

Health Change in the Asia-Pacific Region

Edited by

Ryutaro Ohtsuka and Stanley J. Ulijaszek



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The Asia-Pacific region has seen great social, environmental and economic change across the past century, with great acceleration of change in the last 20 years or so, leading to dramatic changes in the health profiles of all populations represented in South East Asia, East Asia, Pacific Islands and the islands of Melanesia. This volume will consider recent evidence concerning prehistoric migration, and colonial, regional and global processes in the production of health change in the Asia-Pacific region. Notably, it will examine ways in which a health pattern dominated by undernutrition and infection has been displaced in many ways, and is being displaced elsewhere, by over-nutrition and the degenerative diseases associated with it. This book will present a cohesive view of the ways in which exchange relationships, economic modernization, migration and transnational linkages interact with changing rural subsistence ecologies to influence health patterns in this region.

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Health Change in the Asia-Pacific Region

Biocultural and Epidemiological Approaches

EDITED BY

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

Cambridge University Press

The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org

Information on this title: www.cambridge.org/9780521837927

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First published in print format 2007

ISBN-13 978-0-511-28493-9 eBook (Adobe Reader)

ISBN-10 0-511-28253-2 eBook (Adobe Reader)

ISBN-13 978-0-521-83792-7 hardback

ISBN-10 0-521-83792-8 hardback

Cambridge University Press has no responsibility for the persistence or accuracy of urls for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

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Acknowledgements

The meeting which formed a basis for this volume took place in Tokyo, as part of the International Union of Anthropological and Ethnographic Sciences Congress, held in 2002. We thank the Japan Society for the Promotion of Science for helping to support this symposium financially. We also thank Robin Hide, Tony McMichael, Vicki Luker, Don Gardner and Donald Denoon for their comments and suggestions at various stages of this project.

1 *Health change in the Asia-Pacific region: disparate end-points?*

STANLEY J. ULIJASZEK AND RYUTARO OHTSUKA

Introduction

The Asia-Pacific region encompasses South East Asia, East Asia, Pacific Islands and the islands of Melanesia. In the present day, strong economic forces link it to the Pacific Rim nations of the United States, Australia and New Zealand. While epidemiologists have studied some of the relationships across geographical and population units within this region, there is thus far no formal consideration of health impacts of linkages within and across these units in historical and evolutionary contexts. While migrations across the region are known and common, these have both evolutionary and colonial histories. The nature and extent to which knowledge of population movements, past and recent, can impact on present-day human biology in this region has not been synthesized, despite having been considered separately by various authors and research groups. This volume considers recent evidence concerning prehistoric migration, and colonial, regional and global processes in the production of health in the Asia-Pacific region. Using their own research findings and/or by synthesizing those of others, the contributors to this volume describe health change in various populations in relation to their biological, cultural and/or socioeconomic attributes at various scales of time.

This region, consisting of the southeastern frontier of the Eurasian continent and the vast South Pacific, was the geographical locale of the first crossing of wide seas and oceans by human groups. A consequence of this was the adaptation of such migrant groups to a variety of novel environments. Many Pacific population maritime range expansions are likely to have taken place throughout the late Pleistocene, earlier than anywhere else in the world. Between the Pleistocene and the Holocene, various migrations, subsistence introductions and human biological changes took place. However, these took place at rates much slower than the rates of those introduced by European contact and the subsequent subjection of local populations to colonial regimes. Great variation in

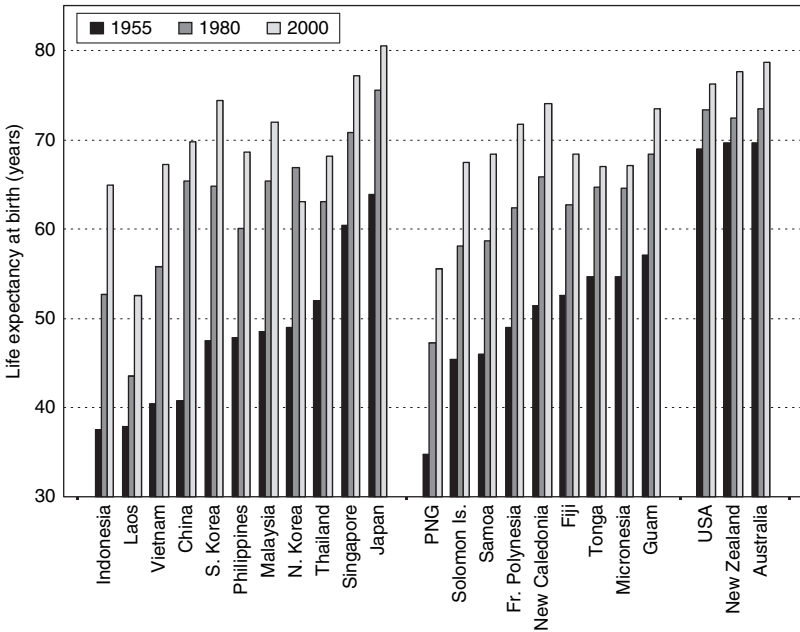


Fig. 1.1. Changing life expectancy at birth in the Asia-Pacific region, 1955–2000 (data from United Nations University 2006).

exposure to, and development of, new political and economic structures across the region has led to varying health profiles across and within populations. Throughout the past century, this region has seen great social, cultural, economic and environmental changes, triggering hasty health transitions in many populations, with this trend accelerating in the past few decades. The forces driving this change now include the following: the emergence of Asian economies as significant global influences; political change; globalization of trade; the penetration of the world food system to all parts of the region; adoption of Westernized foods and dietary habits; widespread dissemination of primary health care; increased adoption of health-conscious behaviours; and increasing urbanization and migration of populations.

Young-child mortality has declined considerably in the Asia-Pacific region since the 1950s. One consequence of this has been increases in life expectancy at birth (LEB) across the region between 1955 and 1980, and further increases between 1980 and 2000 in all nations except North Korea (Fig. 1.1). Almost 30 years have been added to LEB in the last 130 to 150 years in New Zealand, Australia and the United States, most of this

increase having taken place before 1980. Life expectancy at birth in Singapore and Japan has increased similarly across the twentieth century, while increases of similar proportion have taken place since the 1950s in Indonesia, Vietnam, China and South Korea. Increases in LEB of between 20 and 30 years across the period 1955 to 2000 have taken place in the Philippines, Malaysia, Papua New Guinea (PNG), the Solomon Islands, Samoa, French Polynesia and New Caledonia. In the 1950s, the United States, New Zealand and Australia had the highest LEB in the region. By the year 2000, they had been overtaken by Japan, whose LEB came to exceed 80 years. Furthermore, South Korea, Malaysia, Singapore, French Polynesia, New Caledonia and Guam had joined the United States, New Zealand and Australia with LEBs exceeding 70 years.

A potential brake on these dramatic increases in human longevity is the rise in the burden of non-infectious diseases across the region since the 1980s, as well as the persistence and emergence of infectious diseases in some nations, including PNG. Evidence for decline in LEB after generations of increase comes from various nations where there are significant increases in infectious disease mortality, as in Zimbabwe, South Africa, Lesotho, Swaziland, Namibia, Zambia and Botswana (HIV/AIDS and tuberculosis) and increased mortality associated with severe undernutrition (North Korea). It has been suggested that LEB in the United States may decline by up to five years across the next two or three decades unless the rising rates of obesity are somehow controlled (Olshansky *et al.* 2005). In the United States, obesity rates (as defined by body mass index (BMI) exceeding 30 kg/m^2) currently stand at 26% and 32% of males and females respectively, with rates of increase of 0.4% per year in both sexes (Nishida and Mucavele 2005). If an obesity rate of more than 30% can be taken as a level beyond which serious reversals in LEB due to chronic disease mortality may occur, various Pacific Island nations, including Nauru, the Cook Islands, French Polynesia, Tonga, Samoa, and American Samoa, exceeded this value several decades ago and do not appear to be undergoing a reversal in LEB yet. Obesity levels are rising in most nations where records are available (Nishida and Mucavele 2005), and some Pacific Islander populations are the most obese in the world. Indeed, the populations of Nauru, the Cook Islands, French Polynesia, Tonga, Samoa and American Samoa may be close to a possible ceiling on obesity prevalence and its associated chronic disease mortality. Given that it is unlikely that any nation outside of the Pacific has reached a ceiling in obesity prevalence, careful observation and understanding of obesity and chronic disease patterns in this region is therefore of much more than local interest.

While most Asian and Pacific Island nations experienced colonization by European nations in the nineteenth and twentieth centuries, the latter gained independence later. They also experienced slower economic growth, and, in Polynesia in particular, higher levels of out-migration to industrialized nations led to the formation of significant transnational communities by the end of the twentieth century. The most characteristic health outcomes of this rapid change among Pacific Islander populations are the extraordinarily high levels of obesity, non-insulin dependent (type 2) diabetes and cardiovascular diseases in urban populations, in contrast to rural ones, and the continuing high prevalence of malaria and malnutrition in rural populations in Melanesia. In this volume, various authors examine ways in which a health pattern dominated by undernutrition and infection has been displaced in many places by obesity and the degenerative diseases associated with it. The potential impacts of emerging and resurgent infectious diseases on the trend of increasing LEBs are not ignored, since they have the potential to reverse all gains in LEB at some stage in the future. The influence of infant and young-child mortality on LEB is much greater than that of mortality in later life; furthermore, the factors influencing mortality in earlier life are much stronger agents for natural selection than those influencing mortality in later life.

Forces driving increases in levels of obesity and chronic disease include modernization and the geographical and economic relationships between Pacific Island nations and the industrialized and industrializing nations that surround the Pacific. These relationships are also explored by various authors in this volume for the Samoas, Tonga, the Cook Islands, the Solomon Islands and PNG, and in respect of emergent transnational communities that link Tonga with the United States, New Zealand and Australia; the Cook Islands with New Zealand and Australia; American Samoa with the United States; and Samoa with New Zealand.

Physical and human geography in prehistory and its implications for present-day human biology

The Asia-Pacific region is characterized by many islands bounded by Pacific Rim nations, which include China, the United States, Australia and New Zealand. The largest islands, such as Sumatra, Java, Borneo (Kalimantan), Sulawesi (Celebes) and New Guinea, lie in the west of the region, in contrast with the eastern range of this area, where scattered small islands are separated by long distances. Geomorphologically, several deep ocean troughs run in the south–north direction between the island of Bali in the west and

New Guinea in the east, these two being approximately 1,500 km apart. This zone, with its many islands, including Sulawesi, Flores, Timor, Maluku (Mollucas), Halmahera and Seram, is called Wallacea (Dickerson 1928), and makes a zoogeographic boundary between the Palaeotropical region (the Oriental subregion) and the Australian region. Among several zoogeographic lines here, the westernmost is Wallace's (or Huxley's) Line, while the easternmost is Lydekker's Line, close to Weber's Line (Simpson 1977; Hayami 1987). Tropical rainforest predominates from island South East Asia to Melanesia, with monsoon forest in several islands of Wallacea and in some portions of New Guinea, and mountainous vegetation occurring sporadically on several of the large islands. Zoogeographically, the Oriental subregion differs from the Australian region, in that placental mammals dominate in the former and marsupial mammals dominate in the latter. However, flora scarcely differs between the two regions. Another important biogeographic difference among the islands in Oceania is their size and land formation. Large continental islands such as New Guinea, New Caledonia and New Zealand contrast with medium-sized volcanic islands and small coral reefs which abound in Polynesia and Micronesia. Terrestrial flora and fauna are richer on the continental than on the volcanic islands, and both more so than on the coral reefs. In Wallacea (present-day East Indonesia), island Melanesia, Polynesia and Micronesia, however, marine food resources are abundant and were much more abundant in the past.

Wallacea had long been a barrier to human migration from the west to the east. Palaeoanthropological evidence suggests that the island of Java was inhabited by *Homo erectus* more than a half million (perhaps 750,000) years ago (Jacob *et al.* 1978), whereas Oceanian islands located east of Wallacea were not inhabited until much more recently. According to archaeological studies in Oceania, the earliest dates for two sites of human habitation, determined by thermoluminescence in northern Australia, range between 60,000 and 50,000 years before the present (Roberts *et al.* 1990, 1994). Furthermore, the oldest artefact, a stone tool discovered in the Huon Peninsula of the northeastern tip of New Guinea, has been dated to between 60,000 and 40,000 years ago (Groube 1986). Lower global temperature around 50,000 years ago was associated with a sea level lower by between 100 and 150 m than that at present. Land formations on both sides of Wallacea also differed markedly from the present day. Its western and eastern sides were, respectively, Sunda Land, comprising the Asian continent and islands of South East Asia, including Borneo, Java and Bali, and Sahul Land (Australasia), comprising New Guinea, Australia and Tasmania.

The first settlers of Oceania, who were hunter-gatherers, are likely to have crossed Wallacea by 60,000 to 50,000 years ago, using water craft such as logs or weed-bundled rafts (White and O'Connell 1982; Denoon 1997). Several tens of millennia later, when the sea level had risen to the present level, another human group, who had a markedly different material culture, crossed Wallacea. This group's habitation is evidenced by their unique Lapita red-slipped pottery with its intricate geometric patterns, and settlement remains which were discovered in the Bismarck and Solomon Archipelagos. The oldest sites in the Mussau Islands of the Bismarck Archipelago have been dated to between 3,550 and 3,500 years ago (Kirch 2000). Long-distance maritime movement of obsidian probably started from around 20,000 years ago, its trade being carried out across increasing distance by 8,000 years ago. Horticulture and arboriculture began in Near Oceania by 9,000 to 10,000 years ago, earlier than in island South East Asia to the west of the Wallace's Line. The Neolithic subsistence base of Oceanic populations was derived from South East Asia and New Guinea, never having been rice-based.

The bulk of the contemporary inhabitants of the South Malay Peninsula, Taiwan, island South East Asia and Oceania speak Austronesian languages. Historical linguistic analysis has shown that nine of ten Austronesian language subgroups were spoken by indigenous (non-Han speaking) Taiwanese, with the implication that all Austronesian languages outside Taiwan may have diversified from the same proto-Austronesian language in or near Taiwan, and then spread to the wider area (Blust 1999). The Austronesian language sphere abuts the territories of speakers of three language families, one to the east of Wallacea and the other two in mainland Asia (Capell 1969; Wurm 1982; Wurm and Hattori 1983; Bellwood 1985; Bellwood *et al.* 1995). The first is the Non-Austronesian (Papuan) complex of language families in New Guinea and its surrounding islands. The second is the Austro-Asiatic family in mainland South East Asia, while the third is the Thai family in the central and northern parts of mainland South East Asia, extending to South China.

South East Asia and the Pacific region combine elements of ancient and recent colonizations and of admixture and entry into chains of uninhabited islands with extreme founder effects, alongside the powerful and interacting selective effects of nutrition and infectious diseases. The next two chapters, by Stephen Oppenheimer and Ryutaro Ohtsuka, respectively, paint broad pictures of adaptation and health among various human populations in the Asia-Pacific region, from peopling to the present. Oppenheimer (in Chapter 2) presents new insights into population genetic traits, paying attention to their selective interactions with nutrition and

infectious diseases. Human iron deficiency is likely to have emerged as a major culturally induced change in the South West Pacific at an earlier time than in the Near East, because of the earlier transition to agriculture in New Guinea. High rates of alpha thalassaemia are shown not only to be a major cause of anaemia in coastal New Guinea populations, but, as with iron deficiency, to be protective against malaria. This disorder was probably selected for by malaria in lowland areas of Near Oceania. In the early 1980s, detailed DNA mapping of the alpha globin gene identified three deletional mutations that caused the disorder, and which were indigenous to, and geographically distributed across, this region. One of them was a good candidate marker for the population expansion giving rise to the Polynesian dispersal, while the relative distribution of the other two suggested that the Polynesian dispersal had bypassed the New Guinea mainland. Detailed analysis of mitochondrial and Y-chromosome DNA in the past decade has been consistent with this view. This has led to a now dominant view of the peopling of this region, which involves several Pacific expansions across the Holocene, from admixed communities in Wallacea.

Populations that successfully colonized the Pacific Islands may have been adapted to periodic food shortages through biological selection of individuals with more efficient metabolism; while this would have favoured them in the past, the emergence of plentiful diet in the second half of the twentieth century has probably penalized this adaptation. Some present-day Pacific Island nations, such as those of Tonga, Nauru, the Cook Islands, American Samoa, Samoa and French Polynesia, have among them the highest rates of obesity in the world, as well as very high rates of cardiovascular diseases and type 2 diabetes. Ohtsuka (in Chapter 3) examines migration histories of Pacific populations from a biocultural perspective, and identifies some of the changing environmental circumstances which may have led to changes in adaptation and health of present-day Melanesian populations in PNG.

Modernization and health change

While patterns of health change in the Asia-Pacific region are outcomes of powerful economic and political forces across the twentieth century, they are also contingent upon cultural and ecological processes in history and prehistory. Factors influencing health in the prehistoric and pre-colonial past include patterns of migration, transitions in subsistence ecologies, and economic change associated with changing exchange patterns across the

region. Social factors influencing human population size, distribution and health during the colonial period in many countries of the region include different models of colonial administration and different patterns of economic modernization. Western health workers reached the Pacific from the 1880s onwards, after devastating epidemics that seemed to threaten the survival of whole populations. Depopulation was the focus of government anxiety, missionary alarm and scholarly concern up to, and including, the 1950s (Ulijaszek 2006). Before the divorce of anthropology and psychology from medicine, multi-disciplinary analysis was the usual way of trying to understand such crises. Once depopulation fears faded in the decades after the Second World War (Ulijaszek 2006), and segregation, quarantine and anti-malarial medication were seen to keep Europeans alive, the Pacific became an arena for the development of new public health responses. The new availability of penicillin and sulfa drugs prompted quasi-military health campaigns in the Pacific against specific diseases, until the advent of primary health care in the 1970s. Since colonial administrations accepted a mandate to improve population health, and usually had adequate resources for this task, overt arguments over health policies and programmes surfaced mainly after political independence in many nations of the Asia-Pacific region. Resources became more limited, and the cost-effectiveness of fulfilling colonial mandates for health and other areas came to be questioned increasingly. Global health campaigns, as promoted by the World Health Organization and other agencies, often came into opposition with local realities. Some populations have seen far-reaching changes associated with entry into the cash economy in the context of broader economic modernization, including changes in diet, morbidity and mortality, while others have seen less change. Patterns of nutritional health varied and continue to vary enormously, from high levels of under-nutrition in some societies, to a dominance of overnutrition in others.

The nations of South East Asia have varied enormously in their economic profiles across the second half of the twentieth century, poor nutrition remaining a significant contributor to morbidity and mortality in most nations, but overnutrition increasingly becoming a contributor to poor health in places where increased economic prosperity has emerged. In Chapter 4, Geoffrey Marks describes how urbanization, and social and political changes in South East Asia have led to more complex patterns of nutritional health. Where poor nutrition remains prevalent, protein-energy malnutrition and deficiencies of vitamin A, iodine and iron are the most common manifestations of this. Overnutrition has led to increased rates of cardiovascular disease, type 2 diabetes and cancer. Marks argues that while changes in nutritional health are clear to see,

there are also changes in community expectations, governance and other factors that affect how agencies might respond to improved population health. The traditional divide between urban and rural populations is now less important as a classifier of nutritional health in South East Asia, and the nutrition agenda in all countries now involves both undernutrition and overnutrition among most age groups, and not just among young children and women of reproductive age.

Overnutrition has become an increasingly important contributor to chronic disease morbidity and mortality in one nation of South East Asia – Hong Kong. Recent studies of body fat percentage and BMI in the Hong Kong Chinese population have identified lower BMI cut-offs as being more salient for the identification of overweight and obesity than in the case of European populations; in contrast, BMI cut-off values for Pacific Islander populations are higher than those recommended for Europeans. In Chapter 5, Gary Ko shows that Hong Kong Chinese people, and perhaps Chinese elsewhere, may be prone to obesity-associated morbidities at lower BMI levels than Europeans.

The large body size and muscular build of Pacific Islanders was noted by Europeans from the time of Captain Cook's voyages (Pollock 1995). Photographs taken in the 1800s also indicate that body fatness was common among the higher classes of Islander societies (Baker 1984). However, there is little evidence of significant body fatness more generally across all levels of Pacific Islander societies prior to the Second World War. The emergence of fatness and obesity generally among Pacific Islander populations began during the second half of the twentieth century, this being largely attributed to health impacts of economic modernization. Most importantly, dietary change and changes in patterns of physical activity associated with levels of education, occupational status, and rural residence have been invoked as being central to the emergence of obesity in this region (Evans and Prior 1969; Bindon and Baker 1985; McGarvey 1991).

Historically, traditional diets of the populations of the Pacific Islands and Melanesia have been very low in fat, and high in complex carbohydrates, dietary fibre, and foods of plant origin (Shintani and Hughes 1994). Dietary change in the Pacific region has been documented, showing a higher contribution of fat and protein to total energy intake among urban communities than among those practising traditional subsistence (Ringrose and Zimmet 1979; Hanna *et al.* 1986; Hezel 1992). In Chapter 6, Yamauchi describes changes in diet and physical activity among Highlanders in PNG and among coastal Solomon Islanders. Although the increased consumption of energy-dense store-bought foods explains some of the difference in body fatness between urban and rural New

Guinea Highlanders, reduced physical activity is as important. In particular, the decline in gender inequality in the division of labour in the urban populations, which caused the greater decline in physical activity of women, may go some way to explaining their greater body fatness relative to males. In contrast, there was no difference in body fatness between the rural and urban Solomon Islander populations. The traditional diet in the Solomon Islands, based on fish, root crops, and coconut, is nutritionally good, and it is perhaps unsurprising that the nutritional status of rural villagers is similar to that of the more modernized villagers. Unlike the groups seen in PNG, Yamauchi finds no clear difference in physical activity between traditional and more modernized Solomon Islander women, although traditional village men were more physically active than their more modernized counterparts. Yamauchi concludes that the less modernized Solomon Islander population is at an earlier stage of transition from subsistence to cash economy. Thus the influence of modernization on nutritional health is only partly manifest, but constitutes a potential health risk for the future.

While modernization and urbanization took place quickly in the Pacific after the Second World War, with far-reaching effects on human biology, the effects of these changes continue to penetrate many isolated Pacific islands to the present day. In Chapter 7, Tsukasa Inaoka and colleagues describe changing lifestyles, and associations between obesity and metabolism-related factors among the Tongan population in Tonga. The majority of Tongans live in urban areas, although rural populations are not very isolated when compared with populations in many other countries in the region, including PNG, the Solomon Islands and Vanuatu. In addition, about 100,000 Tongan citizens are out-migrants to various developed countries, including the United States, Australia and New Zealand. Many Tongans move between their own country and that of overseas residence, and flows of information between Tonga and the larger developed nations to which they migrate are great, as are remittances from out-migrants to Tongan relatives. For these reasons, it is unlikely that the rate of lifestyle modernization and the concomitant rise in obesity and non-infectious disease mortality will slow down there in the near future.

In Chapter 8, Ember Keighley and colleagues present data on physical and dietary characteristics of modernizing Samoans on independent Samoa, American Samoa and Hawaii respectively. In both Samoas, the prevalence of obesity increased between 1976 and 2003, to one of the highest levels on earth. Levels of overweight and obesity among adults in American Samoa in the 1970s matched the levels in Samoa some 30 years later. Furthermore, levels of overweight in children and adolescents from

Hawaii in the 1970s presaged overweight in youth living in American Samoa in 2002. If current trends continue, Keighley and colleagues speculate, they may also be indicative of future levels of overweight among youth living in Samoa. Prevalence of type 2 diabetes is over one-third higher for all age-sex groups in American Samoa relative to Samoa. Furthermore, rates of type 2 diabetes are increasing rapidly in both Samoas. Exposure to environments predisposing to obesity and diabetes is high and ubiquitous at all levels of Samoan society.

Migration, transnationalism and nutritional health

While European contact with Pacific Islander populations largely took place over 200 years ago, significant migrations of Pacific Islanders to colonizing nations began only in the 1920s, when Samoans and Tongans migrated to Hawaii in large numbers. The greatest influx of Samoans to Hawaii came in the 1950s with the end of US naval administration in American Samoa, but migration has continued at a steady rate to the present day. Of Pacific Islanders living abroad, most are in the United States (about a quarter of a million subjects in the year 2000) (United States 2000 Census 2002). Pacific Islanders have a more recent demographic history in New Zealand. In 1945, there were just over 2,000 people of Pacific origin there. While there was a period of high immigration in the early 1970s, this inflow slowed in the late 1970s, as social, economic and labour market conditions in New Zealand became less favourable. In the early 1980s, the flow reversed, when return migration to the Pacific and chain migration to Australia combined exceeded immigration to New Zealand. Immigration increased again by the end of the decade, and by the year 2001, the number of Pacific Islanders in New Zealand was about 6% of the total resident population, at 232,000 (Statistics New Zealand 2002). In France, Pacific Islander immigration from French colonies has taken place since the beginning of the twentieth century. France is estimated to have had a Pacific Islander population (mostly from French Polynesia) of around 233,000 at the turn of the twenty-first century (Ulijaszek 2005). In Australia, migration of Pacific Islanders was already in place prior to 1950, but increased greatly in the early 1980s. In 1971, the Pacific Islander population of Australia was 23,000 strong; by 1996, there were 96,000 of them, mostly living in the cities of Sydney and Melbourne.

Increasingly, Pacific Islander migrants have been able to maintain closer links with their communities in their nation of origin than were ever possible prior to cheap communication and transport. This has both reduced the

economic risk associated with migration and has favoured the returning of remittances to home communities. Most transnational populations possess urban character. In the early 1970s, first the Niuean and then the Cook Island populations in New Zealand exceeded those of their home island populations (Hau'ofa 1994). In the Cook Islands, the population has shown little increase between 1950 and 2000 (National Statistical Office 2001). However, Cook Islander migrants in New Zealand and Australia came to outnumber island residents by about two to one by the year 2001 (Ulijaszek 2005). Other Pacific Island nations where migrants outnumber, or are likely to outnumber island residents, include Tonga, Wallis and Fortuna, Tokelau and Niue. While there are no strong links between the proportion of migrants from Pacific Island nations and major indicators of economic performance and prosperity in those nations, links between migrants and relatives on their island nations of origin operate to generate tastes for imported foods and in providing remittances which can be used to buy foods and other goods by those living on the home islands. Such migrations have had profound impacts on health of Pacific Islanders both at home and abroad. Most important has been the emergence of obesity and fatness, cardiovascular disease and type 2 diabetes as significant public health problems in Pacific Island nations.

Among migrants from the Asia-Pacific region to more industrialized and increasingly post-industrial nations, there have been dramatic changes in health patterns, sometimes regressing to the greater health pattern of the host nation, but often differing from it in important ways. Parker Frisbie and colleagues (in Chapter 9) examine the extent of heterogeneity in health outcomes among various Asian and Pacific Islander populations in the United States. While most of the larger Asian American subgroups, including those of Chinese, Philippino, Korean and Japanese origin, exhibit fairly healthy profiles, indigenous Hawaiians and Samoans do not. Nor do some of the smaller Asian American subgroups, such as Laotians, Cambodians and Hmong.

Cook Islander transnationalism predominantly spans the Cook Islands, New Zealand and Australia. Stanley Ulijaszek (in Chapter 10) describes changes in the extent of obesity and fatness since the 1950s among adult Cook Islanders living on Rarotonga, the most economically developed of the Cook Islands. The influences of diet, physical activity, modernization and transnationalism on blood pressure, body fatness (as assessed by BMI) and fasting blood glucose of adult Cook Islanders on Rarotonga in the 1990s are examined, and comparisons made with the same measures carried out among Cook Islanders living in Melbourne, Australia. Cook Islanders on Rarotonga have undergone increases in BMI since the 1950s, although

rising blood pressure, while already high by the 1960s, appears to have been kept in check by good compliance to anti-hypertension medication. The importance of transnational connections for elevated blood pressure is demonstrated, as is the importance of physical activity for BMI of males but not females. Diet does not emerge as a factor in the prevalence of obesity, hypertension and diabetes in the Cook Islands, perhaps because transnational factors play stronger roles in all aspects of health-related behaviour and not dietary patterns alone. The Cook Islander population of Australia is younger than that resident in Rarotonga, and shares physical and dietary characteristics of the Rarotongan population of similar age.

In Chapter 11, Alistair Woodward and Tony Blakely examine inequalities in health and wealth across Pacific Island nations, Australia and New Zealand, and their impacts on mortality. They find that the greatest differences in mortality between indigenous and non-indigenous populations are found within the latter two nations. While social and economic deprivation contributes to the gap in life expectancy between Maori and non-Maori, and between Australian Aboriginal and non-Aboriginal people, these differences cannot be attributed wholly to economic factors. Within economically deprived categories, mortality rates for indigenous peoples are higher than those for non-indigenous people. Woodward and Blakely draw a parallel between industrialization in Europe in the 1800s and changes taking place in the Asia-Pacific region now. As the former brought new health problems, particularly for those with few resources, while empires were built and fortunes accrued by others, so modernization in the latter has led to new health problems, but of a different kind from the former. The social consequences of rapid social and economic change in the Pacific are mixed, having brought benefits to some, but having placed others into economic hardship and poor health.

Health transition and biocultural adaptation

The dominant narrative of the majority of the chapters preceding the final one is that of decline in infectious disease mortality and increase in obesity and the chronic disease mortality associated with it. Robert Attenborough (in Chapter 12) shows that this is not a universal narrative in the Asia-Pacific region. By focusing on health change in PNG, he emphasizes that the immediate health outlook there is not one dominated by the diseases of modernization, as it makes its transition from tradition to modernity. While adaptation to long-term stressors such as malaria has been demonstrated, Attenborough points to breakdown in adaptation during rapid

change in environment or way of life, and with this, the emergence of new health problems, including circulatory disease, diabetes and asthma. While the diseases associated with modernization are becoming epidemiologically important in some communities, non-infectious disease is also a matter for real and rising concern (Temu 1991; Tefuarani *et al.* 2002). In PNG as elsewhere, reality is more complex than many of the models of health change, and Attenborough notes that it would be dangerously misleading to ascribe any type of automatism to the health transition process. It is by no means clear in PNG that time and economic development will be sufficient to ensure that lifestyle-related diseases will eventually overtake infections, or even that gains so far in the control of infection and increases in LEB are secure for the future. Malnutrition, diarrhoea and measles continue to cause uncontrolled problems; tuberculosis is increasing; and most saliently, the emergence of HIV/AIDS threatens a large increase in the infectious death toll, while malaria is developing in increasingly dangerous ways.

The *final chapter* begs a broader question: how likely is it that epidemiological and nutritional transitions will run their course in predictable ways in this region? The biological and physical environment of the Asia-Pacific region continues to change at an unprecedented rate, and these changes are likely to continuously have effects on health. Transition models would predict continued increases in obesity levels and the chronic diseases associated with it. Various nations, including Singapore, Malaysia, Japan and South Korea have undergone health transition, but have attained low obesity prevalences relative to most European and North American nations. In the Pacific Island nations, health transition has taken place in French Polynesia and continues to take place in Samoa, Tonga and the Cook Islands; in these nations, obesity rates exceed enormously even the very highest rates of non-Pacific Island nations. It is thus possible to postulate two health transition models for the Asia-Pacific region: one that involves rapidly increasing rates of obesity to exceptionally high levels (as in the Pacific Island nations), and another that involves increases in obesity only to comparatively low levels (as in the modernized nations of East Asia).

The present patterns of obesity in the Pacific Island nations are outcomes of conjoining forces across the past 50 years or so. These include (1) continuing economic development with comparatively few serious setbacks; (2) food security that has increased for most of the region; (3) the penetration of the world food system, even to some of the remotest islands of the Pacific; (4) declining prices for energy-dense foods; (5) progressive mechanization of labour-intensive tasks; (6) urbanization and sedentarization

of work life; and (7) increasing mechanization of transport. It is unlikely that there will be a reversal in obesity prevalence trends in the Pacific Island nations at any stage in the near future. A ceiling on the potential for obesity prevalence in the populations of the Pacific Islands is unlikely to have been reached anywhere apart from perhaps Tonga, where 79% of the adult population has BMI greater than 30 kg/m². Some hope for declines in obesity prevalence rates comes from studies of appropriate body size in modernizing societies. Obesity is also an outcome of cultural and symbolic over-valuation of food in the context of plenty and such over-valuation declines as subsequent generations are born into good times. A number of communities and societies in which obesity has risen across recent decades, and who previously were shown to desire and/or accept larger bodies and obesity, now prefer thinner bodies. This has been observed among Pacific Islanders (Craig *et al.* 1996; Brewis *et al.* 1998; Becker *et al.* 2005) and Korean children (Lee *et al.* 2004), as well as groups elsewhere in the world (Story *et al.* 1995; Rinderknecht and Smith 2002; Katz *et al.* 2004).

While infant mortality rates have declined universally in the Asia-Pacific region between 1978 and 1998, a number of infectious diseases, including tuberculosis and malaria, have spread geographically, increasingly in more virulent and drug-resistant forms. HIV/AIDS has emerged as a new infectious disease which, without drug therapy, is almost universally fatal. Countries in the region with continuing high infectious disease mortalities include Indonesia, Thailand, Laos, Cambodia and Vietnam. Although HIV/AIDS and tuberculosis are predicted to account for the overwhelming majority of deaths from infectious diseases in Africa by 2020, this is much less likely to be so for the Asia-Pacific region. Adult HIV prevalence rates vary from well below 0.1% in Japan and South Korea, to 0.4% in Malaysia, 0.6% in PNG and 1.5% in Thailand (UNAIDS 2005). These rates are well below the rate necessary to cause a decline in LEB. Figure 1.2 shows adult HIV prevalence rates in 36 African nations according to whether or not they experienced a decline in LEB across the years 1990 to 2000. In the vast majority of African nations where adult HIV prevalence rates exceed 5%, LEB is declining, due to high AIDS mortality. Nearly all African nations with rates below this level have stable or increasing LEB. Even if HIV/AIDS proceeded unabated and untreated, it would take a decade or more for the two nations with the highest current adult HIV prevalence rate in the region (Thailand and PNG) to reach 5% adult HIV prevalence, beyond which LEB could undergo decline.

What goes around, comes around. And to complete the circle it is necessary to return to genetic adaptation. A range of genetic susceptibilities and

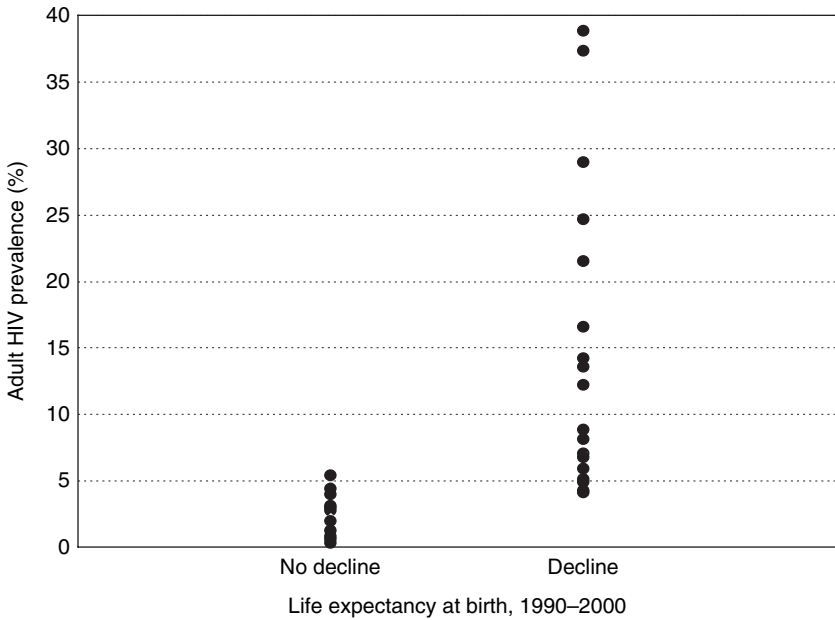


Fig. 1.2. Adult HIV prevalence in 36 African nations according to whether or not life expectancy at birth underwent decline between 1990 and 2000 (data from UNAIDS 2005).

resistances to infectious diseases have been demonstrated among various populations across the world (Hill 1999).

Human leucocyte antigen (HLA) allele variants have been associated with resistance to various infectious diseases such as malaria, AIDS, and hepatitis B and C (Segal and Hill 2003). HLA allele variants have also been associated with susceptibility to tuberculosis, AIDS, typhoid fever and leprosy (Segal and Hill 2003). It is probable that genetic adaptation to malaria will continue in the Asia-Pacific region, even as malarial parasites develop resistance to the medication used for treating it. Genetic susceptibility to tuberculosis has been demonstrated in the region, specifically in Cambodia (Goldfeld 2004), as well as elsewhere in the world (Fernando and Britton 2006). Human host genetic variants of CCR2 and CCR5 genes have been shown to influence susceptibility to, and progression of, HIV infection in various populations (Blanpain *et al.* 2002; Anastassopoulou and Kostrikis 2003; Julg and Goebel 2005; Shrestha *et al.* 2006), including one in South East Asia (Capoulade-Metay *et al.* 2004). It is likely that further evidence for genetic variation in susceptibility to HIV-1 will emerge in the Asia-Pacific region, as elsewhere in the world. Concurrent with

emerging knowledge of genetic variation in susceptibility to HIV, the virus continues to develop resistance to medication used to manage the process of the infection.

To conclude, it seems both unlikely that an epidemiological end-point will occur in the Asia-Pacific region at any time in the near future, and that there will be only one epidemiological end-point. While liberal democracies and free markets may be significant drivers of the nutrition and health transition in the region, it is not yet clear whether they will continue to be so into the future with no significant challenge, either environmental or ideological. In the meantime, infectious disease continues to present new challenges, if not yet a serious threat to the health transition in this region.

References

- Anastassopoulou, C. G. and Kostrikis, L. G. (2003). The impact of human allelic variation on HIV-1 disease. *Current HIV Research* **1**, 185–203.
- Baker, P. T. (1984). Genetics and the degenerative diseases of South Pacific Islanders. In *Migration and Mobility*, ed. A. Boyce. London: Taylor and Francis Ltd, pp. 209–40.
- Becker, A. E., Gilman, S. E. and Burwell, R. A. (2005). Changes in prevalence of overweight and in body image among Fijian women between 1989 and 1998. *Obesity Research* **13**, 110–17.
- Bellwood, P. (1985). *Prehistory of Indo-Malaysian Archipelago*. Sydney: Academic Press.
- Bellwood, P., Fox, J. J. and Tryon, D. (1995). The Austronesians in history: common origins and diverse transformations. In *The Austronesians: Historical and Comparative Perspectives*, ed. P. Bellwood, J. J. Fox and D. Tryon. Canberra: The Australian National University, pp. 1–16.
- Bindon, J. R. and Baker, P. T. (1985). Modernization, migration and obesity among Samoan adults. *Annals of Human Biology* **12**, 67–76.
- Blanpain, C., Libert, F., Vassart, G. and Parmentier, M. (2002). CCR5 and HIV infection. *Receptors and Channels* **8**, 19–31.
- Blust, R. (1999). Subgrouping, circulatory and extinction: some issues in Austronesian comparative linguistics. *Symposium Series of the Institution of Linguistics of Academia Sinica* **1**, 31–94.
- Brewis, A. A., McGarvey, S. T., Jones, J. and Swinburn, B. A. (1998). Perceptions of body size in Pacific Islanders. *International Journal of Obesity and Related Metabolic Disorders* **22**, 185–9.
- Capell, A. (1969). *A Survey of New Guinea Languages*. Sydney: Sydney University Press.
- Capoulade-Metay, C., Ma, L. Y., Truong, L. X., et al. (2004). New CCR5 variants associated with reduced HIV coreceptor function in Southeast Asia. *AIDS* **18**, 2243–52.

- Craig, P., Swinburn, B., Matenga-Smith, T., Matangi, H. and Vaughan, F. (1996). Do Polynesians still believe that big is beautiful? Comparison of body size perceptions and preferences of Cook Islands, Maori and Australians. *New Zealand Medical Journal* **14**, 200–3.
- Denoon, D. (1997). Production in 'Pacific Eden? Myths and realities of primitive affluence'. In *The Cambridge History of the Pacific Islanders*, ed. D. Denoon. Cambridge: Cambridge University Press, pp. 83–90.
- Dickerson, R. E. (1928). *Distribution of Life in the Philippines*. Philippines Bureau of Sciences Monograph No. 21, Manila.
- Evans, J. G. and Prior, I. A. M. (1969). Indices of obesity derived from height and weight in two Polynesian populations. *British Journal of Preventive and Social Medicine* **23**, 56–9.
- Fernando, S. L. and Britton, W. J. (April 2006). Genetic susceptibility to mycobacterial disease in humans. [Review] [164 refs] [Journal Article. Review] *Immunology & Cell Biology* **84**(2), 125–37.
- Goldfeld, A. E. (2004). Genetic susceptibility to pulmonary tuberculosis in Cambodia. *Tuberculosis* **84**(1–2), 76–81.
- Groube, L. M. (1986). Waisted axes of Asia, Melanesia, and Australia. In *Archaeology at ANZAAS Canberra*, ed. G. K. Ward. Canberra: The Australian National University Press, pp. 168–77.
- Hanna, J. M., Pelletier, D. L. and Brown, V. J. (1986). The diet and nutrition of contemporary Samoans. In *The Changing Samoans: Behavior and Health in Transition*, ed. P. T. Baker, J. M. Hanna and T. S. Baker. New York: Oxford University Press, pp. 275–96.
- Hau'ofa, E. (1994). Our sea of islands. *The Contemporary Pacific* **6**, 147–62.
- Hayami, I. (1987) Geohistorical background of Wallace's Line and Jurassic marine biogeography. In *Historical Biogeography and Plate Tectonic Evolution of Japan and East Asia*, ed. A. Taira and M. Tashiro. Tokyo: Terra Publisher, pp. 111–33.
- Hezel, F. X. S. J. (1992). Expensive taste for modernity: Caroline and Marshall Islands. In *Social Change in the Pacific Islands*, ed. A. B. Robillard. London: Kegan Paul International, pp. 203–19.
- Hill, A. V. S. (1999). Genetics and genomics of infectious disease susceptibility. *British Medical Bulletin* **55**, 401–13.
- Jacob, T., Soejono, R. P., Freeman, L. G. and Brown, R. H. (1978). Stone tools from Mid-Pleistocene sediments in Java. *Science* **202**, 885–7.
- Julg, B. and Goebel, F. D. (2005). Susceptibility to HIV/AIDS: an individual characteristic we can measure? *Infection* **33**, 160–2.
- Katz, M. L., Gorden-Larsen, P., Bentley, M. E., *et al.* (2004). 'Does skinny mean healthy?' Perceived ideal, current, and healthy body sizes among African-American girls and their female caregiver. *Ethnicity and Disease* **14**, 533–41.
- Kirch, P. V. (2000). *On the Road of the Wind: An Archaeological History of the Pacific Islands before European Contact*. Berkeley: University of California Press.

- Lee, K., Sohn, H., Lee, S. and Lee, J. (2004). Weight and BMI over 6 years in Korean Children: relationships to body image and weight loss efforts. *Obesity Research* **13**, 1959–66.
- McGarvey, S. T. (1991). Obesity in Samoans and a perspective on its etiology in Polynesians. *American Journal of Clinical Nutrition* **53**, 1586S–94S.
- National Statistical Office (2001). *Cook Islands Annual Statistical Bulletin*. Rarotonga: National Statistical Office.
- Nishida, C. and Mucavele, P. (2005). Monitoring the rapidly emerging public health problem of overweight and obesity: the WHO global database on body mass index. *United Nations System Standing Committee on Nutrition* **29**, 5–12.
- Olshansky, S. J., Passaro, D. J., Hershow, R. C., *et al.* (2005). A potential decline in life expectancy in the United States in the 21st century. *New England Journal of Medicine* **352**, 1138–45.
- Pollock, N. J. (1995). Social fattening patterns in the Pacific – the positive side of obesity. A Nauru case study. In *Social Aspects of Obesity*, ed. I. de Garine and N. J. Pollock. Amsterdam: Gordon and Breach, pp. 87–109.
- Rinderknecht, K. and Smith, C. (2002). Body-image perceptions among urban Native American youth. *Obesity Research* **10**, 315–27.
- Ringrose, H. and Zimmet, P. (1979). Nutrient intakes in an urbanized Micronesian population with a high diabetes prevalence. *American Journal of Clinical Nutrition* **32**, 1334–41.
- Roberts, R. G., Jones, R. and Smith, M. A. (1990). Thermoluminescence dating of a 50,000-year old human occupation site in northern Australia. *Nature* **345**, 153–6.
- Roberts, R. G., Jones, R., Spooner, N. A., *et al.* (1994). The human colonization of Australia: Optical dates of 53,000 and 60,000 years bracket human arrival at Deaf Adder Gorge, Northern Territory. *Quaternary Science Review* **13**, 575–86.
- Segal, S. and Hill, A. V. S. (2003). Genetic susceptibility to infectious disease. *Trends in Microbiology* **11**, 445–8.
- Shintani, T. T. and Hughes, C. K. (1994). Traditional diets of the Pacific and coronary heart disease. *Journal of Cardiovascular Risk* **1**, 16–20.
- Shrestha, S., Strathdee, S. A., Galai, N., *et al.* (2006). Behavioral risk exposure and host genetics of susceptibility to HIV-1 infection. *Journal of Infectious Diseases* **193**, 16–26.
- Simpson, G. G. (1977). Too many lines: the limits of the Oriental and Australian zoogeographical regions. *Proceedings of the American Philosophical Society* **121**, 63–6.
- Statistics New Zealand (2002). 2001 Census of population and dwellings. <http://www.stats.govt.nz> (accessed September 2005).
- Story, M., French, S. A., Resnick, M. D. and Blum, R. W. (1995). Ethnic/racial and socioeconomic differences in dieting behaviors and body image perceptions in adolescents. *International Journal of Eating Disorders* **18**, 173–9.
- Tefuarani, N., Sleigh, A. and Hawker, R. (2002). Congenital heart diseases: a future burden for Papua New Guinea. *Papua New Guinea Medical Journal* **45**, 175–7.

- Temu, P. I. (1991). Adult medicine and the 'new killer diseases' in Papua New Guinea: an urgent need for prevention. *Papua New Guinea Medical Journal* **34**, 1–5.
- Ulijaszek, S. J. (2005). Modernisation, migration, and nutritional health of Pacific Island populations. *Environmental Sciences* **12**, 167–76.
- (ed.) (2006). *Population, Reproduction and Fertility in Melanesia*. Oxford: Berghahn Books.
- UNAIDS (2005). Country data. www.unaids.org (accessed March 2006).
- United Nations University (2006). Globalis – an interactive world map. Life expectancy at birth. www.gvu.unu.edu (accessed March 2006).
- United States 2000 Census (2002). <http://www.tetrad.com/pcensus/usa/census2000data.html> (accessed September 2005).
- White, J. P. and O'Connell, J. F. (1982). *A Prehistory of Australian, New Guinea and Sahul*. Sydney: Academic Press.
- Wurm, S. A. (1982). *Papuan Languages of Oceania*. Tübingen: Gunter Narr Verlag.
- Wurm, S. A. and Hattori, S. (eds.) (1983). *Language Atlas of the Pacific Area*, Part 2. Canberra: Australian Academy of Humanities.

2 *Interactions of nutrition, genetics and infectious disease in the Pacific: implications for prehistoric migrations*

STEPHEN OPPENHEIMER

Introduction

Like some huge natural experiment in population genetics and evolution, South East Asia and the Pacific region combine elements of ancient and recent colonizations, of admixture and of entry into chains of uninhabited islands with extreme founder effects alongside the powerful and interacting evolutionary selective effects of nutrition and infectious disease. New Guinea was one of the first places in the world to achieve its own Neolithic revolution. This may have signalled the onset of specific micronutrient deficiencies, in particular of iron. Neolithic sedentary behaviour may have also increased transmission of malaria. Malaria is a major lethal disease in South East Asia and lowland Near Oceania although not in Far Oceania and, since the Late Pleistocene, has exerted strong selective effects promoting genetic disorders of globin-chain and red cell production. Overlaying this selective mechanism is an exquisite three-way interaction between micronutrient availability (in particular iron), infectious disease (in particular malarial susceptibility) and genetic protection (in particular alpha-globin gene deletions). The Holocene change from mobile hunting and gathering to arboriculture, horticulture and sedentary living may have acted to increase the level of iron deficiency in early childhood both as a result of nutritional inadequacy and as a secondary result of malaria and genetic causes of anaemia in the iron stores of newborn infants. Over-enthusiastic attempts to correct such deficiency have the unfortunate effect of increasing both malarial and non-malarial infectious morbidity.

Early clinical research on such interactions had the serendipitous result of unearthing evidence of ancient migrations and genetic relationships in the region. Unique genotypes for red cell disorders are geographically