1

Introduction to human nutrition

Mark L. Wahlqvist

OBJECTIVES

- To provide an understanding of the dimensions of human nutrition.
- To explore the origins of human food culture.
- To provide an historical basis for deductions about preferred ways of eating in the contemporary world.
- To consider the long-term and unintended consequences of changes in the human diet.

THE DIMENSIONS OF HUMAN NUTRITION

The study of human nutrition encompasses a remarkable breadth of topics. These include the genetic inheritance which determines each individual's susceptibility to disease, and the influence of the physical and social environment which determines whether disease occurs. New knowledge of the human genome is going to revolutionise our understanding of disease, and the interplay of nutrition and disease. It may be that in the future a 'reading' of a child's genome will provide the basis for dietary requirements necessary to prevent the occurrence of particular diseases. Chapter 25 provides a discussion of the genetic basis of disease and how the genome interacts with nutrition.

Whereas the genotype is the underlying gene-plan of the body, the phenotype is the actual body as constructed, allowing for the dominance of certain genes and environmental influences on development. The influence of environment needs to be considered in two ways; first in terms of the environment in which each individual was conceived and developed in utero, followed by early nurturing and breastfeeding as an infant. New information suggests that the health and nutrition of the mother can influence the health of the child many years later as an older adult, particularly with regard to diseases such as heart disease and diabetes (see Chapters 27 and 28). The second consideration concerns the many aspects of the environment as they currently act on the individual. These include the physical environment which encompasses climate, shelter, water, food supply, conditions of hygiene, and the social environment which includes family influence, social supports and obligations, work, money, and government regulations.

Food is part of the human environment and, in an ideal world, just the right amount of safe and nutritious food would be consumed so that each person would have the best chance of achieving optimum health and long life. But, of course, it is not as simple as that. Not all available foods are equally nutritious. The quality of the foods consumed is the result of several factors: (i) government regulations regarding a safe food supply (see Chapter 9); (ii) what foods are supplied by farmers, food manufacturers and supermarkets (see Chapter 4); and (iii) what foods we choose to buy and eat (Chapter 10).

One of our authors, Pat Crotty, likes to divide nutrition into 'pre-swallowing' and 'post-swallowing' aspects. The 'pre-swallowing' considerations can be divided into those that deal with the food supply and those relating to our human individuality and the anthropological and sociological influences that determine what we choose to eat (see Chapter 3). The 'post-swallowing' aspects concern the physiology of nutrition including nutritional requirements for energy, protein, vitamins, and the consequences of too little or too much of these nutrients. Knowing just what nutrients are required and how much of each is complicated. It is not possible to do experiments on humans as might be done with laboratory rats. Certainly, the nutritional requirements of rats—which are, like us, mammals—are similar to human requirements but not exactly the same. Information on nutrition is drawn from two major sources; one is laboratory science, where experimental animals are used, and to a lesser extent, human subjects are used as well. The other main source of information is epidemiology—the study of nutrition and disease in populations. Epidemiology shows up relationships such as an association of heart disease with high intakes of saturated fats, or a higher incidence of the congenital disease spina bifida with low intakes of the B-vitamin folacin. Where such associations are found, laboratory science takes over to determine the nature of cause and effect.

Very often information is not clear-cut. Statistical analysis must be used to determine whether a certain finding might have arisen by chance or not. Even so, knowledge which seemed firmly established may change as continuing research uncovers new information. Assessing the significance of new information can be complicated. Scientists do not necessarily agree and arguments may go on for years before finally being settled one way or another. Some people in the nutrition field may be selective about what they believe. Sometimes their reasons are religious or they may have a financial interest in proclaiming certain 'facts'. With the introduction of computers and the internet, information is no longer hard to find—the more difficult problem is sorting out factual information from that which is biased (see Chapter 2).

EVOLUTION AND THE HUMAN DIET

It might reasonably be assumed that human beings evolved in association with particular diets and that the physiology of the human body is adapted to maintain health on those diets. Thus, the more we understand about what early humans ate, and their state of health, the more we are likely to be able to optimise present food consumption for physical and mental well-being and longevity. Research into the lives and nutrition of early humans is continuing in many parts of the world, particularly in Africa and the Middle East. There are three main ways through which we rediscover these early patterns:

1. anthropological study of early human ancestors (Eaton and Konner 1985; Bryant 1994);
2. the study of contemporary communities that have retained earlier dietary patterns, notably hunter–gatherer societies such as Aboriginal Australians or Malaysians (Orang Asali) (Chong 1975) or Kung Bushmen in Southern Africa (Truswell and Hansen 1968; Truswell 1977);
3. the study of the human genome and how genetic expression may be affected by food intake. Studies of Aboriginal Australians have shown, for example, that Aboriginal physiology is adapted to maintain better health on bush diets than on 'Western' diets rich in saturated fats and sugar. The studies of Kerin

O'Dea on the metabolism and health of Aboriginal Australians typifies this approach (Temple and Burkitt 1994).

ANTHROPOLOGICAL STUDY OF THE HUMAN DIET

Anthropologists reconstruct earlier ways of eating by various methods including:

1. the examination of middens (cooking mounds) and burial sites for evidence of the types of food eaten (Meehan 1982);
2. the study of coprolites (fossilised or hardened preserved faecal specimens) for indicators of foods eaten, such as fish scales or grains (Eaton and Konner 1985);
3. deductions about the ecosystems of the period and their potential for producing various kinds of foods (Hetzel and Firth 1978; Woodward et al. 1987);
4. detailed examination of teeth and jaw development as indicative of types of foods eaten (Katzenberg et al. 1993).

Evidence of the health of early humans comes principally from human remains, which are usually skeletal, but there have also been a few spectacular finds of mummified and frozen corpses for examination (Polosmak 1994; Spindler 1994). These remains have indicated that:

1. Hunter–gatherers were able to live apparently healthy lives at least into their seventh decade.
2. They were sometimes taller than subsequent generations, suggesting that the overall food supply was better and susceptibility to recurrent disease less. Recent increases in human height which have been documented in Scandinavia, through studies at the Stockholm Museum, followed a low-point in height after an earlier taller hunter–gatherer population.

CONTEMPORARY AND ANCESTRAL HUNTER–GATHERERS

From the work of Eaton and Konner (1985) it is possible to make the following deductions about the paleolithic (Pleistocene, 400 000–45 000 BC) diet:

1. There were appreciable quantities of low fat animal-derived foods (see Table 1.1).
2. Plant-derived foods were unrefined.

With regard to nutrient intakes (Table 1.2):

1. For macronutrients, protein was a relatively high, and fat a relatively low, contributor to energy intake.

Table 1.1 **Proposed average daily macronutrient intake for late paleolithic human beings consuming a 3000kcal (12 500 kjoule) diet containing 35% meat and 65% vegetable foods**

Macronutrient	Intake (g)
Protein	251.1
animal	190.7
vegetable	60.4
Fat	71.3
animal	29.7
vegetable	41.6
Carbohydrate	333.6
Fibre	45.7

Source: Eaton and Konner 1985

Table 1.2 **Comparison of the late paleolithic diet,* the current American diet, and US dietary recommendations**

	Late paleolithic diet	Current American diet	US Senate Select Committee recommendations
Total dietary energy (%)			
Protein	34	12	12
Carbohydrate	45	46	58
Fat	21	42	30
P:S ratio[†]	1.41	0.44	1.00
Cholesterol (mg)	591	600	300
Fibre (g)	45.7	19.7[‡]	30–60
Sodium (mg)	690	2300–6900	1100–3300
Calcium (mg)	1580	740[§]	800–1200[¶]
Ascorbic acid (mg)	392.3	87.7[§]	45[¶]

* Assuming the diet contained 35% meat and 65% vegetables
† P:S denotes polyunsaturated: saturated fats
‡ British National Food Survey, 1976
§ U.S. Department of Agriculture Food Consumption Survey, 1977–1978
¶ Recommended Daily Dietary Allowance, Food and Nutrition Board, National Academy of Sciences–National Research Council
Source: Eaton and Konner 1985

2 Relatively high cholesterol intakes were tolerated, but against a dietary background high in fibre and low in fat (with a high P:S ratio).
3 Salt (or sodium) intake was relatively low and the potassium: sodium ratio high.
4 Calcium intakes exceeded those in industrialised societies today.
5 The diet achieved upwards of 400 mg vitamin C (ascorbic acid).

These deductions depend on ancestral and contemporary anthropological studies of hunter–gatherers. There are some important conclusions to be drawn about this work, along with related studies:

1 Foods derived from the sea, rivers, lakes, or streams consistently played a role in human nutrition.
2 The intake of animal-derived fat was low because the creatures caught were undomesticated—the fatty part of a hunted animal, like that in the breast of a gazelle, was highly prized. The fats from wild animals are much less saturated than from current domestic herbivores. Plant-derived fat was relatively unrefined, mainly from seeds or nuts.
3 Cholesterol intake could be relatively high (500–600 mg/day), from land and sea creatures combined, but was not accompanied by significant amounts of animal-derived fat.

THE HUMAN GENOME AND ITS EXPRESSION

The first 'humans' appeared about 4 million years ago and the earlier form of *Homo sapiens* about 400 000 years ago. The human species, as we know it, has existed for about 200 000 years, or some 6000 generations, as judged by studies of genes in mitochondria, which are independent of genes in cell nuclei and derived unchanged from the mother rather than from fusion of sperm and egg. The mutation rate of mitochondrial DNA is well characterised and allows an estimate of the age of the species. Anatomically modern humans (*Homo sapiens sapiens*) appeared about 45 000 years ago. It is likely that, in the 300 or so generations since the emergence of subsistence agriculture, most of the genetic attributes of the hunter–gatherers have been retained, whether or not these are now advantageous. Among the genes concerned are those which apparently increase the efficiency of energy expenditure (reduced metabolic rate) when food supply is limited, (the so-called 'thrifty gene' or genes expressed as a 'thrifty phenotype') (Zimmet 1993). Now, of course, with an abundant food supply and less physical activity a 'thrifty gene' or 'thrifty phenotype' which conserves energy may predispose to obesity and its complications, and therefore becomes a risk factor for a range of diseases.

FOOD BELIEFS AND CULTURE

It is difficult to retrieve information about the entire food culture of our ancestors, especially the belief system which would have developed out of observations about food and health, and social and personal experiences of food. Efforts have been made to deduce the origins of food beliefs now bound up with religious or other cultural terms (Farb and Armelagos 1983). For example, what are the origins of beliefs about the undesirability of pork in the human diet in religious systems whose origin is in the Middle East, namely Judaism and Islam, but not in major food cultures like that of the Chinese where pork is prized? Is it that infestation with the pork tapeworm (cysticercosis) could only be dealt with by food exclusion and religious law, while in the Chinese culture the problem was overcome in other ways? Or is it simply that the habits of pigs were regarded as filthy and risky by some cultures, but not others?

Fasting, which is often partial or periodic, is part of many religious traditions, such as Christian orthodoxy, but may have been a societal way of achieving equity in food distribution or eking out limited supplies of certain commodities, for example meat. Such intentions, overt or covert, may have had biological justification in terms of preferred meal patterns, or avoidance of over-consumption (propositions even now not fully tested); or the practices may have had a fundamental philosophical rather than religious basis in respect for animal life, so minimising meat consumption. Beliefs, no matter how strongly they are apparently held, may not always or consistently be translated into action (Kouris et al. 1991). This limits the certainty of deductions about early food cultures from which the beliefs have been derived, but nevertheless tells something about the food culture of our ancestors (see also Chapter 3).

CRITICAL EVENTS IN HUMAN HISTORY AND FOOD INTAKE

Food intake has affected human history in profound ways (Wahlqvist 1992). These include:

1 ecological change
2 population size
3 war and conflict
4 migration
5 loss of indigenous cultures

Some specific examples are worthy of consideration.

The role of the potato in human history

In the eighteenth century Linnaeus counselled against the introduction of the potato as food into Sweden because of its potential toxicity, later confirmed when the neurotoxicity of solanene in green potatoes was appreciated. Linnaeus's concern proved correct in another way, because with the introduction of the potato, the Swedish population increased dramatically. Farms were able to produce many more calories of food per hectare than before and so larger families could be supported on the same farm. But the population expanded beyond food production capacity and, during the latter part of the nineteenth century, one-quarter of the Swedish population—one million out of four million—emigrated, principally to North America. Similar impacts of potato production on human population were seen in the British Isles (Figure 1.1).

Perhaps one of the major influences of food on history was the transfer of the potato and of maize to Europe from Central America. Evidence points to these crop introductions to Europe as having led to a major population explosion and ultimately to the colonisation of the Americas, Australia and New Zealand by Europeans. Earliest evidence for the use of the potato comes from Central and South America, where it was represented in pottery as early as 200 AD and was probably cultivated for thousands of years. It appears to have become a strong part of food belief and culture, although not to have led to the same degree of population growth as in Europe. The sorts of checks and balances that operated in the Americas but not in Europe are unclear. We know well enough what a profound social effect the potato had on Europe. On account of the monoculture and susceptibility to plant disease, famine became a problem, most notably the Irish potato famine of 1845 and 1846. The potato was also fermented to provide an alcoholic beverage even when the food supply was short. During the years of World War II, Britain still saw the potato as a preferred crop as it could be produced locally, reducing dependence on grains. One of the remarkable aspects of

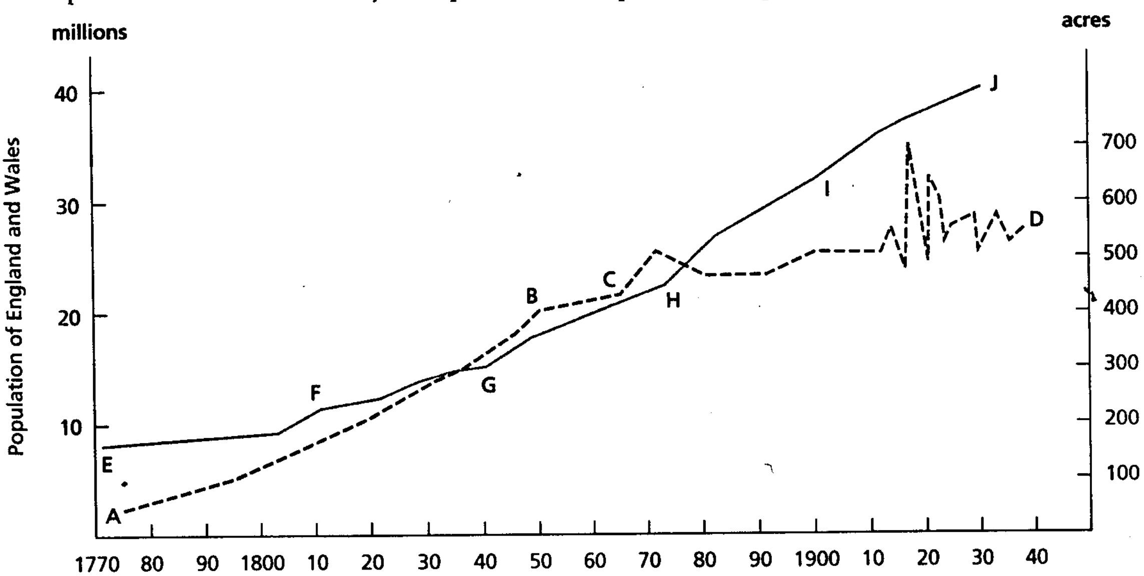

Figure 1.1 Population growth (EFGHIJ) in England and Wales from 1770 to 1940 in relation to the introduction and expanding acreage of potato as a crop (ABCD). During this time the acreage sown with wheat increased to a much lesser extent (Salaman 1987)

the potato is the wide range of climates that it can tolerate. There is ongoing pressure to meet human food requirements, especially locally, by more and more successful potato production, despite the lessons of history. It was reported recently that Australian scientists have developed a 'hairy potato' which would alleviate food problems through greater disease resistance.

Seafaring, exploration and nutrient deficiency

Not only did increased food production stimulate migration as a consequence of population growth, but the very ability to travel long distances depended on the resolution of problems of human nutrition. The classic example of this was the recognition that scurvy was a nutrient deficiency disease among seafarers. Scurvy had been identified by the Egyptians and reference to it appears in the Papyrus Ebers about 50 BC. About 600 BC Hippocrates described what was probably scurvy among the Greeks, and Pliny described the condition among the Romans in 63 AD. An account of scurvy is given in the first edition of the *Encyclopaedia Britannica* in 1771. A report published in Leiden in 1734 by J.F. Bachstrom maintained that the cause of scurvy was a lack of fresh vegetables or greens in the diet. The prevention of scurvy among the crew of Captain James Cook aided his discovery of Australia, yet the first European settlement at Sydney Cove was bedevilled by scurvy. When planted crops and trees failed, the use of Australian bush food helped to reduce the problem. Although James Lind had discovered the effects of citrus fruit in preventing scurvy on the ship *Salisbury* in 1747, his treatise was not published until 1764 and the British Admiralty did not adopt his recommendations until 1795. Thereafter, British sailors were nicknamed 'Limeys' for their use of limes and lime juice to prevent scurvy. The major food problem that arose from relocated populations was that they tended to maintain a dependence on foods imported from their point of origin. Only slowly did locally grown foods take over in terms of cost-effectiveness.

Early European settlement in Australia

The countries to which Europeans migrated lost a good deal of their indigenous food culture and knowledge. The early immigrants had little insight into the value of local plant species and food culture for their own survival and health—let alone the ultimate value of a wider selection of foods for the survival of the human species as a whole. A major consequence of colonisation was deforestation and the turning of more and more of the new land to grazing for meat production and to grain production. By the beginning of the twentieth century, Australians had the highest per capita consumption of meat in the world, some 120 kg per head per year, followed by the USA, 68 kg, England, 45 kg, France, 34 kg and Germany, 29 kg. Australia has since dropped down the international league of meat consumption, the lead now being taken by Argentinians with Australia ranking about fourth or fifth. The fattiness of our meat supply is also undergoing a revolution towards leanness, and there appears to be significant associated change in the rates of diseases, such as coronary disease, that is likely to be related to the reduction in fat intake. It has taken 200 years to identify and correct this particular nutrition-related health problem of European settlement in Australia.

It can be said that these historical events were, in general, long-term and unintended consequences of changes in human food acquisition, production, technology, trade and food preferences.

SUMMARY

- The health of the individual is influenced by both genetic background and diet which is one of many environmental influences.
- Our knowledge of the science of nutrition is incomplete and new discoveries may change our understanding in the future.
- As information about nutrition and health becomes readily available, it is important to recognise that some sources of information may be biased due to financial, political, religious or other interests—facts need to be separated from misinformation and bias.
- Knowledge of the early human diet obtained by anthropological, archaeological and experimental science can be useful in aiding our understanding of the relationship of diet to health.
- An understanding of common nutritional practices and health outcomes among hunter–gatherers has implications for contemporary food practices, notably in relation to food diversity, aquatic food sources and fat intake.
- Some genetic characteristics that may have been advantageous to hunter–gatherers could actually predispose to disease people exposed to modern diets with excess calories and fat.
- Traditional food beliefs and cultures that have a long historical basis may be more understandable when viewed in the light of the historic environments in which they arose.

REFERENCES

Bryant, V. Jr. The Palaeolithic Health Club. In *Yearbook of Science and the Future*. Encyclopaedia Britannica Inc., USA, 1994; 114–33.

Chong, Y.H. & Khoo, K.L. Serum lipid levels and the prevalence of hyperlipidaemia in Malaysia. *Clin Chim Acta* 1975; 65:143–8.

Eaton, S.B. & Konner, M. Palaeolithic Nutrition: A consideration of its nature and current implications. *New Eng J Med* 1985; 312(5):283–9.

Farb, P. & Armelagos, G. *Consuming Passions: The Anthropology of Eating*. Washington Square Press, New York, 1983.

Hetzel, B.S. & Firth, H.J. (eds). *The Nutrition of Aborigines in Relation to the Ecosystem of Central Australia*. CSIRO, Melbourne, 1978.

Katzenberg M.A., Saunders S.R., & Fitzgerald W.R. Age differences in stable carbon and nitrogen isotope ratios in a population of prehistoric maize horticulturists. *Am J Phys Anthropol* 1993; 90(3):267–81.

Kouris, A., Wahlqvist, M.L., Trichopoulos, A. & Polychronopoulos, E. Use of combined methodologies in assessing food beliefs and habits of elderly Greeks in Greece. *Food Nutr Bull* 1991; 13(2):139–44.

Meehan, B. *Shell Bed to Shell Midden*. Australian Institute of Aboriginal Studies, Canberra, 1982.

Polosmak, N. A mummy unearthed from the pastures of heaven. *National Geographic* 1994; 186(4):80–101.

Salaman, R. *The History and Social Influence of the Potato*. Cambridge University Press, Cambridge, 1987.

Simopoulos, A.P., Herbert, V. & Jacobson, B. *Genetic Nutrition*. Macmillan Publishing Company, New York, 1993.

Spindler, K. *Man in the Ice*. Orion Publishing Group, UK, 1994.

Temple, N.J. & Burkitt, D.P. *Western Diseases: Their Dietary Prevention and Reversibility*. Humana Press, Totowa, New Jersey, 1994.

Truswell, A.S. Diet and nutrition of hunter-gatherers. Ciba Found Symp 1977; 49:213–21.

Truswell, A.S. & Hansen, J.D. Medical and nutritional studies of Kung Bushmen in north-west Botswana: a preliminary report. *S Afr Med J* 1968; 42(49):1338–9.

Wahlqvist, M.L. Critical nutrition events in human history. *Asia Pac J Clin Nutr* 1992; 2(1):101–5.

White, N.J. & Breman, J.G. Malaria and babesiosis. In *Principles of Internal Medicine*. K.J. Isselbacher, E. Braunwald, J.D. Wilson, J.B. Martin, A.S. Fauci & D.L. Kasper (eds) 13th edn. McGraw-Hill Inc. USA, 1994; 887–96.

Woodward, D., McPhail, M. & King, H. Diet and health of the Tasmanian Aborigines—the perspective of a thousand generations. In *Epidemiology in Australia*. Brolga Press, 1987.

Zimmet, P. The thrifty genotype in non-insulin dependent diabetes. *BMJ* 1993; 306(6877):532–3.

FOOD AND NUTRITION

Australasia, Asia and the Pacific

Second Edition

Edited by
Mark L. Wahlqvist

Contributors
Madeleine Ball
David R. Briggs
Patricia A. Crotty
Gwyn P. Jones
Antigone Kouris-Blazos
Louise B. Lennard
Richard S.D. Read
Iain Robertson
Ingrid H.E. Rutishauser
Mark L. Wahlqvist
Naiyana Wattanapenpaiboon

Thanks to Antigone Kouris-Blazos for her editorial and technical assistance.

ALLEN&UNWIN

First published in 1997
Second edition published in 2002 by
Allen & Unwin Pty Ltd
83 Alexander Street, Crows Nest, NSW 1590 Australia
Phone: (61 2) 8425 0100
Fax: (61 2) 9906 2218
E-mail: info@allenandunwin.com
Web: www.allenandunwin.com

National Library of Australia
Cataloguing-in-Publication entry:

Food and nutrition: Australasia, Asia and the Pacific.

2nd ed.
Includes index.
ISBN 1 86508 692 4

1. Food. 2. Food analysis. 3. Food—Australian.
4. Food—New Zealand. 5. Nutrition.
6. Nutrition—Requirements. 7. Nutrition
Australia. 8. Nutrition—New Zealand.
I. Wahlqvist, Mark L.

641.3

Set in 10/12 Bembo by Asset Typesetting Pty Ltd
Index compiled by Russell Brooks
Printed by South Wind Productions, Singapore

10 9 8 7 6 5 4 3 2

Contents