is a blunted ability to defend ourselves against dehydration. This occurs because of the reduced sensation to thirst and a decline in kidney function.<sup>72</sup> In order to avoid dehydration (and constipation), it is advisable to consume at least four large cups of water or other fluids such as tea (which has the added benefit of containing anti-oxidant phytochemicals) irrespective of thirst. Consuming foods with a high-water content, such as fruit, will also help hydration status.

### Food versus supplements?

Dietary supplements are widely used among older women (45–80%), and to a lesser extent men (35–60%), in the United States, Canada, Australia and New Zealand.<sup>34</sup> Supplement manufacturers often target older people, claiming their products prevent disease or promote longevity. Unfortunately the nutrients most often taken as supplements are rarely those in shortest supply in the diet; furthermore, the people who regularly take supplements generally tend to be those who make healthier food choices anyway.

The consensus amongst nutritionists is that, in most situations, nutrients are best obtained from foods rather than from supplements.<sup>66</sup> Foods supply a range of essential nutrients and other potentially beneficial substances in amounts which, in contrast to many supplements, generally carry no risk of toxic effects or adverse nutrient interactions. Adverse nutrient interactions refer to the reduction in the level of utilization of one nutrient that can occur as a result of a high (usually supplement-derived) intake of another. Interactions among minerals and trace elements are common. For example, the reduction in copper utilization that occurs with the use of zinc supplements can lead to the development of copper deficiency. Other potential concerns are the risk of supplement interference with drug absorption in an age group that heavily consumes both prescription and over-the-counter drugs, and some evidence suggesting that vitamin A may be toxic at lower levels in older, as opposed to younger, adults.

There are, nevertheless, some situations in which supplement use by older adults is advisable. Vitamin D is an important example which has already been mentioned; however, care is required since this nutrient can be highly toxic if taken in levels above those recommended. Other appropriate uses include calcium supplements for bone health in those who have lactose intolerance or a cows' milk allergy. However, lactase-treated milk and yoghurt are available and are excellent calcium sources, as well as being rich in a host of other nutrients. Furthermore, those calcium supplements based on bonemeal, dolomite or oyster shells are not recommended due to potential contamination with toxic metals such as lead, arsenic, cadmium or mercury. Recommended dietary allowance (RDA) level multivitamin and mineral supplements may be helpful for those more frail and inactive older adults with very low food intakes (i.e. less than 5000 kJ per day). Recent recommendations are for a daily RDA level vitamin B12 supplement for all older adults. This recommendation reflects the findings that the reduction in stomach acid production that commonly occurs in older adults results in lowered dietary vitamin B12 absorption.<sup>15</sup>

Nevertheless, a well-balanced diet will provide most healthy older people with most of the nutrients they need and for those whose food intakes are very low, the more important priority is to identify and try to correct any underlying physical or psychosocial reasons for the existence of eating problems or for a poor nutritional state.

### Recommended levels of physical activity

Physical activity can fall into two broad categories. It may include everyday activities such as gardening, cleaning, and shopping, as well as more vigorous and structured type activities such as playing sport and participating in planned exercise programs. The latter are usually repetitive and performed with the intention to improve health and fitness. In the Risk Factor Prevalence Study,<sup>73</sup> the prevalence of both vigorous and less vigorous exercise declined progressively with age and this pattern appears to have changed little in recent years.<sup>74</sup> As mentioned previously, ageing is usually associated with a decline in function. However, whether this decline in function is an inevitable phenomenon of ageing or whether it relates to changes over which we may have some control requires further investigation. Fiatarone<sup>75</sup> states that "ageing as we know it in modern society is, in many ways, an exercise deficiency syndrome, implying that we may have far more control over the rate and extent of the ageing process than we previously thought."

Similar to the age-related loss of bone mass, the loss of muscle mass (sarcopenia) that occurs with age is more marked in women and it has been shown that reduced muscle mass is a direct cause of the age-related decrease seen in muscle strength.<sup>76,77</sup> Furthermore, this decline in muscle strength is responsible for much of the disability observed in older adults and, in the old elderly, muscle strength is a crucial component of walking ability.<sup>78,79</sup>

The two principal forms of physical activity or exercise important in promoting health and well-being include endurance exercise and strength training. Endurance activity improves heart and lung fitness while strength training enhances muscle size and strength. Strength training in older adults seems particularly promising in reducing or preventing the decline in muscle mass observed with ageing.<sup>47</sup> It can improve walking ability and balance and its associated risk for falls.<sup>80</sup> Strength training also contributes to improved tendon and ligament strength, bone health<sup>81</sup> and improvements in blood sugar levels.<sup>82</sup> Additionally, the benefits of physical activity, such as strength training, should make activities of daily living easier for older people. Such activities might include climbing stairs, getting out of a chair, pushing a vacuum cleaner, carrying groceries and crossing a road with sufficient speed.

As the level of physical activity is low among many older Australians, it is important that suitable, regular, physical activity programs that (preferably) include both an endurance (e.g. daily walk of 30 min duration or three bouts of 8–10 min)<sup>83</sup> and strength training component are undertaken by older adults in order to maintain health and quality of life. The level of physical activity required to achieve optimal health benefits for older adults has not been established but studies show that very frail and old elderly can still derive benefits from participating in physical activity.<sup>47</sup>

### Conclusion

Eating a wide variety of foods improves the nutritional adequacy of most diets and appears to be protective against many chronic diseases associated with ageing. Food variety, combined with appropriate levels of physical activity, will also assist in preserving muscle mass and function and help to ensure ageing is a successful and enjoyable period in one's life.

### References

1. Gingold R. Successful ageing. Melbourne: Oxford University Press, 1992: 4–5.
2. Butler RN. Quality of life: can it be an endpoint? How can it be measured? *Am J Clin Nutr* 1992; 55: 1267S–1270S.
3. Palmore EB. Successful aging. In: Maddox GL, ed. The encyclopedia of aging. New York: Springer Publishing Company Inc., 1987: 654.
4. Evans WJ, Meredith CN. Exercise and nutrition in the elderly. In: Munro HN, Danford DE, eds. Nutrition, aging and the elderly. New York: Plenum Press, 1989.
5. Evans WJ, Campbell WW. Sarcopenia and age-related changes in body composition and functional capacity. *J Nutr* 1993; 123: 465–468.
6. WHO Report Study Group. Epidemiology and prevention of cardiovascular diseases in elderly people. WHO Technical Report Series: 853, Geneva: WHO, 1995.
7. Russell RM, Suter PM. Vitamin requirements of elderly people: an update. *Am J Clin Nutr* 1993; 58: 4–14.
8. Murray T. Calcium nutrition and osteoporosis. *Can Med Assoc J* 1996; 155: 935–939.
9. Prince R. The calcium controversy revisited: implications of new data. *Med J Aust* 1993; 159: 404–407.
10. Dawson-Hughes B, Dallal GE, Krall EA, Harris S, Sokoll LJ, Falconer G. Effect of vitamin D supplementation on wintertime overall bone loss in healthy postmenopausal women. *Ann Intern Med* 1991; 115: 505–512.
11. Heikinheimo RJ, Inkovaara JA, Harju EJ *et al.* Annual injection of vitamin D and fractures of aged bones. *Calcif Tissue Int* 1992; 51: 105–110.
12. Chapuy MC, Arlot ME, Duboeuf F *et al.* Vitamin D and calcium to prevent hip fractures in elderly women. *N Engl J Med* 1992; 327: 1637–1642.
13. Euronut-SENECA investigators. Euronut SENECA study on nutrition and the elderly. Intake of vitamins and minerals. *Eur J Clin Nutr*, 1991; 45 (Suppl. 3): 121–138.
14. Hartz SC, Rosenberg IH, Russell RM, eds. The Boston nutritional status survey. London: Smith-Gordon & Co Ltd, 1992.
15. Hurwitz A, Brady DA, Schaal SE, Samloff IM, Dedon J, Rohl CE. Gastric acidity in older adults. *J Am Med Assoc* 1997; 278: 659–662.
16. Kromhout D, Feskens EJM, Bowles CH. The protective effect of a small amount of fish on coronary heart disease mortality in an elderly population. *Int J Epidemiol* 1995; 24: 340–345.
17. Gillum RF, Mussolino ME, Madans JH. The relationship between fish consumption and stroke incidence. *Arch Intern Med* 1996; 156: 537–542.
18. Dreher ML, Maher CV, Kearney P. The traditional and emerging role of nuts in healthful diets. *Nutr Rev* 1996; 54: 241–245.
19. Koehler KM, Romero LJ, Stauber PM, Pareo-Tubbeh SL, Chi Laing H, Baumgartner RN, Garry PJ, Allen RH, Stabler SP. Vitamin supplementation and other variables affecting serum homocysteine and methylmalonic acid concentrations in elderly men and women. *J Am Coll Nutr*, 1996; 15: 364–376.
20. Selhub J, Jacques PF, Bostom AG, D'Agostino RB, Wilson PWF, Belanger AJ, O'Leary DH, Wolf PA, Schaefer EJ, Rosenberg IH. Association between plasma homocysteine concentrations and extracranial carotid-artery stenosis. *N Eng J Med* 1995; 332: 286–291.
21. World Cancer Research Fund/American Institute for Cancer Research. Food, nutrition and the prevention of cancer: a global per-

- spective. Washington, DC: American Institute for Cancer Research, 1997; 252–287.
22. Smith CL, Kricger A, Armstrong BK. Breast cancer mortality trends in Australia. *Med J Aust* 1998; 168: 11–14.
  23. Ingram D, Sanders K, Kolybaba M, Lopez D. Case-control study of phyto-estrogens and breast cancer. *Lancet* 1997; 350: 990–994.
  24. Anonymous. The prevention and management of osteoporosis. Consensus statement. Australian National Consensus Conference 1996. *Med J Aust* 1998; 167: S1–15.
  25. Delmas PD. What role of vitamin K deficiency in the pathogenesis of osteoporosis. In: Andrews GR, Mykyta LJ, Andrews MM, Pearson, SA, Gregory AJ, Hagger JC, eds. *Aging beyond 2000: One world one future*. Book of abstracts. Bedford Park, South Australia: World Congress of Gerontology, 1997.
  26. Mertz W. Essential trace metal: New definition based on new paradigms. *Nutr Rev* 1993; 51: 287–295.
  27. Dalais FS, Rice GE, Wahlqvist ML, Grehan M, Murkies AL, Medley G, Ayton R, Strauss BJG. Effects of dietary phytoestrogens in postmenopausal women. *Climacteric* 1998; 1: 124–129.
  28. Steen B, Landin I, Mellström D. Nutrition and health in the eighth decade of life. In: Wahlqvist ML, Truswell AS, Smith R, Nestel PJ, eds. *Nutrition in a sustainable environment*. Proceedings of the XV International Congress of Nutrition. London: Smith-Gordon, 1994: 331–333.
  29. Wahlqvist ML, Russell J, Beumont P. Prevention of dieting disorders: screening and preventive intervention (the NHMRC initiative). *Asia Pacific J Clin Nutr* 1997; 6: 153–161.
  30. Walker RB, Roberts DCK. Colonial food habits 1788–1900. In: Truswell AS, Wahlqvist ML, eds. *Food habits in Australia*. Proceedings of the first Deakin/Sydney Universities symposium on Australian nutrition. Melbourne: Rene Gordon, 1988; 40–59.
  31. Teow BH, Wahlqvist ML, Flint DM. Food patterns of Australians at the turn of the century. In: Truswell AS, Wahlqvist ML, eds. *Food habits in Australia*. Proceedings of the first Deakin/Sydney Universities symposium on Australian nutrition. Melbourne: Rene Gordon, 1988; 60–76.
  32. Boulton J, Magarey A. Food habits of children. In: Truswell AS, Wahlqvist ML, eds. *Food habits in Australia*. Proceedings of the first Deakin/Sydney Universities symposium on Australian nutrition. Melbourne: Rene Gordon, 1988; 77–84.
  33. Worsley A. Australians' dietary and nutritional concerns. In: Truswell AS, Wahlqvist ML, eds. *Food habits in Australia*. Proceedings of the first Deakin/Sydney Universities symposium on Australian nutrition. Melbourne: Rene Gordon, 1988; 60–76.
  34. Horwath CC. Dietary intake studies in elderly people. In: Bourne GH, ed. *Impact of nutrition on health and disease*, *World Rev Nutr Diet*. 1989; 59: 1–70.
  35. Wahlqvist ML, Hsu-Hage BH-H, Kouris-Blazos A, Lukito W, eds. *Food habits in later life: A cross-cultural study*. Melbourne: Asia Pacific Journal of Clinical Nutrition and United Nations University Press, 1995 (CD Rom).
  36. Wahlqvist ML, Hsu-Hage B, Kouris-Blazos A, Lukito W. Food habits in later life—An overview of key findings. *Asia Pacific J Clin Nutr* 1995; 4: 1–11.
  37. Kouris-Blazos A, Wahlqvist ML, Trichopoulou A, Polychronopoulos E, Trichopoulos D. Health and nutritional status of elderly Greek migrants to Melbourne, Australia. *Age Ageing* 1996; 25: 177–189.
  38. Newspoll national omnibus: Elderly nutrition study, September 1998. Eating risk for elderly, *Herald Sun*, 1/10/98: 33.
  39. Wahlqvist ML, Kouris-Blazos A, Savige G. Food based Dietary Guidelines for older adults: healthy aging and prevention of chronic non-communicable diseases. In: Consultation on nutrition guidelines for the elderly. Boston: WHO; in press.
  40. Rosenberg IH, Miller JW. Nutritional factors in physical and cognitive functions of elderly people. *Am J Clin Nutr* 1992; 55: 1237S–1243S.
  41. Horwath CC. Socio-economic and behavioural effects of the dietary habits of elderly people. *Int J Biosocial Med Res* 1989; 11: 15–30.
  42. Horwath CC. Nutrition and ageing. In: Mann JM, Truswell ST, eds. *Essentials of human nutrition*. New York: Oxford University Press, 1998; 499–411.
  43. SENECA investigators. Dietary habits and attitudes. *Eur J Clin Nutr* 1991; 45: 83–95.
  44. Olsen RB, Olsen J, Gunner-Svensson F, Waldstrom B. Social network and longevity. A 14-year follow-up study among elderly in Denmark. *Social Sci Med* 1991; 33: 1189–1195.
  45. Wahlqvist ML, Kouris-Blazos A, Lukito W, Hsu-Hage B. Water soluble vitamin intakes in the elderly: Cross-cultural findings in the IUNS study. In: Rosenberg IH, ed. *Nutritional assessment of elderly populations: Measure and function*. New York: Raven Press, 1994; 225–233.
  46. CSIRO. Does five years make a difference? Results from Australian Food and Nutrition Surveys 1998 and 1993. CSIRO Division of Human Nutrition, Adelaide, 1996.
  47. Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, Nelson ME, Roberts SB, Kehayias JJ, Lipsitz LA, Evans WJ. Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Engl J Med* 1995; 330: 1769–1775.
  48. Kaplan GA, Seeman TE, Cohen RD, Knudsen LP, Guralnik J. Mortality among the elderly in the Alameda County Study: behavioural and demographic risk factors. *Am J Public Health* 1987; 77: 307–312.
  49. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis Ch, Lagiou P, Polychronopoulos E, Vassilakou T, Lipworth L, Trichopoulos D. Diet and overall survival in elderly people. *BMJ* 1995; 311: 1457–1460.
  50. Kouris-Blazos A, Gnardellis C, Wahlqvist ML, Trichopoulos D, Lukito W, Trichopoulou A. Are the advantages of the Mediterranean diet transferable to other populations? A cohort study in Melbourne, Australia. *Br J Nutr* 1999; 82: 57–61.
  51. Kouris-Blazos A, Wahlqvist ML. The traditional Greek food pattern and overall survival in elderly people. *Aust J Nutr Diet* 1998; 4 (Suppl.): 20–23.
  52. Osler M, Schroll M. Diet and mortality in a cohort of elderly people in a north European community. *Int J Epidemiol* 1997; 26: 155–159.
  53. Australian Bureau of Statistics. National Nutrition Survey Selected Highlights Australia 1995. AGPS cat. no. 4802. Canberra: Australian Government Publishing Service, 1997.
  54. Cashel K, Jeffreson S. The core food groups. The scientific basis for developing nutrition education tools. National Health & Medical Research Council. Canberra, Australian Government Publishing Service, 1995.
  55. Wahlqvist ML, Kouris-Blazos A. Dietary Advice and Food Guidance Systems. In: Wahlqvist ML, ed. *Food and nutrition: Australasia, Asia and the Pacific*. Sydney: Allen & Unwin, 1997; 508–522.
  56. Sinclair AJ, Oon KS, Lim L, Li D, Mann NJ. The omega 3 fatty acid content of canned, smoked and fresh fish in Australia. *Aust J Nutr Diet* 1998; 55: 116–120.
  57. Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr* 1993; 57: 434–440.
  58. Walter P. Effects of Vegetarian Diets on Ageing and Longevity. *Nutr Rev* 1997; 55: S61–S68.
  59. Kushi LH, Lenart EB, Willett WC. Health implications of Mediterranean diets in light of contemporary knowledge. 2. Meat, wine, fats and oils. *Am J Clin Nutr* 1995; 61 (Suppl.): 1416S–27S.
  60. Murkies AL, Wilcox G. A GP's guide to phytoestrogens. *Modern Medicine of Australia*, March 1998: 26–31.
  61. Keys A, ed. Seven countries: a multivariate analysis of death and coronary heart diseases. Cambridge: Harvard University Press, 1980.
  62. deLorgeril M, Renaud S, Mamelle N, Salen P, Martin JL, Monjaud I, Guidollet J, Touboul P. Mediterranean alpha-linolenic acid-rich diet in secondary prevention of coronary heart disease. *Lancet* 1994; 11: 1454–1459.
  63. Hertog MG, Feskens EJ, Hollman PC, Katan MB, Kromhout D. Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen elderly study. *Lancet* 1993; 342: 1007–1011.
  64. Clinton S. Lycopene: Chemistry, biology and implications for human health and disease. *Nut Rev* 1998; 56: 35–51.
  65. Nestel P. Intestinal flora and human health – introductory remarks. *Asia Pacific J Clin Nutr* 1996; 5: 1.
  66. Wahlqvist M, Wattanapenpaiboon N, Kannar D, Dalais F, Kouris-Blazos A. Phytochemical deficiency disorders: Inadequate intake of protective foods. *Current Therapeutics*, July 1998: 53–60.

67. Sinclair AJ. The good oil: omega 3 polyunsaturated fatty acids. *Today's Life Sci* 1991; 8: 18–27.
68. Stanton R. Complete book of food and nutrition. Brookvale, NSW: Simon & Schuster, 1995.
69. Anderson R. Chromium as an essential nutrient for humans. *Regulatory Toxicol Pharmacol* 1997; 26: 535–541.
70. Allsop KA, Miller JB. Honey revisited: a reappraisal of honey in pre-industrial diets. *Br J Nutr* 1996; 75: 513–520.
71. Wahlqvist ML, Kouris-Blazos A, Wattanapenpaiboon N. The significance of eating patterns: an elderly Greek case study. *Appetite* 1999; 32: 23–32.
72. Wahlqvist ML, Savige GS, Lukito W. Nutritional disorders in the elderly. *Med J Aust* 1995c; 163: 376–381.
73. Risk Factor Prevalence Study Management Committee. Risk factor prevalence study, survey no. 3, 1989. Canberra: National Heart Foundation of Australia and Australian Institute of Health, 1990.
74. Australian Institute of Health, Welfare. Australia's Health 1998: The sixth biennial health report of the Australian Institute of Health and Welfare. Canberra: Australian Institute of Health and Welfare, 1998.
75. Fiatarone MA. Fit for your life exercise program. Boston, MA: Hebrew Rehabilitation Centre, 1996: 3.1–3.13.
76. Mazzeo RS, Cavanagh P, Evans WJ, Fiatarone M, Hagberg J, McAuley E, Startzell J. Exercise and physical activity for older adults. *Med Sci Sport Ex* 1998; 30: 992–1008.
77. Frontera WR, Hughes VA, Evans WJ. A cross-sectional study of upper and lower extremity muscle strength and mass in 45- to 78-year-old men and women. *J Appl Physiol* 1991; 71: 644–650.
78. Evans WJ. Effects of aging and exercise on nutrition needs of the elderly. *Nutr Rev* 1996; 54: S35–S39.
79. Fiatarone MA, Evans WJ. The etiology and reversibility of muscle dysfunction in the aged. *J Gerontol* 1993; 48: 77–83.
80. Wolfson L, Judge J, Whipple R, King M. Strength is a major factor in balance, gait, and the occurrence of falls. *J Gerontol a Biol Sci Med Sci* 1995; 50A: 64–67.
81. Nelson ME, Fiatarone MA, Morganti CM, Trice I, Greenberg RA, Evans WJ. Effects of high-intensity strength on multiple risk factors for osteoporotic fractures. *JAMA* 1994; 272: 1909–1914.
82. Craig VW, Everhart J, Brown R. The influence of high-resistance training on glucose tolerance in young and elderly subjects. *Mech Ageing Dev* 1989; 75: 147–157.
83. Fletcher GF, Balady G, Froelicher VF, Hartley LH, Haskell WL, Pollock ML. Exercise standards. A statement for healthcare professionals from the American Heart Association. *Circulation* 1995; 92: 3579–3580.
84. Savige GS, Hsu-Hage BH-H, Wahlqvist ML. Food variety as nutritional therapy. *Current Therapeutics*, March 1997; 57–67.
85. National Health, Medical Research Council. Recommended Dietary Intakes for Use in Australia, Canberra: Australian Government Publishing Service, Canberra 1991.