SECTION 1: THE BIOLOGICAL BACKGROUND TO NUTRITION

1B: THE BIOHISTORY OF NUTRITION IN HUMANS

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An evolutionary perspective

The early days

Picture yourself on the stage of a large theatre with room for an audience of two thousand. In your mind's eye, place your mother in the seat at one end of the front row, and then her mother next to her and so on – until you have filled the place with 2,000 generations of mothers and daughters. The great majority of your maternal ancestors in the theatre would have known nothing of agriculture or the urban way of life. Only the women in the front twenty or so rows would have been alive since the time when farming first began. Only those in the front six or seven rows would have lived after the earliest cities came into existence, although very few of them are likely to have actually lived in cities. You could fill at least one other similar theatre with earlier maternal hunter-gatherer ancestors belonging to the species *Homo sapiens*. All these women really existed, and they lived in a state of health, at least until the birth of a child.

This mental exercise is relevant to the theme of this book because the human species has been in existence for at least 100,000 years, or about 4-5000 generations. The fact that civilisation is such a recent phenomenon has important implications for our understanding of human nutrition, as well as of many other aspects of our biology and behaviour.

The conditions of life experienced by our pre-civilisation ancestors were the conditions to which our species had become adapted through natural selection, and there have been too few generations since that time for major changes in the innate characteristics of humankind. There has not come into existence a new breed of humanity better adapted, genetically, to modern urban conditions than our Stone Age ancestors would have been. We are basically the same animal as our hunter-gatherer forebears of, say, 15,000 years (6-700 generations) ago. If we could bring back to life some of these people from that time, dress them in appropriate modern clothing and set them loose on a city street, they would be indistinguishable from the better physical specimens of modern humanity.

Thus the phylogenetic, or innate, characteristics of humankind as a species are the same now as they were before the advent of farming and civilisation. This means that our biologically determined health needs, including our nutritional requirements, are the same now as they were then.[1] Consequently, knowledge of the typical conditions of life of hunter-gatherers can provide useful clues about the innate health needs of our species. We can be sure that those conditions satisfied these needs in the case of every one of our hunter-gatherer ancestors, at least to the extent that they were fit enough to grow up and successfully reproduce.

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[1] If an animal is removed from its natural environment - from the environment, that is, to which the species has become adapted through evolution - or if the environment changes in some significant way, then it is likely that the animal will be less well adapted to the new conditions, and consequently it is likely to show some signs of physiological or behavioural maladjustment. This fundamental biological principle is referred to as the ***evolutionary health principle***. It applies to all animal species.

In the natural environment *Homo sapiens* was an omnivorous species. The typical diet consisted of a wide range of different foods of plant origin, including berries and other fruits, nuts, roots, grain and leaves, and a certain amount of cooked lean meat, which usually made up around 20 percent of the diet by weight. The meat had a low fat content, and the ratio of polyunsaturated to saturated fat was considerably higher than it is in most meat available in modern society.[2]

Nevertheless, there was clearly considerable variation in diet from one region to another. The reindeer hunters of northern Europe around 10,000 years ago, for instance, and the Eskimos of more recent times, apparently consumed a higher proportion of meat than hunter-gatherers living in the African savannah where, at some times of year, the diet contained only a small amount of animal protein. It is very unlikely, however, that any groups of primeval people have ever been entirely vegetarian. The diet of infants in primeval communities was, without exception, human milk. Breast-feeding was frequent and on-demand, and it usually continued for several years.

The amount of time that people spent actually looking for, and collecting food varied according to local circumstances, but in general averaged 2 to 3 hours a day. Much of the food was brought back to the group's campsite for sharing, although some was eaten beforehand. The rules for food sharing varied from culture to culture.

There is a common misconception that before the introduction of agriculture humans were always on the verge of starvation. For example, the eminent biologist Konrad Lorenz once wrote, rather surprisingly, that 'Palaeolithic people hardly ever had enough to eat'.[3] This is very unlikely. As in the case of other species under natural conditions, most of the time most of the people had plenty of food and were well nourished. Observations on recent hunter-gatherer societies support this assumption.

After the introduction of farming

The introduction of farming was a pivotal event in the ecological history of our species. It was the first of a number of major cultural developments which eventually led to far-reaching changes in the biological conditions of life of humankind.

Here, with the aid of a few examples, we will consider some of the ways that culture has affected eating and nutrition in human populations, focusing first on the quantity of food consumed, and then on food quality. Cultural influences on the acquisition of food will not be discussed.

Early farming people, and city dwellers, who became dependent mainly on a single food source, such as wheat or some other cereal, were particularly vulnerable to food shortages resulting from the effects of abnormal weather conditions. One or two bad seasons could be devastating. Hunter-gatherers, whose food sources were typically very diverse, had been much less at risk.

Indeed, recurrent famine has been an outstanding feature of civilisation in many parts of the world. In China famine is said to have struck one region or another on average once a year over the last 2,000 years, each time resulting in numerous deaths from starvation. At least two million people died from famine in China in 1929.

The ancient literature of the Middle East is also full of accounts of famine due to drought, warfare or crop disease. A particularly well-documented instance is the famine that

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[2] This brief account of the typical conditions of the diet and eating habits of our hunter-gatherer ancestors is based mainly on the reports of anthropologists who have studied surviving hunter-gatherer societies in the 20th Century

[3] K. Lorenz. 1966. *On aggression*. Methuen, London. p.218

occurred in Egypt in Joseph's time, in 1708 BC. Egyptian scribes recorded altogether 1829 different famines. In France 75 severe famines were recorded between the years 501 to 1500 AD, and in Russia, nine million people died of famine between 1921 and 1922, four to seven million between 1933 and 1934 and nearly two million between 1944 and 1947. Although famine does not seem to have been common in the history of Britain, there has certainly been variation in intake of calories and protein over the centuries, as reflected in the striking variations in average height of adults over the centuries.

Heavy dependence on a single foodstuff also puts populations at risk due to crop failure resulting from pests or disease. A tragic example of this was the Irish Potato Famine in 1845 and 1846 which, directly or indirectly, caused hundreds of thousands of deaths and an immense amount of human distress. The disease was due to infection of potato plants with the fungus of potato blight, which flourished partly because of a couple of unusually wet seasons and partly because of the high density of the potato plantations in Ireland. Two million people left Ireland for North America, Britain and Australia, and the famine has had long-lasting political repercussions.

Today it is estimated that about 1.2 billion people world-wide are hungry or suffering from a deficiency of calories and protein,[4] and the great majority of them are in the less developed countries, although they also exist among underprivileged groups in affluent nations. In India 21 per cent of the population is chronically undernourished. The UN Food and Agriculture Organisation estimates that around 250 million children in the less developed countries are underweight due to calorie and protein deficiencies, and it has recently been reported that about half the Aboriginal children living in the Northern Territory in Australia are underweight. Undernutrition in children not only stunts growth: it can also interfere with mental development.

The effects of industrialisation

In contrast, the main quantitative deviation from the natural diet in the more affluent countries today is over-consumption of food. This is the outcome of two main sets of influences. First, in many social settings, humans perform much less physical work than was usual in the natural habitat. Consequently, even if they consume about the same amount of food as their primeval ancestors, their calorie intake is in excess of their metabolic requirements.

Second, a number of new factors have come into play that tend to increase the amount of food eaten by various sections of the population. These include the following: efforts, through the culinary art and the food-processing industry, to increase the palatability and general attractiveness of foodstuffs; the cultural notion of three meals a day; sheer boredom; and certain cultural rituals, such as business lunches and social dinner parties.

Another important influence has been the refining of carbohydrates and the removal of plant fibre from the diet. Natural vegetable foods contain enough cellulose to give the stomach a comfortable sense of repletion before calories have been consumed in excess. The consumption of sugar and refined carbohydrates is without this built-in restraint. The energy content of an apple and that of a spoonful of sugar are about the same, but much more sugar than apple has to be consumed before the stomach feels replete.

As a consequence of these various influences, people in our society often consume far more calories than are necessary to satisfy their needs. WHO estimates that around 1.2 billion people are suffering from the undesirable consequences of over-consumption of food. North America leads the world in overweightedness, where 55 per cent of adults are

[4] This is a WHO estimate. Other authorities have come up with the lower figure of 840 million

affected; but the populations of Europe and Australia are not far behind. In England, the incidence of obesity doubled between 1990 and 2000 (see section 2b).

Over-eating contributes to a multitude of ailments, including cardiovascular disease, adult diabetes and some forms of cancer, and WHO sees overweightedness and obesity as one of the most neglected public health problems of our times.

Conversely, in present Western society extreme slimness is also proving a cause of ill health in some sections of the population, especially among younger women. This is the consequence of the prevailing subcultures which decree that extreme slimness is especially attractive, with the result that women deliberately reduce their food intake in order to achieve this unnatural state.

The history of micronutrient deficiencies

The specific nutritional requirements of the human species are, of course, the same as they have always been; and, as in the case of all other species, there is no better diet for humankind than that typical of the species living in the natural habitat. We noted above that people living in the natural environment were typically omnivorous, consuming a wide range of different foods of plant origin, including roots, tubers, fruits, nuts and leaves, as well as some cooked lean meat. From the beginning of farming onwards, cultural developments have resulted in a range of qualitative deviations from this natural diet. These deviations have been broadly of two kinds: deficiencies and additions.

Probably the most important general change following the introduction of farming was a tendency for people's diets to become narrower, leading to deficiencies of a range of essential nutrients. One of the best-known nutritional deficiency diseases in Western civilisation was scurvy, due to lack of vitamin C. Before the importance of fruit or vegetables in the diet was recognised, scurvy was an occupational hazard for sailors on long voyages. It was also common among soldiers, and it often played a decisive role in the outcome of military engagements.

Another important ailment in European cities was rickets, associated with a deficiency of vitamin D. Evidence for the prevalence of rickets in the Netherlands and in northern Germany in the 15th and 16th centuries is provided by oil paintings from that time showing small children with swollen bellies, bent limbs and squarish heads - all typical of this condition. Vitamin D can be synthesised within the body, provided that the skin is exposed to sufficient direct sunlight, but the wearing of clothes, the habit of living indoors and air pollution from industry all interfere with this exposure. Moreover, at the beginning of the industrial era, poorer people could not afford such luxuries as eggs and milk products, which were the only common foods containing adequate vitamin D. In the 19th century as many as 75 per cent of the children in some European cities were seriously affected with rickets. Even today the disease is not uncommon in some parts of Europe.

In the Far-East, beri beri and pellagra, due to the absence of vitamins of the B complex, were common causes of ill health and death in populations depending on polished rice. In South America, endemic pellagra, due to niacin deficiency, was caused by the milling of maize or the treatment of maize with alkali during food preparation. It can be prevented by nutritional education and by the supplementation of grain with niacin. Vitamin A deficiency is also quite common in South America.

Vitamin deficiency diseases have not always been due to the lack of availability of appropriate food sources, or even to economic disadvantage. Sometimes they have been simply the result of cultural delusions. For instance, in the 17th century in England vitamin A deficiency occurred among children of the wealthy, because it was the custom of the nobility not to eat green vegetables or butter, both of which were considered to be inferior foods.

The most prevalent specific nutritional deficiency today is lack of iron which, according to WHO, affects 80 per cent of the world's population, two billion of whom suffer from anaemia or mental disability as a result. Iodine deficiency is also common, affecting about 13 per cent of people on the Earth (section 2f).

In the high-consumption societies today a serious dietary deficiency is lack of plant fibre. This deficiency is the result of developments in the food industry associated with the refinement of carbohydrates. While fibre is not an essential nutrient, the human digestive system is adapted, through evolution, to diets containing plant fibre. Its removal has a number of consequences, one of which is over consumption of calories associated with fibre's role in contributing to a feeling of repletion. Removal of fibre from plant foodstuffs also results in a slowing of the rate at which gut contents move through the intestines, leading to constipation, and probably also contributing to colon cancer, haemorrhoids and various other disorders.

Effects of energy-rich and refined foods

The consumption of refined carbohydrates has been blamed for a range of different disorders. Dental caries is a well-known example. In 1598 Paul Hentzner, a visitor to England from the Continent, described a visit of Queen Elizabeth I to the Royal Palace at Greenwich. He remarked on her black teeth, with the comment that it was a 'defect the English seem subject to, from their great use of sugar'.[5]

Another much discussed characteristic of the diet in high-consumption societies is an excessive intake of animal fats, especially saturated fats. This change is believed to increase the likelihood of cardiovascular disease, as well as some forms of cancer.

The following quotation from State of the World 2000 sums up the situation with respect to both refined carbohydrates and fat:[6]

'In Europe and North America fat and sugar account for more than 50 per cent of calorie intake, and have squeezed complex carbohydrates, such as grain and vegetable, to just a third of total calories – a near complete reversal of the diet of our hunter-gatherer forebears.'

The history of food additives

Countless substances have been, and still are, added to human food for specific purposes – to improve its flavour, to make it more attractive visually, or to act as a preservative. The most widely used of all these additives is sodium chloride or 'salt', which has been added to food since time immemorial. The majority of people in our society consume ten to fifteen times more salt than is necessary to satisfy their metabolic requirements, and there is now a strong body of medical opinion that holds that this deviation from the natural diet makes an important contribution to the high blood pressure that affects such a high proportion of the adult population.

Other substances are added to food to make it look more attractive. In the mid-nineteenth century, for example, millers and bakers tried to boost their sales by adding alum to flour to make bread appear whiter. Around 1850 a chemist in London by the name of Accum analysed some of the bread sold in that city and showed that it was adulterated with alum. He published his results in a pamphlet; but the anti-reform backlash from vested interests, consisting of millers and bakers, was so severe that he was forced to leave the country. Many years later the validity of his claim was confirmed and legislation was introduced

[5] Quoted by J. C. Drummond and A. Wilbraham. 1957. The Englisman's food: a history of five centuries of English diets. Jonathan Cape, London. p.165.

[6] G.Gardner and B. Halweil. 2000. Nourishing the underfed and overfed. In L.R. Brown, C.Flavin and H. French (Eds.) State of the world 2000. W. W Norton, New York.p.63.

aimed at preventing adulteration of bread with any substance not approved by the authorities. During the twentieth century various bleaches have been added to bread made from white flour in order to make the bread appear even whiter, and concern was voiced in some quarters when it was shown that one of the bleaching agents commonly used for this purpose caused dogs to have fits.

Chemical agents added to foodstuffs in the food industry today include preservatives, anti-oxidants, colouring agents, flavouring agents, sweeteners, sequestrants, filling agents, stabilisers, emulsifiers and other 'improving agents'. The battery of approved flavouring agents alone includes well over a thousand different chemical compounds.

An interesting example of undesirable consequences of chemical contamination of the diet comes from Rome at the beginning of the first millennium AD. At that time it was the practice, especially among the nobility, to store fruit juice and other drinks in lead containers. It therefore seems likely that many people were regularly consuming small amounts of lead, and chemical analysis of human bones from this period has confirmed that this was happening. The symptoms of mild lead poisoning include tiredness, constipation, slight abdominal discomfort or pain, altered sleep patterns, irritability, anaemia, pallor, and, less frequently, diarrhoea and nausea. The nature of these symptoms is such that the people affected might well have come to accept them as 'normal', perhaps assuming that they were merely the natural consequences of growing older. Nevertheless, if most of the members of the ruling class were suffering from symptoms like these, the impact on society as a whole might well have been considerable – possibly even contributing, as one author has suggested, to the decline of the Roman Empire.

In our society today contamination of human food with various chemical products of industrial processes is a cause for concern. Especially important is contamination with various pesticides, such as DDT. Another important contaminant is PCB (polychloro-biphenols), which is used for various industrial purposes. Like DDT, it is a chlorinated hydrocarbon and persists in the environment for a long time; and like DDT it accumulates in the internal organs of animals, including humans. The physiological effects of these compounds are uncertain, but it is believed that they interfere with fertility and increase the likelihood of some forms of cancer.

In the developed countries there has been growing awareness of the risks associated with the chemical pollution of foodstuffs, and much progress has been made towards the regulation of the use of potentially noxious substances, although most of us still have some chlorinated hydrocarbons in our bodies.

The situation is less satisfactory in the developing regions of the world. While in the USA public outcry led to legislation banning the use of some pesticides and regulating the use of others, no such legislation exists in many Third World countries. Moreover, corporations in the USA which manufacture biocides that are banned in that country are still exporting them on a massive scale to developing regions of the world.

Alcohol

We cannot leave the topic of nutrition without brief reference to alcohol. Once people took up farming, it was not long before they worked out ways of making alcoholic beverages. They were producing wine in Armenia at least by 8,000 years ago, and recipes for making beer appear on 6,000 year old Babylonian clay tablets. Beer was also well known to the Egyptians 5,000 years ago. In fact, beer and wine became important staples in Western diets, contributing a significant proportion of the total calorie intake until the end of the 19th century. The technique of distillation of alcohol was invented by Arabs around 700 AD, but was not practised in Europe until 1100 AD.

The adverse effects of excessive consumption of alcohol have, no doubt, been well known since it was first introduced eight millennia ago. Only recently, however, has biomedical science shown that the consumption of a small amount of alcoholic beverages each day can be beneficial for health.

In conclusion

Finally, let us note that the advances in nutritional science over the past hundred years, including the discovery of vitamins and essential amino-acids, represent one of the most impressive chapters in the annals of scientific research, and they have contributed immensely to human health and well-being. It is sobering to bear in mind, however, that no knowledge of the existence, chemistry or biological function of the vitamins or any other nutrient is necessary for the avoidance of the nutritional deficiency diseases. All that is required is, first, understanding of the evolutionary health principle[7], and second, knowledge that the typical diet of *Homo sapiens* in the natural habitat of the species consisted mainly of a wide variety of different kinds of fresh vegetables, fruits, nuts and roots, and a certain amount of cooked, lean meat.

Note

This paper has concentrated on the biohistory of nutrition in humans. The same biohistorical approach can usefully be applied to the impacts of food production and acquisition on the health of the natural environment. In the days of our hunter-gatherer ancestors, humans fitted into the ecosystems of which they were a part in much the same way as any other omnivorous mammal. This is very far from the case today, and much of the current degradation of the ecosystems of this planet is a direct consequence of human food-producing activities.

Discussion notes

- The argument that "the phylogenetic, or innate characteristics of human kind as a species are the same now as they were before the advent of farming and civilisation" has to be reconciled with the observable genetic differences between different races of the species *Homo sapiens.* These differences are thought to be the outcome of both genetic drift and, to some degree, of different selection pressures operating in extremes of biophysical environments/settings, as contrasted, for example, between the Inuit and Australian Aborigines.
- Humans in their natural environment, like all other animals, will sometimes have experienced food shortages, due to drought or floods, which may have exerted selection pressures. However, it is likely that the great majority of people would have been living in parts of the world with fertile soil and a favourable climate. That is to say, most of the time most people would have been well fed.
- While diet diversity of hunter-gatherers was able to sustain our human society for many millenia, the introduction of farming tended to make people's diets narrower, with some adverse health effects. The introduction of permaculture may help to restore the biological advantages of biodiversity to the modern world (see section 6d).
- Palaeolithic lifestyles inevitably involved exercise – frequent and of low intensity in food gathering (mainly by women) and infrequent and of high intensity in hunting (mainly by men). Evidence from recent hunter-gatherers suggests that dancing was also common, and involved both men and women. At the other end of the scale the tendency towards indolence is an important human characteristic that played a positive role in primeval

[7] See footnote 1.

society (e.g. energy conservation in the individual and preventing overkill of animal food sources). If, as in the case of modern industrial society, the need and incentive to go gathering, hunting and to enjoy active recreation is taken away, then the behavioural equation is shifted in favour of indolence, tending to promote sedentariness and hence obesity and its adverse consequences.

- The benefits of small amounts of alcohol in preventing cardiovascular disease appears at first sight to be an exception to the evolutionary health principle. This effect of alcohol may lie in counteracting the undesirable effects of certain other influences associated with modern lifestyles (there is good evidence that cardiovascular disease was non-existent, or very rare, in hunter-gatherer societies). The apparent protective effect of alcohol may be likened to taking a small daily dose of aspirin to prevent heart attacks, or incorporating fluoride in drinking water to prevent dental caries (hunter-gatherers seldom experienced this condition).

Further reading

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