Nutrition and Aging, pages 175–202

VITAMINS, NUTRITION AND AGING

Mark L. Wahlqvist
B. Med. Sc., M.D., B.S. (Adelaide)
M.D. (Uppsala), F.R.A.C.P., F.A.I.F.S.T., F.A.C.N.

Department of Medicine, Monash University
Prince Henry's Hospital, St. Kilda Road, Melbourne,
Victoria, Australia, 3004

Address for correspondence:
Professor Mark L. Wahlqvist
Department of Medicine
Monash University
Prince Henry's Hospital
St. Kilda Road
Melbourne, Victoria 3004

Presented at:
International Conference
on Nutrition and Aging
Galveston, Texas, U.S.A.
5th–7th October 1988

Whenever one speaks of a class of nutrients and what constitutes their biological importance, misunderstanding may arise. This is principally because nutrients are considered independent of food and of the context of eating and the scientific basis for advice about vitamins must include these broader issues. They are rarely acknowledged, but they are in a recent treatise on geriatric nutrition from Hanchou University Medical School in China (29). Another problem is that we have little in the way of long-term prospective studies that have taken into account vitamin intakes and their impact on morbidity and mortality, especially those rates in later life. This is rather remarkable when one considers other areas like nutrition and cardiovascular disease, or nutrition and cancer. For riboflavin intake, one of the vitamins I am going to use as a case study, We know a good deal about its short-term deficiency effects, but little about what its intake means in terms of long-term morbidity and mortality. Assessment of vitamin status in the elderly needs a dynamic view, taking into account legacies from earlier life and prospects for an even later life.

Requirements and RDIs

Much of the discussion that surrounds vitamin intakes and their biological relevence is couched in terms of recommended dietary intakes (RDIs). There are problems in establishing RDIs for the elderly as there are indeed for other age groups. Firstly, for the elderly, present needs may reflect cumulative problems. It is arguable to what extent this is the case, but theoretically it is a problem. Secondly, there may be the effects of the aging process itself, whatever that might be, on nutrient requirements and tolerance. It might be even more important at the upper end of nutrient intakes than at the lower end. Thirdly, there may be effects on nutrient requirements of age-related disease, as opposed to the aging process. Fourthly, the elderly population is one of great heterogeneity for social and economic reasons, and because of differing levels of physical activity. For countries like the United States, Canada, and Australia we have to reckon with great cultural heterogeneity. Another source of heterogeneity, which we think we address clinically, but we actually address very poorly, is the disparity between chronological and biological age. We need better markers of biological age before nutrition and aging achieves any good degree of definition.

In the development of recommended dietary intakes for elderly people we have largely depended on extrapolations from younger people. This appears reasonable in the main and the recent accounts of recommended dietary intakes published in the American Journal of Nutrition in 1987 bear that out (7,8,9,17,18,19). Secondly, the development presumes the intakes of apparently healthy elderly people, but it is only relatively recently that we have good population based studies of what healthy elderly people actually eat. Another aspect of the development of RDIs is that intake levels should look at functional outcomes and health problems. RDIs also can take account of when specific nutrient deficiencies arise.

It is interesting to consider to what extent various countries have considered those older than seventy years in making recommendations about dietary intakes. The work of Stewart Truswell for the International Union of Nutrition Sciences, where recommended dietary intakes from around the world were compiled, shows us that in at least 14 countries, recommendations have been made for those over the age of 70 (25). In one country, Japan, recommendations for the over 80s, and in yet another, Bulgaria, recommendations for those over the age of 90 have been made. Of course none of this means there is any better evidence available in one country over another. Only in one country has a comprehensive effort been made to make either recommendations or note safe and adequate ranges of intakes for all the 13 vitamins and that is the United States, which has made recommendations for the 50 and over age group (Table 1).

Observed nutrient and food intakes, and centile distributions

It is worth considering the kinds of data we have on nutrient and, in particular, vitamin intakes for community based elderly folk, because these will, ultimately, provide the reference against which we judge at risk populations. In Melbourne several years ago we set out to find in what ways the nutritional status of institutionalised elderly was different from community based elderly, using representative samples in a provincial city in Victoria, namely Geelong(6,26)(Table 2 A & B).

TABLE 1. RDIs* or estimated daily safe and adequate intakes†† for vitamins (mass per day for elderly people).

		Australia†		Sweden§		UK¶		UK¶		US††	
		65+ years	55+ years	50+ years		65-74 years	55-74 years	75+ years		51+ years	
		M	F	M	F	M	F	M	F	M	F
Retinol equivalents	(μg)*	750	750	1000	800	750	750	750	750	1000	800
Vitamin D	(μg)*	-	-	5.0	5.0	-	-	-	-	5.0	5.0
Vitamin E	(mg)*	-	-	-	-	-	-	-	-	10.0	8.0
Vitamin K	(μg)††	-	-	-	-	-	-	-	-	70-140	
70-140											
Thiamin	(mg)*	0.9	0.7	1.2	1.0	1.0	0.8	0.9	0.7	1.2	1.0
Riboflavin	(mg)*	1.3	1.0	1.4	1.2	1.6	1.3	1.6	1.3	1.4	1.2
Niacin equivalents	(mg)*	14-17	10-12	16	13	18	15	18	15	16	13
Vitamin B_{12}	(mg)*	1.0-1.5	0.8-1.1	2.2	2.0	-	-	-	-	2.2	2.0
Vitamin B	(μg)*	2.0	2.0	-	-	-	-	-	-	3.0	3.0
Folacin (total)	(μg)*	200	200	-	-	300	300	300	300	400	400
Pantothenic acid	(mg)††	-	-	-	-	-	-	-	-	4-7	4-7
Biotin	(μg)††	-	-	-	-	-	-	-	-	100-200	100-200
Vitamin C	(mg)*	30	30	60	60	30	30	30	30	60	60

*RDI means Recommended Daily Dietary Intake. The wording differs between countries; for example 'allowance' may be used instead of 'intake'.

† National Health and Medical Research Council of Australia, 1984
§ Swedish National Food Administration 1982
¶ Department of Health and Social Security, UK 1968 and 1979
†† Committee on Dietary Allowance, Food and Nutrition Board, USA 1980

TABLE 2A Vitamin intakes of representative community-based elderly in selected countries (Mean ± S.D. are shown).

		A* (Geelong, 1979) 70+		I* (Perugia, 1984) 65-69.9		70+		S* (Dalby 1969) 67		(Gothenburg 1971-1972) 70		UK* (Department of Health and Social Security, (1972-73) Under 80		80 and over		US* 65-75 years	
		M (10)	F (17)	M (41)	F (54)	M (60)	F (52)	M (16)	F (19)	M (191)	F (199)	M (111)	F (125)	M (58)	F (71)	Whites (2762)	Blacks (577)
Retinol equivalents	(µg)	1024 ±3488	1693 ±1737	679 ±704	857 ±899	675 ±755	656 ±733			1505 ±802	1357 ±684	1120 ±728	1050 ±1161	1050 ±689	980 ±776	1098 ±2979	1107 ±2832
Vitamin D	(µg)	1.3 ±0.8	1.6 ±0.9														
Vitamin E	(mg)	4.2 ±1.1	3.9 ±0.9														
Vitamin K	(µg)																
Thiamin	(mg)	1.1 ±0.4	1.2 ±0.3	0.93 ±0.28	0.76 ±0.25	0.88 ±0.36	0.71 ±0.20			1.4 ±0.35	1.2 ±0.43	1.0 ±0.27	0.8 ±0.27	0.9 ±0.26	0.7 ±0.20	1.01 ±0.05	0.97 ±1.2
Riboflavin	(mg)	2.0 ±0.7	2.0 ±0.7	0.95 ±0.30	0.94 ±0.34	0.96 ±0.40	0.88 ±0.31			1.8 ±0.61	1.6 ±0.54	1.5 ±0.62	1.3 ±0.53	1.4 ±0.47	1.1 ±0.40	0.55 ±0.1	0.86 ±0.4
Niacin equivalents	(mg)	17.2 ±6.7	17.1 ±6.0	28 ±8	24 ±7	27 ±9	22 ±6					14.4 ±5.97	10.3 ±3.45	12.3 ±4.02	9.7 ±2.86		
Vitamin B_6	(mg)	1.2	1.1									1.3 ±0.41	0.9 ±0.26	1.2 ±0.37	0.9 ±0.29		
Vitamin B_{12}	(µg)							5.3 ±4.5	4.5 ±3.7								
Folacin	(µg)	204 ±53.7	215 ±41.2					175 ±87	145 ±94								
Panthothenic Acid	(mg)	4.8 ±1.1	4.1 ±1.1														
Biotin	(µg)	26.5 ±10.4	22.9 ±9.6														
Vitamin C	(mg)	84.6	89.8	55	56	62	58			82 ±41.7	87 ±53.7	46 ±28.2	40 ±29.3	38 ±31.1	37 ±25.1		

*See references 6, 23, 24, 26.

A=Australia Refs 6,26
I=Italy (Fidanza, F. et al, Int. J. Vit. Nutr. Res 1984; 54:75-79
S=Sweden Refs 23,24
UK= United Kingdom Ref. Department of Health and Social Security, 1979; Reports on Health & Social Subjects No. 15 and 16, H.M. Stationery Office, London
US=United States Ref. Kerr, G.L. et al. Amer. J. Clin. Nutr. 1982; 35:294-308; National Center for Health Statistics, Department of Health, Education and Welfare, 1974; Publ. No. (HRA) 74-1219-1

Table 2B.

Vitamin intakes of institutionalized elderly, Geelong, Australia, 1979 (Mean±S.D.)

		M (n=17)	F (n=70)
Retinol equivalents	(μg)	874.2±212.2	905.6±303.3
Vitamin D	(μg)	1.7±1.0	2.0±1.2
Vitamin E	(mg)	3.4±1.2	3.2±1.1
Vitamin K	(μg)	-	-
Thiamin	(mg)	0.72±0.18	1.02±0.8
Riboflavin	(mg)	1.04±0.42	1.16±0.43
Niacin equivalents	(mg)	9.2±3.3	9.1±3.9
Vitamin B_6	(mg)	0.87±0.28	0.78±0.24
Vitamin B_{12}	(μg)	-	-
Folacin	(μg)	147±49**	123±33***
Pantothenic acid	(mg)	3.1±1.2	3.1±0.8
Biotin	(μg)	21.6±15.9	21.6±7.9
Vitamin C	(mg)	54*±8	41***±3

Significance of difference from community elderly (see Table 2A, Australia) shown by

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$
(26)

For folacin and vitamin C we found that the institutionalised elderly frequently had lower intakes than community based elderly. This may be reflected in biochemical measurements of nutritional status, but this of course does not necessarily mean functional problems. Within institutions we found a differential and that one of the most helpful ways of seeing that differential was to grade individuals in accordance with functional status, using American Rheumatism Association (ARA) criteria. In general with declining functional status, intakes of a number of nutrients, of which dietary fibre is an example, were less good (6,16) (Figure 1) until the point was reached where more intensive care and nursing was required.

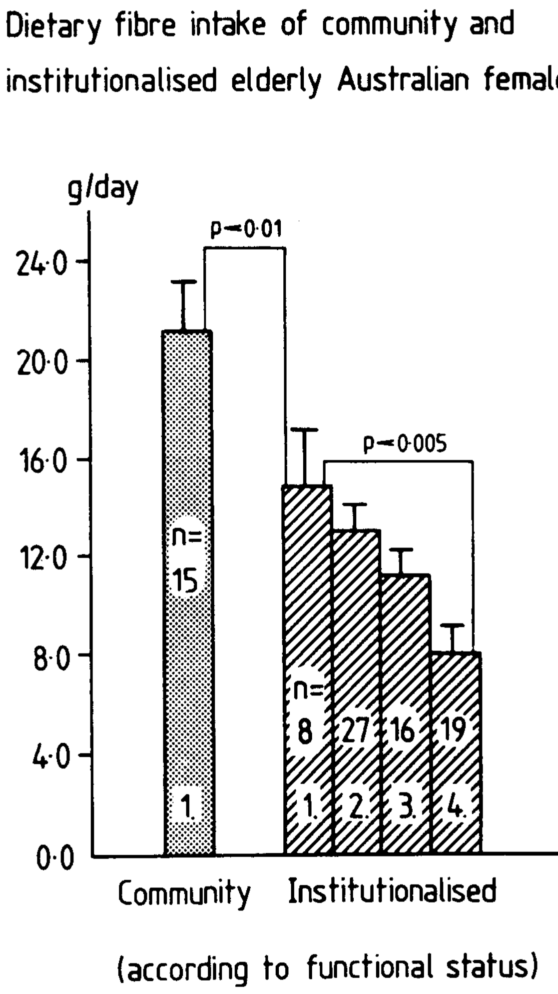


Figure 1

Then the status, as judged by intake, improved again for several nutrients (16) (Table 3).

Table 3.
Nutrient intake of independent and dependent nursing home patients (mean).

Nutrients	Intake	
	Independent (n=20)	Dependent (n=18)
Engergy (kJ)	4926	6406*
BMR (kJ/kg BW)	95	125*
Protein (g/kg BW)	0.9	1.0
Fat (g)	52.1	51.4
Absorbable carbohydrate (g)	136.3	230.0***
Simple sugars (g)	53.2	91.4**
Thiamin (mg)	0.65	2.16***
Riboflavin (mg)	1.37	1.14
Niacin (mg niacin equiv.)	17.7	6.7*
Vitamin B_2 (mg)	0.65	1.99***
Vitamin B_{12} (µg)	2.6	2.0
Total folacin (µg)	82.5	116.4*
Pantothenic acid (mg)	2.99	2.18*
Biotin (µg)	21.6	16.7*
Vitamin C (mg)	24.7	27.1
Vitamin A (µg retinol equivalent)	815.2	545.0*
Vitamin D (µg)	2.7	2.0
Vitamin E (mg)	2.75	2.27
Iron (mg)	6.3	7.3
Calcium (mg)	619	566
Zinc	7.1	11.1**
Dietary fibre (g)	7.9	15.3**

Significance of difference between groups is indicated by * $p<0.05$, ** $p<0.01$, *** $p<0.001$

(16)

This illustrates the complexity of assessing nutrient intakes and their biological relevence in the elderly, and the particular need to take account of the circumstances of eating and functional status.

In 1983, in Australia, the first effort was made since the 1940s to look, in a representative fashion, at food and nutrient intakes in the Australian adult population (2 & 3). This has now also been done and just published for children and adolescents. The studies are representative for Australian capital cities and they were stimulated by the National Heart Foundation which wanted to look at food intake in relation to coronary risk: so these observations have been made at the time of the assessment of coronary risk factor profiles. Regrettably, in 1983, the great importance of looking at those older than 65 was not appreciated, but what we do have are data that allow us to look, cross-sectionally, at food and nutrient intakes up until that age (Table 4 and 5).

Table 4.
Major food groups eaten by a representative sample of adult Australian men in capital cities during 1983.

(grams per day)

	25-34 years	35-44 years	45-54 years	55-64 years
Men				
Cereal and cereal products	297	277	266	245
Vegetables	303	304	290	290
Fruits	160	174	186	185
Meat and meat products	274	244	229	215
Fish, seafood and products	18	23	23	20
Eggs	23	21	20	22
Nuts and seeds	8	8	6	4
Milk and milk products (a)	539	429	426	372
Fats	24	23	22	22
Sugar, jams, honey and syrups	29	28	27	27
Confectionery	9	7	6	5
Snack foods	3	1	1	0
Beverages (b) - non-alcoholic	1166	1148	1146	1077
- alcoholic	422	477	485	460

Table 5.

Major food groups eaten by a representative sample of adult Australian men in capital cities during 1983.
(grams per day)

	25-34 years	35-44 years	45-54 years	55-64 years
Women				
Cereal and cereal products	212	174	190	174
Vegetables	235	237	236	253
Fruits	183	151	193	209
Meat and meat products	150	138	125	129
Fish, seafood and products	17	18	19	14
Eggs	17	17	15	15
Nuts and seeds	6	5	4	3
Milk and milk products (a)	411	410	390	380
Fats	15	15	15	15
Sugar, jams honey and syru	17	19	18	16
Confectionery	9	7	7	6
Snack foods	1	2	1	0
Beverages (b) - non-alcoholic	1084	1131	1101	1080
- alcoholic	94	120	101	86

In the next survey, planned for 1989, all age groups will be examined. Within these limitations, in the Australian National Dietary Survey of 1983, for many foods there is a progressive decline in intake with advancing years. In relation to the case study of riboflavin, the important dairy and cereal food sources decline. Fruit is one of the only food categories, for men and women, whose consumption increases. Fresh consumption changes little. Alcoholic beverage intakes up until this age (Dr Frank Ibers elsewhere in this book refers to older age groups) are maintained for Australian men, so that as a fraction of energy, intake alcohol is greater up until the age of 64. Australian women, have a similar profile, at lower alcohol consumption.

It is also possible, with these population based data to speak about the contribution that particular foods or food categories make to the intake of a vitamin. This is important, not only from a public health point of view, but also to allow those in clinical practice to make rapid assessments of where problems might be. It is not surprising to find in a population, like the Australian, with such a strong Anglo-celtic food cultural orientation that milk and milk products are the main sources of riboflavin (Table 6).

Table 6
Contribution of food sources to riboflavin intake amongst Australian adults

	All persons (per cent)
Milk & milk products	30.0
Meat & meat products	23.9
Cereal & cereal products	17.0
Vegetables	7.0
Condiments, flavourings, soups	6.2
Eggs	4.2
Beverages, alcoholic	3.3
Beverages, non-alcoholic	3.2
Fruits	3.0
All other food items	2.2

National dietary survey of Australian adults : 1983.

Riboflavin intakes decline with age (Table 7).

Table 7
Riboflavin intake (mg per day) in adult Australians

	Mean
Men	
25-34 years	2.47
35-44 years	2.28
45-54 years	2.13
55-64 years	2.07
Women	
25-34 years	1.97
35-44 years	1.62
45-54 years	1.72
55-64 years	1.67

National dietary survey of Australian adults : 1983

But this does not apply throughout the Australian community (Table 8).

Table 8
Mean riboflavin intake (mg per day) amongst Australian adults by region of birth

	Men	Women
Australasia	2.45	1.79
United Kingdom	2.26	2.07
Northern Europe	2.09	1.51
Southern Europe	1.61	1.63
Asia	1.82	1.38
Other regions	1.68	1.46

National dietary survey of Australian adults : 1983.

Those born in Southern Europe and Asia have lower riboflavin intakes as they do milk and dairy products.

The Victorian Nutrition Survey, a state survey, conducted by the Food and Nutrition Policy Project in conjunction with the Commonwealth Scientific and Industrial Research Organization's Division of Human Nutrition, is allowing us to develop more detailed information than the National Australian survey: it is a representative sample drawn from 5,000 individuals (18 years and over) of the Victorian population which is about 4 million (1). An example of the insights it provides is in relation to milk as a source of riboflavin (Table 9A).

Table 9A
Milk-Whole
g per day

	18-29 years	30-39 years	40-49 years	50-59 years	60 years and over
Male	492	373	372	306	306
Female	311	344	328	314	278

For women there is a progressive decline with age, after 30 years, in whole milk intake but reduced fat milk intake increases with advancing years, so that women maintain their overall milk intake fairly well by a switch from one kind to another. Since these are cross sectional data rather than prospective data this could be a cohort effect, but it does raise the possibility that elderly women have more insight and interest in recommendations about diet, like those to reduce fat. On the contrary, men, whether for whole milk or for reduced fat milk undergo an overall age-related decline in its intake. This is an interesting gender difference in food intake behaviour with advancing years. We need this background when considering vitamin intakes in elderly people.

One of the great values of population based studies is that they allow us to consider the centile distributions of not only nutrient intakes, but also food intakes. This is a major step forward in our thinking and equates with the approach taken for growth and development in children. We do not, then, need a recommended dietary intake, but can position individuals we wish to assess in relation to the centile distributions in a reference population. My own view is that this is the way to go in assessing the elderly and their vitamin intakes. As an example, in Table 9B, for 55-64 year old Australian men, we can examine riboflavin intakes and their centile distribution.

Table 9B
Riboflavin intake (mg per day) 55-64 years (men)

	Percentiles				
Mean	5th	10th	50th	90th	95th
2.07	0.87	1.03	1.89	3.11	3.66

National dietary survey of adults in Australia : 1983

This can be done region by region. In the Victorian Nutrition Survey, the population was stratified in various ways (such as urban, provincial and rural) so that in a particular subgroup, these centile distributions could apply (1). Thus, in health care delivery, say in a major provincial city in Victoria, one could look at how one's patients perform in relation to a distribution.

Nutrient Density and RNDs

A crucial consideration for vitamin status is the decline in energy intake with advancing years. In the Australian National Dietary Survey, for men, energy intake dropped from 12,000 kilojoules per day in younger age groups to 9,700 in older age groups and, for women, from 8,000 to 6,800 kilojoules per day (Table 10).

Table 10
Mean energy intakes (KJ per day) for Australian adults

Men	
25.34 years	12010
35-44 years	11200
45-54 years	10350
55-64 years	9680
Women	
25-34 years	8040
35-44 years	7290
45-54 years	7120
55-64 years	6770

National dietary survey of Australian adults : 1983

Energy RDIs also decline (Table 11), but it is arguable how far this decline should go. Where the energy comes from in each age group is itself bound to be important. If we are to put together information about nutrient intakes and energy intakes we can do so in terms of nutrient densities, which is an expression of the mass of nutrient intake in relation to the energy intake. Estimated nutrient density (END) then is the estimated nutrient intake divided by the estimated energy intake. A recommended nutrient density (RND) would be the recommended nutrient intake divided by the recommended energy intake. However this has all the limitations pertaining to RDIs and perhaps percentile distributions of estimated nutrient densities and position in relation to those distributions is to be preferred. In any case, in the Australian Food Survey of 1983 a nutrient density score (NDS) has been devised, which is the END divided by the RND, and this allows us to see whether or not the food intake is providing its fair share of a particular

Table 11.

RDIs for energy according to age.

	Australia			Sweden			United Kingdom			United States		
	Age	Body mass kg	Energy kJ	Age	Body mass kg	Energy kJ	Age	Body mass kg	Energy kJ	Age	Body mass kg	Energy kJ
Young adult	18–35	M 70 F 58	11600 8400	19–22	M F	12000 9000	18–34	M 65 F 55	10500 9000	19–22	M 70 F 55	12200 8800
Middle years	35–50	M 70 F 58	10400 7600	23–50 Light Activity	M F	11500 8500	35–64 Sedentary 35–54	M 65 M 55	10000 9000	23–50	M 70 F 55	11300 84000
Older	55–75	M 70 F 58	8800 6400	51–70 Light Activity	M F	10000 8000	65–74 Sedentary 55–75 Sedentary	M 63 F 53	100000 8000	51–75	M 70 F 55	10100 76000
				71+ Sedentary	M F	9000 7000	75+ Sedentary	M 63 F 63	9000 7000	76+	M 70 F 55	8600 6700

nutrient in relation to recommendations. Although it may be reassuring if recommended nutrient density progressively increases as energy intake and expenditure decrease, it still may be desirable to maintain energy intake and expenditure (see pp192-194). As an illustration, Australian men in the older age group have nutrient density scores for riboflavin less good than do younger age groups (almost inevitably undesirable), but women maintain theirs (apparently acceptable, but at a lower plane of energy balance)(Table 12).

Table 12
Distribution of nutrient density scores for riboflavin (per cent) in Australian adults

	Nutrient density score >1
Men	
25-34 years	79-2
25-44 years	63.6
45-54 years	70.4
55-64 years	55.2
Women	
25-34 years	82.3
35-44 years	71.7
45-54 years	75.4
55-64 years	82.5

National dietary survey of Australian adults : 1983

Food Cultural Diversity and Vitamin Status with Age

In some countries there is great cultural diversity. For Australia, women born in Asia have the greatest potential problem with riboflavin intake (see Table 8), confirmed by an examination of nutrient density scores (Table 13). Even so the overall food intake pattern in that culture must be considered in relation to health, as there may be other factors which enhance or reduce this perceived risk relative to non-Asian Australians.

Table 13

Distribution of Nutrient Density Scores

for riboflavin (per cent) amongst Australian adults

Region of birth	Nutrient density score	Nutrient density score
	Men	Women
Australasia	73.9	80.6
United Kingdom	70.5	83.4
Northern Europe	66.3	77.3
Southern Europe	48.2	66.5
Asia	50.4	59.8
Other regions	47.9	58.5

National dietary survey of Australian adults : 1983

Vitamins of particular note in later life

There are vitamins of particular interest in later life, and some important fields for vitamin research. As far as fat soluble vitamins are concerned, provitamin A needs evaluation in its own right. Individual carotenes and carotenoids are likely to have unique functions, independent of vitamin A precursor status. The effects of lycopene, the major carotene in tomatoes has negligible provitamin A activity, but deals with singlet oxygen and therefore risk of tissue damage.

Because of sunlight in Australia, we think vitamin D is not much of a problem, but elderly people in institutions need assessment of sunlight exposure as well as vitamin D intake. Vitamin E status as tocopherols has generally been presumed satisfactory, but a new literature is emerging on tocotrienols as inhibitors of HMG CoA reductase which may remain relevant for the elderly. Again, with vitamin K, the recognition of a range of vitamin K dependent proteins, including at least 2 in bone, raises the need to examine vitamin K status in its own right in the elderly, rather than indirectly and exclusively through coagulation factors.

Shortly we will be asking, when is a nutrient a nutrient or when is a vitamin a vitamin? My view is that there will be a blurring of the nutrient/non-nutrient distinction and that we will be more interested in food components at large with biological properties. The term "nutrient" may ultimately fall into disuse.

Energy intakes and expenditure and vitamin status

It has been argued that energy restriction is a likely advantage in terms of aging but this is by no means certain. We may not be able to extrapolate from rodents in cages to free-living homo sapiens. The evidence is in favour of a greater energy intake than that prevailing in sedentary homo sapiens, leading to greater life expectancy and not the reverse, whatever the rodent studies appear to show (13,14,15). One of the most important prospective studies to demonstrate this is that of Kromhout and colleagues from Zutphen in the Netherlands(13). In this 10 year prospective study, those who died prematurely had about 300 calories intake a day less than those who survived. Expressed in energy intake per kilogram body weight, the same phenomenon was found. Presumptively, on that basis, one should eat more, with maintenance of body weight, presumably by being more physically active. And what foods were these people eating more? A range of plant foods for which dietary fibre is a marker and, from other studies from Zutphen, more fish. Dietary fibre intake may, like vitamin intake, be a marker for a desirable food intake pattern. In real life one usually obtains vitamins from food and not in isolation from food. A vitamin in food interacts with other nutrients and its bioavailability is a characteristic of the food from which it comes. To decrease food intake is to decrease these entire phenomena. Thus a decrease in food energy intake with advancing years is a dubious proposition; at the very least it creates the need to increase nutrient density.

As far as the major burden of excess mortality in later life is concerned, we know little of the relationships with vitamin intake. For a cohort of Swedish women studied prospectively, with increasing intakes of energy intake, expressed in quintiles, there was an impressive decline in the incidence of coronary disease over a 12 year period (15). There are now several studies which show this relationship of energy intake to coronary rates.

The corollary is that increased levels of energy expenditure are required in relation to increased energy intakes. From the Harvard Alumni Study (20) we see that, up to the age group of 70-84 with an increase in level of physical activity by calorie expenditure per week from about 500 to 2000, there is a progressive decline in death rate. The kinds of activities in this study are shown in Table 14.

Table 14.

Age-adjusted rates and relative risks of death (from all causes) among 16,936 Harvard Alumni, 1962 to 1978, according to measures of physical activity.

Physical Activity (Weekly)	Relative Risk of Death	P of Trend
Miles Walked ≥ 9	0.79	0.0009
Stairs climbed ≥ 1050	0.92	0.0646
Light sports played (hr)* ≥ 3	0.70	<0.0001
Vigorous sports played (hr)+ ≥ 3	0.74	<0.0001
Physically activity index (kcal)++ ≥3500	0.62	<0.0001

* Excludes subjects who played vigorous sports
\+ With or without light sports play
++ Summation of above measures equated to kilocalories (20)

A Finnish study of Pekkanen et al (21) compared those with high physical activity against those with low physical activity in a twenty years prospective study. More survived who belonged to the high physical activity category. These data fit with the energy intake studies.

Exercise has other benefits in later life. A recent study from Australia shows that a three month, very modest exercise program in elderly people improved measures of mood state, the so called POMS profile (Table 15)(22).

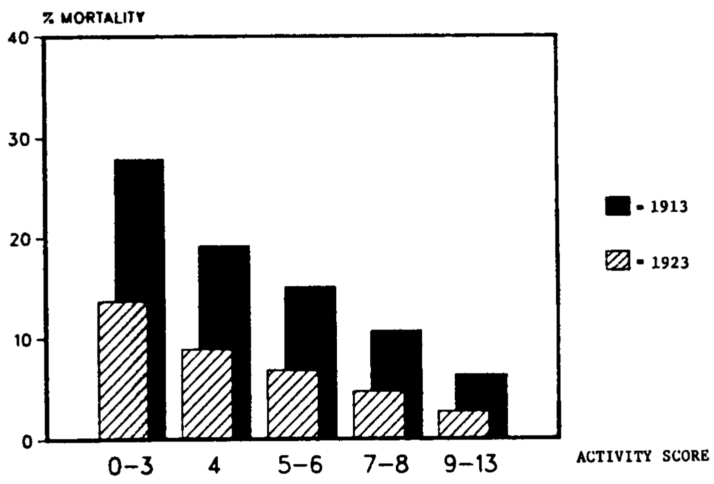
Table 15.
Psychological factors by POMS scale before and after the three-month exercise programme

FACTOR	PREPROGRAMME	POSTPROGRAMME	SIGNIFICANCE
Tension	10.7	5.2	0.001
Depression	6.8	4.1	0.020
Anger	5.1	4.4	ns
Vigour	16.0	21.2	0.005
Fatigue	8.6	4.2	0.005
Confusion	8.7	6.0	0.010

POMS: Profile of mood states.
ns: Not significant

Social Activity and Vitamin Status

Not only food intake, but social activity may be important in relation to vitamin intake. This may seem a little strange at first. But Wilhelmsen's group in western Sweden has followed two cohorts of men born in 1913 and 1923 in accordance with social activity and shown that mortality rate decreases as social activity increases (Figure 2)(28).



Nothing was said about food intake, but Caroline Horwath in Adelaide, Australia, studied a representative sample of some 2000 elderly individuals, and found that more social activity was associated with more dietary variety (Table 16)(10).

Table 16.
Statistically significant correlations between lifestyle and dietary variables in a representative sample of elderly Adelaide men.

	TOTAL NO. OF ACTIVITIES	NO. OF SOCIAL PURSUITS	NO. OF ACTIVE PURSUITS
Total dietary variety	0.43****	0.41****	0.22****

(**** p<0.0001)

Even though dietary variety is a consistent and primary recommendation or dietary guideline in most countries, apart from improvement in nutritional quality of the diet, expressed in essential nutrients, there are few data to validate the recommendation. We have recently shown that food variety is associated with less non-invasive evidence of macrovascular disease(27). Horwath has shown that, as dietary variety increases, so the self assessment of health also increases from poor to very good, (Table 17)(10).

Table 17.
The association between self-assessment of health and dietary scores in a representative sample of elderly Adelaide residents.

	SELF-ASSESSMENT OF HEALTH				
	Very good (n=453)	Good (n=897)	Fair (n=668)	Poor (n=149)	SIGNIFICANCE (F)
DIETARY VARIETY SCORE	50	50	48	46	7.73****

(**** p<0.0001)

Elderly at Risk

Where we might encounter vitamin problems in the elderly is where there are two or more risk situations (Table 18).

Table 18.
ELDERLY AT RISK OF VITAMIN DEFICIENCY

. Physically inactive

. Precarious food supply

. Alcohol excess

. Decreased interest in food

- Taste and smell
- Loneliness
- Depression

. Disease which alters nutrient status

. Medication which interacts with nutrients or decreases appetite.

Horwath looked in a formal way at risk factors for indices of poor dietary intake in elderly subjects (10). What was important was living alone for men; poor health for a variety of reasons; low participation in physical and social activities; shopping difficulties; poor appetite; diminished enjoyment of eating; individual life difficulties; reports that some foods are "too acid" (whatever that means); pension as an only source of income; lower education attainment; lower occupational status; feelings of extreme inertia; missed meals and cooked meals eaten on less than 5 days per week. This reminds us that we cannot think about vitamins without thinking about food and without thinking about how people eat.

What has been happening in the coronary heart disease literature will become part of the vitamin and health literature. Whereas the Hegsted and Keys scores tell us about the lipid quality of the diet and lipoprotein status, they predict coronary mortality with a J shaped curve rather than a linear curve (Figure 3a).

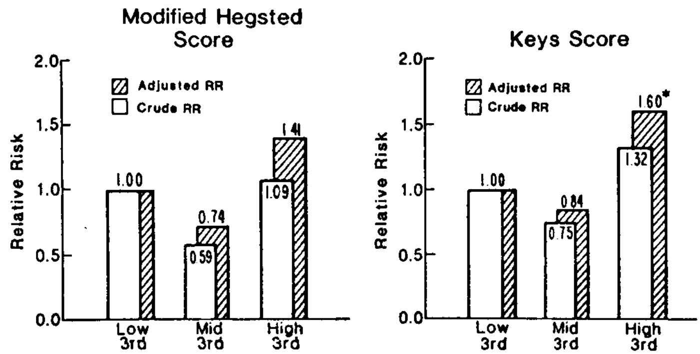


Figure 3a

However, a vegetable score and a fibre plant-food score predict linearly and inversely coronary mortality (Figure 3b).

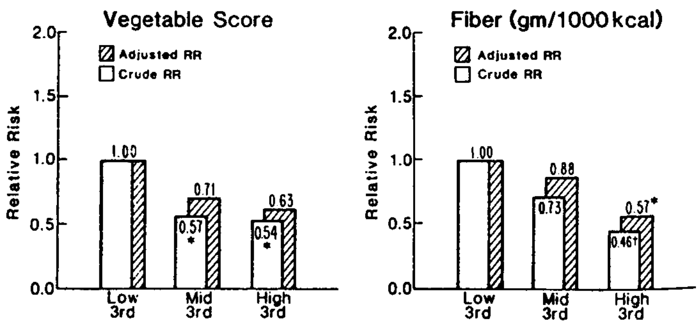


Figure 3b

<u>A Cross-Cultural View</u>

It is important that we are not preoccupied with a mechanistic nutrient point of view, as far as health outcome goes. For this reason the International Union of Nutrition Sciences Committee on "Nutrition and Aging", which I now chair, has embarked on a major cross-cultural study of food habits, rather than nutrient habits in later life. We think this cross-cultural analysis will help us see the role of a particular vitamin in context (12). We have begun working with a recently, and still partly, hunter-gatherer population in the Kimberley ranges in north-western Australia. These are Aboriginal Australians. They are fond of goanna (a reptile). They continue to gather small quantities of foods such as bush bananas, boab nuts (which only grow in the Kimberleys), bush cucumbers, and a native plum which has about 3000 milligrams of vitamin C per 100 grams. They hunt cockatoo, ducks, echidnas (which are a sort of anteater), and flying foxes (a kind of bat). This and much more adds up to a diet of great variety. The variety ensures adequate vitamin intake. It is a matter of "food rather than vitamins".

When we deal with at-risk groups there may be times when we need nutrient supplements as well as food. With formula foods we simply have to make some decisions about what the requirement are, vitamin by vitamin. But in the meantime, and perhaps for a long time to come, what we would prefer would be to see food and social activity going together throughout life. Healthy elderly people, are usually seen enjoying their food in variety and each others company. Physically active as well, elderly people can take care of their vitamin status and optimise their health.

REFERENCES

1. Baghurst K, Worsley A, Crawford D, Baghurst P, Record S and Syrette J. The Victorian Nutrition Survey. Part 1 - Food Intakes by Age, Sex and Area of Residence. Social Nutrition and Epidemiology Programme, CSIRO Division of Human Nutrition, August 1987.

2. Commonwealth Department of Health in Collaboration with the National Heart Foundation. National Dietary Survey of Adults: 1983. No.1 - Foods consumed. Australian Government Publishing Service, Canberra 1986.

3. Commonwealth Department of Health in Collaboration with the National Heart Foundation. National Dietary Survey of Adults: 1983. No.2 - Nutrient Intakes. Australian Government Publishing Service, Canberra 1987.

4 Department of Health and Social Security. Nutrition and health in old age: The cross-sectional analysis of the findings of a survey made in 1972-1973 of elderly people who had been studied in 1967-1968, Reports on Health and Social Subjects, 1979; No.16. H M Stationery Office, London.

5 Department of Health and Social Security. A nutrition survey of the elderly. Report by the Panel on nutrition of the elderly, 1972; Reports on Health and Social Subjects, No.3. H M Stationery Office, London.

6. Flint DM, Wahlqvist ML, Prinsley DM, Parish A, Fazio V, Peters K and Richard B. The nutritional assessment of community and institutionalised elderly in Australia. Food and Nutrition: Notes and Reviews 1979; 36:173-6.

7. Herbert V. Recommended dietary intakes (RDI) of folate in humans. American Journal of Clinical Nutrition 1987; 45:661-670.

8. Herbert V. Recommended dietary intakes (RDI) of vitamin B-12 in humans. American Journal of Clinical Nutrition 1987; 45:671-678.

9. Herbert V. Recommended dietary intakes (RDI) of iron in humans. American Journal of Clinical Nutrition 1987; 45:679-686.

10. Horwarth CC. A Random Population Study of the Dietary Habits of Elderly People. PhD thesis, University of Adelaide, 1987.

11 Kerr GR. et al Relationships between dietary and biochemical measures of nutritional status in H A N E S 1 data. American Journal of Clinical Nutrition 1982; 35: 294-308.

12. Kouris A, Wahlqvist ML, Davies L, Scrimshaw NA. Development of a survey instrument for the assessment of food habits and health in later life. In: Proceedings of the 10th Congress of Dietitics "Dietetics in the 90's" John Libbey Eurotext, London, Paris 1988 Vol 1:235-239.

13. Kromhout D, Bosschieter EB and De Lezenne Coulander C. Dietary fibre and 10-year mortality from coronary heart disease, cancer and all causes. The Zutphen Study. Lancet 1982; ii:518-521.

14. Kushi L, Lew RA, Stare FJ, Ellison CR, Lozy ME, Bourke G, Daly L, Graham I, Hickey N, Mulcahy R and Kevaney J. Diet and 20-year mortality from coronary heart disease. The Ireland-Boston Diet Heart Study. New England Journal of Medicine 1985 (312):811-818.

15. Lapidus L, Andersson H, Bengtsson C and Bosaeus I. Dietary habits in relation to incidence of cardiovascular disease and death in women: a 12 year follow-up of participants in the population study of women in Gotheburg, Sweden. American Journal of Clinical Nutrition 1986; 44:444-448.

16. Nguyen NH, Flint DM, Prinsley DM, Wahlqvist ML. Nutrient intakes of dependent and apparently independent nursing home patients. Human Nutrition: Applied Nutrition (1985) 39A, 333-338.

17. Olson JA. Recommended dietary intakes (RDI) of vitamin K in humans. American Journal of Clinical Nutrition 1987; 45:687-692.

18. Olson JA and Hodges RE. Recommended dietary intakes (RDI) of vitamin C in humans. American Journal of Clinical Nutrition 1987; 45:693-703.

19. Olson JA. Recommended dietary intakes (RDI) of vitamin A in humans. American Journal of Clinical Nutrition 1987; 45:704.

20. Paffenbarger RS, Hyde RT, Wing AL, Msieh CC. Physical activity, all-cause mortality and longevity of college alumni. New England Journal of Medicine 1986; 314:605-613.

21. Pekkanen J, Marti B, Nissinen A, Tuomilehto J. Reduction of premature mortality by high physical activity: A 20-year follow-up of middle-aged Finnish men. Lancet 1987; i:1473-1477.

22. Millar AP. Realistic exercise goals for the elderly: Is feeling good enough? Modern Medicine of Australia August 1988; 30-32.

23. Steen B. Nutrition in 70-year olds: dietary habits and body composition. A report from the population study '70-year-old people in Gothenburg, Sweden'. Thesis, Department of Geriatric and Long-term Care Medicine, and Department of Clinical Nutrition, University of Gothenburg, Sweden 1977.

24. Steen B. et al. Intake of energy and nutrients and meal habits in 70-year-old males and females in Gothenburg, Sweden. A population study. Acta Medica Scandinavia, 1977; Supplement 611:39-86.

25. Truswell AS. et al Recommended dietary intakes around the world. A report by Committee 1/5 of the International Union of Nutritional Sciences. Nutrition Abstracts and Reviews: Reviews of Clinical Nutrition 1983; 53:939-1118.

26. Wahlqvist ML, Flint-Richter DM. Nutritional requirements and recommended dietary allowances for the elderly - vitamins. In: Nutrition in the Elderly. Oxford University Press for WHO, Geneva 1988.

27. Wahlqvist ML, Lo CS and Myers KA. Food variety is protective against Macrovascular Disease in Type II Diabetes. Journal of American College of Nutrition (in press).

28. Welin L, Tibblin G, Svardsudd K, Tibblin B, Ander-Peciva S, Larsson B and Wilhelmsen L. Prospective study of social influences of mortality. The study of men born in 1913 and 1923. Lancet 1985; 1:915-918.

29. Zhu SM. Dietary habits and nutrition handbook for the elderly. Zhejiang Science and Technology Publishing, Hanchou 1985

NUTRITION AND AGING

Proceedings of the 1988 International Conference on Nutrition and Aging held in Galveston, Texas, October 5–7, 1988

Editors

Derek M. Prinsley, M.D., F.R.C.P., F.R.A.C.P.
Professor, Director of Geriatric Medicine
Department of Internal Medicine
The University of Texas Medical Branch
Galveston

Harold H. Sandstead, M.D., F.A.C.P.
Professor and Chairman
Department of Preventive Medicine and Community Health
The University of Texas Medical Branch
Galveston

ALAN R. LISS, INC • NEW YORK

Address all Inquiries to the Publisher
Alan R. Liss, Inc., 41 East 11th Street, New York, NY 10003

Printed in United States of America

The publication of this volume was facilitated by the authors and editors who submitted the text in a form suitable for direct reproduction without subsequent editing or proofreading by the publisher.

Library of Congress Cataloging-in-Publication Data

International Conference on Nutrition and Aging (1988 : Galveston, Tex.)
Nutrition and aging : proceedings of the 1988 International Conference on Nutrition and Aging, held in Galveston, Texas, October 5-7, 1988 / [edited by] Derek M. Prinsley, Harold H. Sandstead.
p. cm. -- (Progress in clinical and biological research ; v. 326)
Includes bibliographical references.
ISBN 0-471-56680-2
1. Aged--Nutrition--Congresses. 2. Malnutrition--Congresses. 3. Aging--Nutritional aspects--Congresses. I. Prinsley, Derek M. II. Sandstead, Harold H., 1932- . III. Title. IV. Series.
[DNLM: 1. Aging--congresses. 2. Nutrition--congresses. W1 PR668E v. 326 / QU 145 I6015n]
QP86.I578 1988
612.6'7--dc20
DNLM/DLC
for Library of Congress 89-12161
CIP

Contents