Nutrition and Ageing

Mark Wahlqvist

Introduction

There are many ways in which nutrition relates to the process of ageing. This afternoon I want to discuss some of the dimensions of this process. We can all think of someone we know who is old but who is also fit and well. In fact, bodily functions do not change uniformly with advancing years.

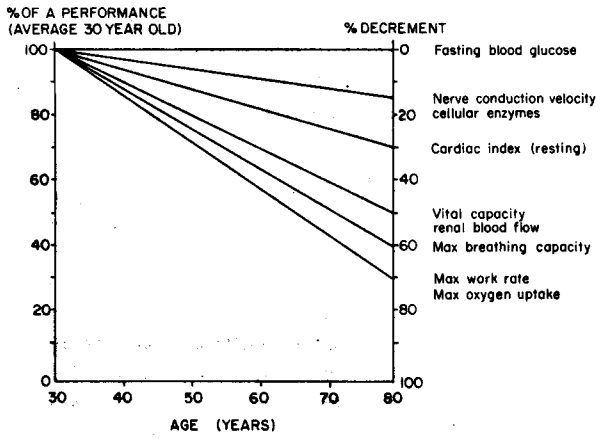

Figure 1

The decline in physiological performance with increasing age. The average performance of 30 year old people has been taken as the standard and is rated as 100%. The graph shows (schematically) the different rates of decline in (a) fasting blood glucose levels, (b) nerve conduction velocity (c) resting cardiac index, (d) vital capacity and renal blood flow (e) maximum breathing capacity and (f) the maximum work rate and the maximum oxygen uptake.
[Based on Fig. 2 p. 13 *Nutrition in Old Age,* (ed.) L.A. Carlson, Swedish Nutrition Foundation.]

In fig. 1 a number of physiological performances are shown as they change with age. Cardiac function is shown as a percentage of performance at age 30, when it is at its peak. You will notice that performance declines with age, but at a different rate to the decline of respiratory function.

Diet and Life Expectancy

These rates of change in different functions do not necessarily have to be as they are shown here. Moreover, different people grow old in different ways, life expectancies differ from one person to another, and are changing with time. There is also a difference between the life expectancy of men and women.

Figure 2 shows that over this century the situation has improved for women, probably because of fewer fatalities during childbearing years than there used to be. Now we are in the situation where women can expect to live longer than

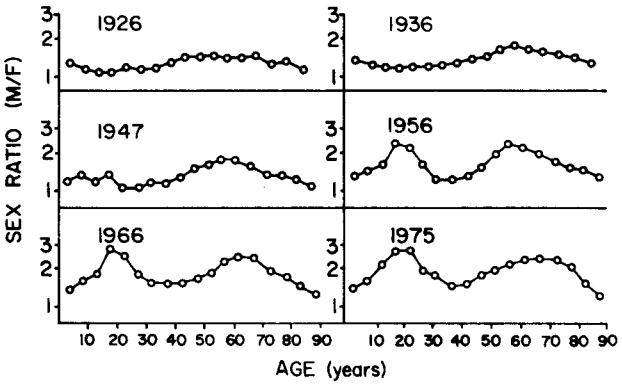

Figure 2

These graphs show the changes from 1926 to 1975 in the ratio of male to female mortality rates at specific ages. The figures are for England and Wales.
[Based on Fig. 2.2, p. 31, *Recent Advances in Medicine,* No. 18, (eds.) A.M. Dawson, N. Compston, G.M. Besser, Edinburgh: Churchill Livingston, 1981.]

men in almost all countries of the world, although there are some exceptions – Papua New Guinea, for example.

Even between developed countries there is a good deal of difference in life expectancy. This is of particular interest to nutritionists since in these countries there remain considerable differences in what people eat. At the top of the list of

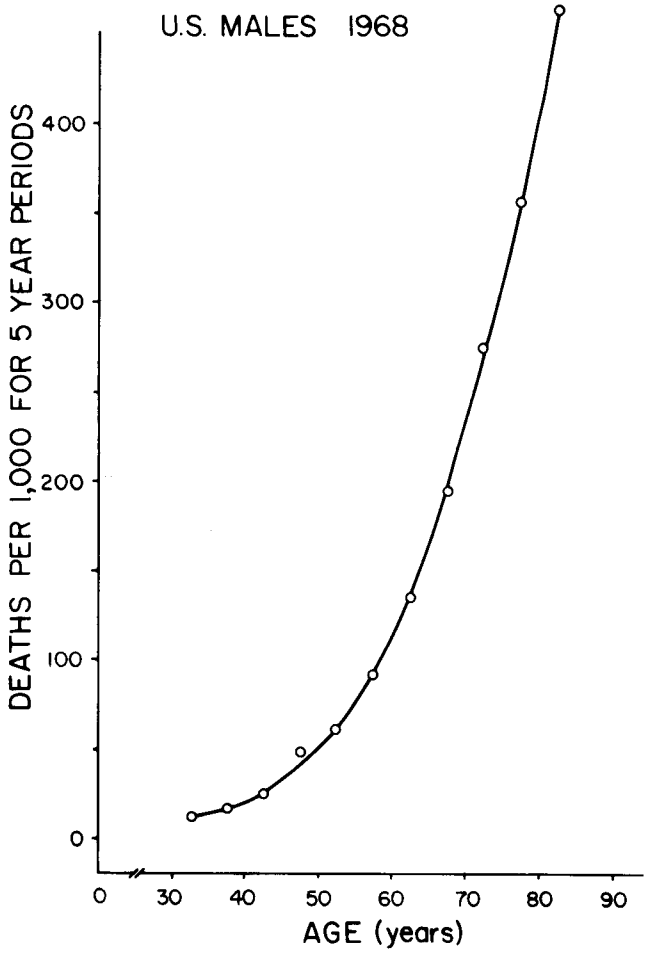

Figure 3

The number of deaths per 1,000 males at 5 year age intervals.
[From the U.S. Dept. of Health, Education and Welfare, 1971.]

countries in which people have the longest life expectancy are Sweden, Greece, The Netherlands and Japan, all of them well ahead of Australia. If you live in Sweden or Greece you can expect to live four or five years longer than if you live in Australia. This is of interest because of the different diets of people in these countries. In Sweden a considerable amount of fish is eaten, in Greece there is more emphasis on plant food than on animal foods high in saturated fats. In Japan, the diet is largely made up of plant and seafood. Although diets in these countries differ from each other, they have something in common: an emphasis on plant and seafood, and in all these countries the life expectancy is greater than in Australia, where at the turn of this century, we had the world's highest per capita consumption of meat. (We now rank about fourth or fifth, about the same as the United States.)

The improvement in life expectancy this century is not evenly distributed across all ages. Most improvement has been in the earlier years, especially due to the reduction in infant mortality. But premature mortality still persists in the middle years of life. In this graph of deaths for males in the United States (Fig. 3), the sharp increase begins in the forties and fifties. The same phenomenon occurs in this country, and we have a lot to gain if we can understand what can be corrected and prevented at this time of life.

The ageing process versus age-related disease?

I want now to reflect on the term 'ageing' for a moment. It is important to distinguish those aspects of growing old which might be regarded as part of the ageing process from those phenomena which might be regarded as age-related disease. An example is atherosclerotic vascular disease. 'Atherosclerosis' means hardening of the arteries, and 'vascular' means blood vessels. This is the major cause of premature death in affluent western societies. It can cause coronary disease, affecting the cerebrovascular system leading to strokes, and peripheral vascular disease where it affects the blood vessels supplying the legs. This is obviously a process which is age-related – the older we are the more likely we are to sustain the outcomes of atherosclerotic disease – but it is clearly not part of the ageing process since there are many populations, and within our own population many people, who can survive to old age with little or no evidence of this particlar process. So it is not a *sine qua non* of growing old.

Nutrition and the ageing process

An interesting question is whether energy balance has something to do with the ageing process. You may be aware of studies where rodents have been kept in a state of slight undernutrition and life expectancy appears to have increased. Extrapolations have been made to man suggesting that we may be advantaged by being modestly undernourished. In fact there is very little evidence for this in human studies. There is a good deal of evidence, however, that energy derived from fat can adversely affect life expectancy. How much of that is through age-related diseases like atherosclerotic vascular disease and neoplastic disease and how much is through an effect on the ageing process is not clear.

We do have data, for example from prospective studies by Morris on London men over 16 years, that energy intake is indeed a predictor of life expectancy. But Morris found that, the higher the energy intake, the greater the life expectancy; in particular, the less the risk of dying prematurely from coronary disease. Morris has taken this to indicate that the greater the *expenditure* of energy (and therefore the greater the level of physical activity), the better the chances are of prolonging one's life. It is difficult to measure physical activity, and Morris sees this as an indirect way of getting a measure. I think that, as far as we know, the relationship between body weight and height is important, but thinking about energy intake and expenditure in isolation is not good enough.

Vitamins and the ageing process

There are certain other areas of nutrition which have been suggested to have a relationship with ageing process. It has been claimed, for example, that if we increased our intake of antioxidants such as vitamin C or vitamin E or if we increased the concentration of enzymes such as peroxidases, we might reduce tissue damage and so retard the ageing process. These are attractive ideas but they have been inadequately tested and there is no evidence in man that any of these play a role in the ageing process. Indeed, even for vitamin C, what evidence there is, suggests that life expectancy in rodents given large doses of vitamin C is reduced, rather than increased. It is not as simple as it might appear and I do not have time to go into details but we must be very wary of taking a particular vitamin, using it in a pharmacological way without too much thought, and being falsely reassured that it is safe because it is found in our food. Any of these compounds can assume pharmacological and toxicological properties at larger doses.

AGEING PROCESS AND NUTRITION

1. Energy Balance
   a) Intake
   b) Expenditure

2. Body Weight
   a) Overnutrition (adiposity)
   b) Undernutrition
   c) Malnutrition

3. Antioxidants and Perioxidases
   a) Vitamin C
   b) Vitamin E
   c) Selenium

4. Repair & Regeneration
   a) Zinc
   b) Protein

Repair and regeneration of tissues may also be influenced by the kind of nutrients we take in. Macfarlane Burnet has suggested in *The Lancet* that zinc nutrition may have a relationship with the ageing process. Certainly there are many zinc metallo-enzymes in the body and they are

involved in fundamental processes. But again we must be wary about getting our zinc from non-food sources because it is possible, through nutrient interactions, to compromise the state of other nutrients by increasing disproportionately the intake of zinc. In Prince Henry's Hospital in Melbourne in the last few months we have had a patient diagnosed with a copper deficiency, resulting from zinc overnutrition, causing a very profound depression of bone marrow.

Body weight and height

Now what about weight for height relationships? So that we can relate the weight of a person of one height to that of a person of another height, we express weight as a ratio of height^2 – the so-called 'body mass index'. This becomes an index of adiposity – the extent to which there is an excess of fat tissue. If we relate this index to mortality rates, we find that as body mass increases, so our risk of dying also increases. Conversely, it is also true that as the body mass index drops, the mortality ratio increases. This is the case in some developing countries where undernutrition and malnutrition are the order of the day.

It is important to remember that we do have these kinds of relationships between body mass and mortality. Admittedly, the relationships are derived from life assurance data and are not necessarily applicable to the entire population. But I think they point to the kind of body mass index that is related to optimal life expectancy. This gives us reason for added caution before we start to recommend that people live in an undernourished way in order to improve their life expectancy. I think a lot of what is said about undernutrition is really a condemnation of excess fat in the diet, rather than of eating too much across the board. And certainly one has to take into account another item in the equation and that is physical activity. Even in regard to body mass index, the extent to which one is physically active is important. The indices apply only to people of average physical activity. An elite athlete (for example, Australian Rules football players have been studied) can have a high body mass index, but many of them come into the undernourished category when their adiposity is determined by such means as underwater weighing (which gives an index of body density). This is because they are more muscular and have less adipose tissue.

Another important consideration in interpreting height/weight data and life expectancy from insurance tables is that there is a group of people who are underweight probably – or certainly – because they are cigarette smokers. As a group, cigarette smokers weigh less for a given height than do non smokers. In this case it might be safer to be heavier and not to be a smoker.

Nutritionally related disease

Now I would like to consider nutritionally related diseases which occur more commonly as we get older, but which do not need to accompany ageing. These are diseases which are important in Australia and other developed countries. The first of these, which I have mentioned already, is atherosclerotic vascular disease – hardening of the arteries – leading to premature heart attacks, strokes and what is called 'intermittent claudication' – difficulty in walking because of reduced blood flow to the legs, ultimately leading to gangrene. This is a leading cause of premature death in Australia.

There are a number of ways in which nutrition relates to the propensity to develop atherosclerotic disease. One is through the blood fats: blood cholesterol and triglyceride levels and levels of HDL – high density lipo protein which seems to be protective against atherosclerotic vascular disease. There is no question at all that you can change your blood cholesterol level by changing your diet. There is also no question that reducing the levels of blood cholesterol reduces the risk of atherosclerotic vascular disease. Blood cholesterol is a consistent predictor of atherosclerotic vascular disease.

Diet, blood cholesterol and coronary disease are links in a chain. But diet links with heart disease in ways other than through the blood cholesterol level. For example, the stickiness of platelets in blood is influenced by diet – again the kinds of fat eaten seem to be important. The Eskimo diet, which includes a high intake of marine fat and a particular kind of fatty acid called eicosapentaenoic acid seems to reduce the stickiness of platelets and therefore to decrease the risk of vascular occlusion which might arise out of that platelet stickiness. Even coagulation factors in blood are now known to be influenced by diet.

Blood pressure, another risk factor for coronary disease, is also influenced by diet. Sodium and the sodium potassium ratio seem to be important. Probably other elements such as magnesium, maybe even calcium, relate to blood pressure. Alcohol is clearly recognised as affecting both systolic and diastolic blood pressure. Weight over a long period of time is related to blood pressure.

There is also some relationship between vegetarianism and lower blood pressure. We are not sure whether it is the fibre in the diet, or whether it is the potassium that goes with the fibre, or perhaps the magnesium that comes with the green leafy vegetables; maybe it is less fat in the diet or perhaps the kind of fat is important. Each of these factors is a possible explanation.

There is a growing recognition that diet relates to neoplastic disease or cancer. The relationship between diet and large bowel cancer (colon/rectal cancer) is known. Less obvious is the possibility that diet may be related to bronchiogenic or lung cancer. Several studies have now shown that, for a given level of cigarette smoking, the higher the intake of green leafy and yellow vegetables, the less the risk of lung cancer. The protection is thought to reside in the carotenoids or vitamin A precursors in those foods, but there may well be other factors in the foods which are important. Even breast cancer has its dietary correlates which include, for example the extent to which one is obese, the fat intake, and perhaps the age of onset of menarche – so diet early in life may be important.

Diabetes is another age-related disease, and although we usually think of it as being insulin-dependent, in fact 80 to 90% of diabetes is non-insulin-dependent, but much of it is related to obesity which in turn increases with advancing years.

To indicate the changes that occur in your blood sugar with advancing years Table 1 shows blood sugar concentrations at different ages, 2 hours after a glucose load. You can see that with advancing years there is a big difference in the proportion of people with a diabetic-type abnormality. (These criteria have been changed in recent times, but the same relationship holds; that as we get older, the risk of being diabetic-like in our blood glucose response increases.) It is interesting that at the same time the renal threshold – the level at which you spill sugar into the urine – also rises. It might be a compensatory mechanism, but it is certainly a real phenomenon. So the symptoms of polydipsia (thirst) and polyuria (passing a lot of urine) are actually less for this proportion of abnormalities in older populations.

Table 1

The effect of different criteria upon the estimated prevalence of diabetes in an age stratified random sample, which underwent standard 50 gm. oral glucose tolerance tests.

per cent with diabetic abnormality when blood sugar* is:

Age	No.	≥120mg./dl. at 2 hours	≥140mg./dl. at 2 hours	≥180mg./dl. at peak	*≥180mg./dl. at peak and* ≥120mg./dl. at 2 hours
20–	96	7.3	2.1	11.5	2.1
30–	95	6.4	1.1	14.9	1.1
40–	97	9.7	4.7	29.0	6.5
50–	96	15.4	6.6	48.4	14.3
60–	99	18.4	5.7	51.7	11.5
70–	93	40.2	22.0	61.0	34.1
Total	576	15.7	6.6	32.2	11.1

*capillary blood. Autoanalyzer micro method, ferricyanide reduction.

[From: *Diabetes Melitos,* Eds. K.E. Sussman & R.J.S. Metz 4 edition, American Diabetes Assoc. 1975]

Osteoporosis is the thinning of bones as we get older. It is clear, especially for postmenopausal women but also for men, that there is an increased risk of osteoporosis – particularly fractures of the hip and wrist and crushed fractures of the vertebral column. While this may not be a direct cause of death, any visit to the wards of an Australian hospital will indicate to what extent a fractured neck is a turning point in the lives of elderly Australian women.

Nutritional status in the aged

To consider the question of the nutritional well-being of someone we must take account of current and past events. How well nourished is that person? Does she have a vitamin C deficiency? Is there something which can be corrected in the short term? Even in our community there are specific nutritient deficiencies in elderly Australians. We have done a good deal of work in Melbourne and Geelong on community and institutionalised elderly people and perhaps the most striking feature is that, on institutionalisation, there is a considerable increase in the extent to which these problems occur.

NUTRIENTS AT RISK

1. Energy

2. Macronutrient
   - Protein
   - Essential fatty acid
   - Absorbable carbohydrate
   - Dietary fibire

3. Micronutrient
   - Vitamin
     - Folacin
     - Vitamin C
     - Vitamin A
     - Riboflavin
   - Element
     - Zinc
     - Potassium
     - Magnesium
     - Calcium

Some of the more important problems are listed here:

- *Inadequate energy intake* (calories or kilojoules). I have discussed the question of undernutrition above.

- *Protein nutritional problems* (lowered serum albumin concentrations). Hypoalbuminaemia is surprisingly common in institutionalised elderly people. It might be thought that it is simply a question of protein nutrition, but it is associated with zinc deficiencies. Zinc is albumin bound and, therefore, as the albumin level declines, so does the zinc level, but we have found that when our only dietary supplment is zinc, we can significantly increase the plasma albumin in two to three weeks in those who have both low zinc and low albumin levels. So the zinc problem is really a protein problem.

- *Essential fatty acids:* We are not certain but there is some evidence that if there were adequate amounts of eicosapentaenoic acid – an essential fatty acid from marine sources – there might be fewer thromboembolic events, less clotting and hence less thrombosis.

- *Dietary fibre:* If the non-absorbable carbohydrate especially associated with fibre in the diet were higher there would be less diabetes in elderly people. The present dietary management of diabetes is not to decrease the intake of carbohydrate, but to increase it from foods rich in dietary fibres – whole grain cereals and vegetables especially. On the other hand, increasing dietary fibre intake disproportionately in the elderly may have untoward consequences. Increased bowel function, for example, might compromise zinc nutrition, and work that we have done at Mount Royal with Professor Prinsley indicates that that can be a problem.

- *Micronutrient deficiencies:* Folic acid or folacin, vitamin C, vitamin A, riboflavin, certain elements. I have already mentioned zinc, and there may be others from time to time. Folic acid is a B complex vitamin, found in green leafy vegetables and whole grains, but also in oranges. Folic acid deficiency is probably the commonest vitamin deficiency in the Western world. Deficiency leads to anaemia.

The source and prevention of nutrient problems

These specific nutrient problems arise in elderly people in several ways: The food supply itself can be compromised for the elderly, for economic reasons or because access to shops is difficult. Preparation of food often does not interest elderly people. They may be handicapped in some way and less able to prepare food or oral problems may make eating difficult. There may also be problems in digestion and absorption.

NUTRITION PROBLEMS

Food Supply
Food Preparation
Food/Nutrient Intake
Digestion and Absorption

For example, in Uppsala some years ago, research showed that if you challenge elderly people with different loads of fat, there can be a degree of fat malabsorption at higher fat intakes. The same is true of protein.

One thing we must not forget about food is that it has important social functions associated with it in all societies. Think of wedding feasts and Sunday dinners and all the times we meet with people while we eat. Eating provides an occasion for interaction that will often bridge generations. It is important to remember that old people in our community can be adversely affected by inadequate access to food, not only from a nutritional point of view, but also because the social function of food is lost. The impact of this on well being is a difficult aspect to gauge, but it should not be forgotten.

Finally I come to preventive action. The single most important thing that can improve the relationship between food intake and health as it relates to getting older is to be physically active. If we are active we can afford for our food to be more energy dense. We can get away with a little more fat in the diet. Activity will maintain our muscle mass to a greater extent, to say nothing of the benefits of being physically well that come from physical activity, particularly as we approach retirement. If activity cannot be maintained then it is important to watch the energy density in the diet. We need to remember that the excess calories (or kilojoules) in the Western diet come not from carbohydrate but from fat and to a lesser extent from alcohol.

Questions:

Q: Why is it that women live longer than men? What do we men do wrong?

A: I will restrict myself to nutritional considerations, and the answer is not easy: Men are certainly less conscious of the relationship between food and health. When we did a study of men working at Alcoa it was very difficult to elicit information about what they ate – they do not have the consciousness that food is related to their health. Once they are aware of this, a lot of progress can be made. We are impressed with the extent to which men can lose weight once they realise the relationship between fat and alcohol intake and weight; or between their blood fats and their blood pressure.

Q: With ageing, would you recommend a non animal food diet?

A: No I would not. I have indicated that the major problem with a high animal food intake is the fat that goes with it. Lean meat is very nutrient dense. There is no question about it from an evolutionary point of view; as hunter-gatherers we did gather animal and insect food as well as plant food. No, I think one of the cardinal nutritional principles is variety, and with variety there will not be an excess of anything, and that includes fat. I think we could concentrate on producing leaner domestic animals. It appears that we export most of our lean beef to North America and keep the fattier meat for ourselves. We should also look for lower fat dairy products. Ideally, there should be a predominance of plant food in the diet, but not to the exclusion of animal foods.

Q: Is there a connection between diet and confusion in the elderly?

A: It comes back to the question of whether there are any particular nutritional problems which might relate to brain function. There is a surprising amount of both folic acid and, to a lesser extent, vitamin B_{12} deficiency amongst elderly people admitted to institutions. In Newcastle, Stephen Leader and a group have shown that about 30 to 35% of elderly people admitted with confusional states had low folic acid levels. The same relationship occurs in elderly people admitted to Prince Henry's Hospital, and also a small number of people with low vitamin B_{12} status. The test is to give folic acid and see whether these states improve as a result of that treatment and not just as a consequence of coming into hospital. There is still some doubt about the extent to which folic acid status relates to brain function.

Q: You mentioned a difference between the nutritional status of people who live in the community and those in institutional care. Can you suggest the factors causing this difference?

A: We must recognise that in general, people in institutions are sicker, and for that reason alone they may be less well off nutritionally. But we must not accept that and ignore nutritionally reversible components of disease and illness in our institutions. I think there is a sub group in the community with problems who get admitted to institutions. We can show that there is, for example, a higher proportion of people admitted with folic acid deficiency to Mount Royal than exists in the community. However, within the institution there are clearly identifiable problems. For example, at one institution there was a fundamental error in catering. To overcome a deficiency in vitamin C intakes an orange juice substitute was provided. It dealt with the problem of vitamin C, but it was not a substitute for oranges. With the absence of citrus fruit, there was not enough folic acid. So for these people the folic acid deficiency

persisted, while the vitamin C deficiency was corrected. It shows that you cannot attend to a single nutrient problem with a single nutrient supplement. So in institutions there can be catering difficulties, problems in ward management, a declining interest in food, and insufficient assistance with food intake for people who become dependent. All these things are important and many are correctable. They do contribute towards differences between the elderly in the community and in institutions.

Q: Can you suggest any preventive measures in nutrition for the osteoporotic person.?

A: We do not have the answers on osteoporosis. There is some relationship between calcium intake and risk of osteoporosis – this is apart from the non nutritional factors, like changes in sex hormones, which are very clearly related to it. In nutritional terms, it is not enough to increase the intake of dairy products, for in doing so you may actually increase the intake of interacting nutrients which may adversely affect calcium status. For example, protein may actually compromise calcium status: Cheese has a lot of salt in it and salt (sodium) leads to an increased loss of calcium. One must be careful about glib solutions – every dairy product is different. But I would suggest an increase in calcium intake without a corresponding increase in salt and without increasing unnecessarily the protein intake could be an important strategy.

Footnote: This paper was prepared by M. Wallace from a transcript of the address given by Professor Wahlqvist at the Seminar.

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AGEING

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