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978-0-521-85180-0 - Western Diseases: An Evolutionary Perspective
Tessa M. Pollard
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1 *Introduction*

This book sets out to examine why certain non-communicable diseases have become common, first in affluent western populations and now, increasingly, worldwide. I use an evolutionary perspective because of its value in showing us why and how human bodies are vulnerable to these diseases. In this chapter I introduce the concept of western diseases and outline the evolutionary perspective applied throughout the book.

Western diseases

In the 1960s and 1970s concerns developed about the rise of diseases such as coronary heart disease, type 2 diabetes and colon and breast cancer as important causes of mortality and morbidity in the western world (Cleave *et al.* 1969; Boyden 1970; Burkitt 1973). The origins of the term western diseases, and of the approach I adopt in this book, lie in this work. The diseases identified were linked to 'modern western civilisation' and were considered to be 'man-made' (Trowell and Burkitt 1981a). Specifically, the rise of western diseases was blamed on increased availability of food (accompanied by a decline in the consumption of dietary fibre) and a reduction in physical activity. These authors also acknowledged the impact of an increase in life expectancy, which led to a higher proportion of susceptible older people in the population. The emergence of western diseases in non-western societies, for example in the Far East and in Africa, was linked to the process of westernisation, that is, the adoption of elements of the modern western lifestyle in other areas of the world (Trowell and Burkitt 1981b), a simplistic but nevertheless helpful concept.

The most obvious alternative descriptors for western diseases are 'non-communicable diseases' and 'diseases of affluence', both of which I also employ, but in general I find them less useful in this context. 'Non-communicable diseases' includes diseases that are not associated with a western lifestyle, such as chronic obstructive pulmonary disease, common both in rich and poorer countries. 'Diseases of affluence' is unsatisfactory principally in that there is a difference between the disease profile of affluent countries in the 'west' and in the east. In particular, diets in the affluent east (e.g. in Japan

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and South Korea) have traditionally been low in fat, and rates of coronary heart disease and other diseases strongly associated with dietary fat intake are, accordingly, lower than in the west (Ueshima *et al.* 2003). The second issue is that 'diseases of affluence' are not necessarily most prevalent among the most affluent members of a population. Within the United Kingdom, United States and many other countries, obesity and cardiovascular disease are more common in the poorer members of society (Marmot *et al.* 1984). High rates of type 2 diabetes and cardiovascular disease, in particular, are also increasingly common in poorer countries (Ezzati *et al.* 2005).

I have therefore chosen to retain the term western diseases, despite the fact that it is not geographically accurate, encompassing populations living as far apart as north America, western Europe and Australia. Its main advantages are that it neatly encapsulates the group of diseases with which I am concerned, and links to a paradigm, as described above, that I find helpful. The group of diseases I consider in this book is much as characterised above, although I also extend it to include allergies and mental health problems, as well as aspects of reproductive function and events, as detailed below.

An evolutionary perspective

This book draws on an evolutionary perspective to consider the rise of western diseases. As indicated by the recent surge of interest in evolutionary medicine (also called Darwinian medicine), an evolutionary perspective has much to offer the traditional understanding of biomedical science (Nesse and Williams 1994; Trevathan *et al.* 1999; Stearns and Ebert 2001; Nesse *et al.* 2006; Trevathan *et al.* 2007). At the heart of this approach is the notion that human evolution occurred in circumstances very different from the modern affluent western environment and that, as a consequence, human biology is not adapted to the contemporary western environment (Harrison 1973). It is worth examining this idea in more detail at the outset.

The precise evolutionary history of hominins (humans and their immediate ancestors) has been the subject of hotly contended debate for many years. Given the indirect and often sparse nature of the evidence, it is unlikely that a firm consensus will emerge for some time. Nevertheless, it is generally agreed that the human line diverged from the line leading to modern chimpanzees between about 5 and 7 million years ago (Boyd and Silk 2006). Our genus, *Homo*, appeared in Africa about two million years ago (Wood and Collard 1999), and subsequently these early hominins spread out of Africa, as far away as, for example, Indonesia. The emergence of *Homo* marked the first appearance of some important skeletal characteristics shared by all future members of the genus, including modern *Homo sapiens*. These features

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include large relative brain sizes, large bodies, dedicated bipedal locomotion and smaller teeth and jaws (Aiello and Wells 2002), features that were probably accompanied by marked changes in physiology and behaviour. For example, it is now thought that the energetic needs of *Homo*'s larger body size relative to earlier hominins and other primates were satisfied by an increase in the consumption of meat relative to other foods (Aiello and Wheeler 1995). The metabolic costs of the relatively large and energy-expensive human brain are also thought to have been met through a variety of characteristically human features. These include a corresponding reduction in the size of the equally energy-expensive gut (Aiello and Wheeler 1995) and a slow growth rate (Foley and Lee 1991). It is also likely that there was an increase in the relative proportion of adipose tissue (fat) at this time, as discussed further in Chapter 3.

The timing and location of the origins of our own species, anatomically modern *Homo sapiens*, has been a particular focus of debate in recent years, but the hypothesis that *Homo sapiens* first emerged in Africa about 100 000 years ago, often known as the 'Out of Africa' theory, is now the best supported (Stringer 2002; Stringer 2003). Subsequently, these modern humans colonised other parts of the world, where they may have entirely replaced the original hominin occupants, or may have interbred with them (Stringer 2003) (Fig. 1.1). In the last 50 000 years or so modern humans colonised Europe, Asia, the Pacific and eventually, around 20 000 years ago, they reached the Americas (Cavalli-Sforza and Feldman 2003). During the period in which

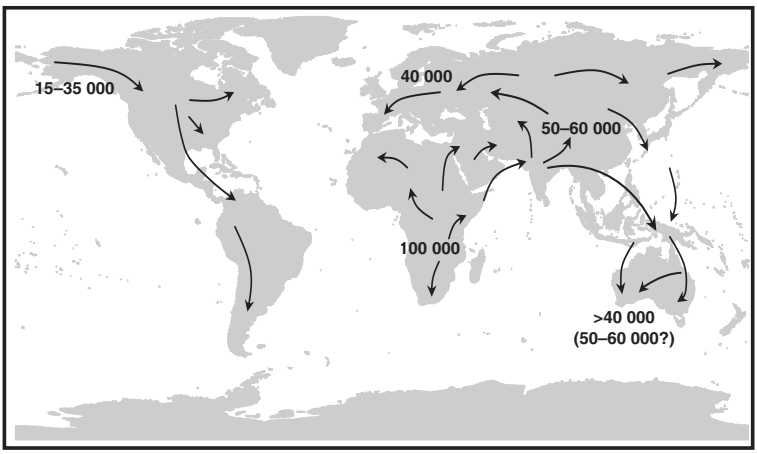

Fig. 1.1. Map showing the migration of modern *Homo sapiens* from Africa to the rest of the world. Figures are years before present. Redrawn with permission from Cavalli-Sforza and Feldman (2003).

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different populations of anatomically modern *Homo sapiens* have lived in widely differing environments, they have experienced different selective pressures, so that we should expect some adaptive genetic differentiation to have arisen between populations, in addition to random differentiation due to isolation and the chance process of genetic drift (Tishkoff and Kidd 2004). This is important because such processes may have resulted in genetic differentiation between populations that affects their relative vulnerability to some western diseases.

The environment experienced by *Homo* from its emergence about two million years ago until the origins of agriculture about 10 000 years ago, the Palaeolithic period has been called the environment of evolutionary adaptedness (EEA) for humans (Bowlby 1969). During the Palaeolithic, hominins used stone tools and subsisted by a combination of hunting and gathering (also known as foraging). The EEA approach sees human biology as having adapted, through the process of natural selection, to the environment experienced during this long period. Individuals whose genes resulted in greater survival and fertility in the EEA, and which conferred those same advantages on their descendants, would have contributed more offspring to subsequent generations than those who were less well adapted. This greater reproductive success increased the relative frequency of genes conferring adaptation to that environment. This view is summarised by the notion that 'Human biology is designed for Stone Age conditions' (Williams and Nesse 1991). Some versions of this approach suggest that there has not been enough time for further evolutionary change since the origins of agriculture.

The concept of an EEA is a powerful one, but it has been criticised on a number of counts. Perhaps the most important criticism is of the implication that human evolution started two million years ago and ended ten thousand years ago. Clearly, this is not the case (Strassmann and Dunbar 1999). It is also likely that early species of *Homo*, who all lived within the last two million years and thus in the EEA as defined above, were very different, and lived in very different ways, from modern *Homo sapiens*. Certainly brain size increased markedly during this period. Nor was the environment static; there was major climatic change associated with glaciation (Foley 1996). To focus on the fact that humans were hunter–gatherers or foragers for one or two million years therefore creates a false picture of stasis in hominins and their environment during this period (Irons 1998). The approach adopted in this book is to follow Williams and Nesse and others in emphasising the importance of human adaptedness to the hunter–gatherer way of life, as experienced by modern humans before the origin of agriculture, whilst acknowledging that in discussing some traits it is important to draw on a deeper or shallower view of human evolutionary heritage.

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Of course, an individual's biology is not determined solely by the genes he or she inherits as a consequence of past evolutionary processes. The environment he or she experiences helps determine his or her phenotype. Of particular relevance here, individuals are able to respond adaptively at the phenotypic level to different environments, and humans are good at this in comparison to other species (Thomas 1998). Such adaptation may occur as relatively short term and reversible acclimatisation, or by developmental adaptation, when an individual develops in a particular way in response to the environment experienced in early life. The long developmental period of humans probably contributes to our ability to adapt to prevailing environmental conditions in ways that improve future survival and reproduction (Vitzthum 2001). Biological anthropologists were among the first to recognise the importance of this developmental plasticity and of viewing an individual's biology as the outcome not only of his or her genetic inheritance, but also of his or her experiences over a lifetime, from life in the womb onwards (Lasker 1969). More recently, this lifespan perspective has become a focus of great interest in epidemiology (Barker 1994; Kuh and Hardy 2002; Kuh *et al.* 2003).

Of course, the ability to respond adaptively to the environment (and the limits to that adaptability) evolved over our long evolutionary history. There is little reason to expect an individual raised in an affluent western environment to adapt entirely successfully to his or her environment, as many aspects of it have never previously been encountered by humans. Furthermore, a rapidly changing environment poses special challenges to developmental adaptations. Permanent developmental adaptations are likely to be beneficial only when environments do not change a great deal during an individual's lifetime, so that information available during development serves as a reliable predictor of future conditions. During the relatively stable environments encountered during most of human evolution, such mechanisms would have worked well. However, if people encounter very different environmental conditions in adulthood from those during development, the developmental adjustments they make may not be beneficial. Today, this is particularly likely for populations in economic transition in the poorer countries of the world, and for migrants from poorer to wealthier circumstances, as we shall see.

We must also recognise that not all plasticity is adaptive. For example, lack of food may limit growth, and while some have argued that this is adaptive, most would now disagree. Often the task of distinguishing adaptive responses from those that arise simply as a result of environmental constraint is a difficult one (Ellison and Jasiénska 2007).

This, then, is the basis of the evolutionary perspective that I apply to this investigation of western diseases. The central point is that human biology is the

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product of a long evolutionary history in very different environments from the modern western environment, which is very new in evolutionary terms.

Outline of the book

In Chapter 2 I provide an evolutionary history of the human disease experience, starting with a consideration of diseases experienced by hunter–gatherers. My aim here is to provide important background information on the disease context in which modern *Homo sapiens* lived for the majority of the time since it emerged as a species. Next I examine the impact of the development of agriculture and of urban societies on human disease, innovations that exposed humans to more infectious disease. I then explore the concept of the epidemiologic transition, the term used to describe the decline in mortality from infectious disease and increase in mortality from non-communicable disease that started in the west after the industrial revolution. Finally, I summarise the position with respect to trends in the prevalence of western diseases over the last 50 years or so.

When western diseases were first identified as a group, they were poorly understood. It is now possible to draw on a huge wealth of information to examine each group of diseases, highlighting where an evolutionary perspective provides insights unavailable to standard biomedical science. In the main body of the book, from Chapter 3 to Chapter 8, I have aimed to do this for four major groups of diseases or health issues.

Obesity is the central pathology at the heart of many western diseases, and it plays a role in most others. Chapter 3 starts by reviewing research by biological anthropologists on diet and physical activity patterns in hunter–gatherer societies that helps us understand the energetic regimes to which our bodies are adapted. It then examines the reasons for the current increases in rates of obesity, and the most clearly obesity-related diseases, particularly type 2 diabetes and cardiovascular disease. Chapter 4 goes on to describe and critique two dominant hypotheses, often known as the thrifty genotype and thrifty phenotype hypotheses, that have been put forward to explain why some populations appear to be particularly susceptible to the development of type 2 diabetes and cardiovascular disease.

Breast cancer and other reproductive cancers in women are linked to exposure to oestrogen, and probably progesterone, produced by a woman's own body. In men, prostate cancer has been linked to high levels of testosterone. Research has shown that the high levels of these gonadal hormones in women and men in western societies today are an evolutionarily new phenomenon. This research is discussed in Chapter 5. Chapter 6 continues the reproductive health theme, but focuses mainly on women, examining the

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impact of a modern western lifestyle on reproductive function, infant feeding choices and their health consequences, and on the experience of the menopause.

In recent decades there has been an enormous rise in the prevalence of asthma and other allergic disease in children, particularly in the west, so that they can also be considered as western diseases. In many western countries, allergic diseases in general are now the commonest type of chronic disease in children, and asthma is the commonest reason for emergency hospital admission and use of medications (Anderson 1997). In contrast, allergies are very rare in populations living subsistence lifestyles. Here the cause may be related to changes in exposure to infectious diseases, environmental and gut bacteria and parasitic worms during early life, although other hypotheses have also been posited. These ideas are considered in Chapter 7.

Mental health problems, particularly high rates of depression and stress, have also been associated with life in modern industrial societies. Furthermore, they contribute to other health problems, acting as risk factors for cardiovascular disease and probably for other diseases too. Changes in relationships with kin and in social organisation more generally have been blamed for rising rates of depression and stress. The case for this approach is examined in Chapter 8.

Chapter 9 offers a summary overview of what an evolutionary perspective teaches us about human vulnerability to western diseases. It goes on to look at projected trends in western diseases, especially in relation to the developing world. It is clear that western diseases are likely to become more and more important as populations become westernised and urbanised and as age profiles change so that the proportion of older people in the population increases. Here I also consider what an evolutionary perspective has to offer to the development of possible preventive strategies in the face of this growing problem.

I have not attempted to include a discussion of all western diseases, although I have covered most of the most important diseases. The obvious omission from the list given above is lung cancer, which is one of the biggest killers in most western societies and also elsewhere. I chose not to consider lung cancer in detail because it is so clear that smoking tobacco is its main risk factor. Instead, I have focused on those diseases for which an evolutionary perspective is particularly valuable.

Summary

There has been interest in the concept of western diseases and concern about the mismatch between human biology and the affluent western environment

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for nearly 40 years. This book sets out to apply and extend this evolutionary perspective, making use of our much increased understanding of evolutionary processes and of the biology and epidemiology of disease. I aim to show that western diseases, which constitute one of the major problems facing humans at the beginning of the twenty-first century, can be understood far more completely using this perspective.

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2 *An evolutionary history of human disease*

In order to place western diseases in an evolutionary context it is necessary to consider the experience of human disease throughout human evolutionary history. To achieve this I adopt a framework drawn from the work of Boyden (1987) and Cohen (1989), illustrated in Table 2.1. This approach emphasises the need to understand the way of life, ecology and health experience of hunter–gatherer people, because such an understanding informs us about the context in which members of our species lived for so much of its evolutionary history. An examination of the enormous impact of agriculture and then of urban living on human health illustrates how changes in ways of life have had profound effects on disease experience in the past. As will become clear in later chapters, it is also increasingly apparent that an understanding of the evolutionary history of human exposure to infectious disease and nutritional pressures, which was profoundly affected by these innovations, is relevant to our understanding of western diseases. Finally, I consider the decline of infectious diseases and rise of non-communicable disease in the west, the so-called epidemiologic transition, and trends in the prevalence of western diseases over the nineteenth and twentieth centuries.

Human ecology and health in the Palaeolithic

Anthropologists have used various kinds of evidence to try to find out more about the ways of life of humans during this period, and to characterise their experiences of health and disease. The main sources of evidence are contemporary hunter–gatherers (also known as foragers) and relics of the Palaeolithic, such as fossils, prehistoric skeletal material, tools and other archaeological evidence. Neither type of evidence provides perfect information. There are few hunter–gatherer populations left, and these few have been profoundly affected by the economies and cultures of the people living around them, and are now generally limited to the harshest parts of their original terrain. As a result, they probably offer only a narrow view of how

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Table 2.1. *Framework showing timescale of major cultural innovations that have affected human exposure to disease since the emergence of anatomically modern* Homo sapiens. *Generation time is estimated at 25 years*

Innovation	Years before 2000	Generations before 2000	Size of human communities
Emergence of anatomically modern *Homo sapiens* (living as hunter–gatherers)	100 000	4000	Scattered nomadic bands of 30–50
Development of agriculture	10 000	400	Relatively settled villages of <300
Development of cities and irrigated agriculture	5500	220	Few cities of 100 000; mostly villages of <300
Introduction of steam power	250	10	Some cities of 500 000; many cities of 100 000; many villages of 1000
Introduction of sanitary reforms	140	6	

Adapted from Mascie-Taylor (1993).

life might have been in the Palaeolithic. Relics of the Palaeolithic are limited. However, together these sources provide enough useful information to allow us to build up a picture of what life was like for modern *Homo sapiens*, and to a certain extent for earlier hominins, before agriculture.

During this time humans lived in band societies, foraging (mostly hunting and gathering) for food from wild resources. It is likely that a band consisted of around 30–50 people, and that bands were loosely coordinated into a network (Cohen 1989, p. 16). Hunter–gatherers hunt, fish and trap animals and gather or harvest wild fruits, roots, tubers, leaves and seeds. Scavenging from corpses of large animals may also have been important for the earliest *Homo sapiens*. Hunter–gatherers do not farm or raise domestic animals. Their population density is limited by their dependence on wild resources, which are generally more sparsely distributed than farmed foods. As a result they usually have to be mobile, moving on once the wild foods in an area are depleted either by exploitation or because of seasonal change (Cohen 1989).

Extrapolation from present-day hunter–gatherer societies also suggests that pre-agricultural human groups were characterised by egalitarianism; there is generally no dominance ranking and no evidence of institutionalised leadership amongst modern hunter–gatherers (Runciman 2005). The exact mechanisms maintaining such a social order, which contrasts with that of

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