SECTION II

THE DYNAMICS OF DISEASE OCCURRENCE
Chapter 2
CHAPTER 2

HEALTH TRANSITIONS: HEALTH DETERMINANTS AND DISEASE OCCURRENCE

2.1. SUMMARY

Introduction  The second chapter justifies the selection of the research theme and chosen modelling approach. It gives an outline of the current health issues in various world regions using concepts from the health transition theory and epidemiological understanding of disease occurrence.

Methods  A review of the health transition literature.

Results  It gives an overview how most populations of the world during the past two centuries experienced increases in social welfare and economic development and entered the health transition. The result has been an increase in life expectancy and an increase in size and ageing of the world’s populations with an unprecedented demand for societal resources. In consequence, all over the world, societies are confronted with a huge demand also for health resources due to increased survival and the ageing process. The investments during the later stages of life need to be greater as they show diminishing returns. In contrast, in the poorer regions of the world, population increases have caused a pressing need for continuing investments to just maintain present health standards. The awareness has grown that the natural assets relevant to human health, especially food and water, are scarce and diminishing. At the same time, there is hope. The past decades have shown that, at relatively low budgets per capita, modern insights in prevention and treatment have a lot to offer to the poorer nations.

Conclusion  The description of the patterns of changing population health leads to the postulate that in an analytic approach to population health issues one has to account for multiple roads towards health i.e. multiple health determinants, diseases and interventions, within each stage of the health transition. In addition, the approach has to account for both morbidity and mortality as the important outcomes. Multi-state modelling of population health and resource use seems to be a methodology that can incorporate these aspects. This is the core theme of this book.
2.2. HEALTH TRANSITIONS

In the coming section we give a justification of our approach and summarize the population and health issues that we address. We first outline the theory on the health transition and then we give an overview of the various health problems during the health transition stages. Last, it leads to the postulate that multiple roads to health are possible, both at an aggregate level of general population health and at a disease specific level. It leads to the conclusion that multi-state modelling might be a suitable analytic approach.

During the past century, most world populations have experienced an increase in their levels of social welfare and economic development. These changes have shown a concomitant increase in the average life expectancy at birth and a decrease, although slower, in fertility levels (World Bank, 1993; UNFPA, 1995). The result has been an increase in worldwide population size and a demand for resources unprecedented in history (WCED, 1987; UN, 1992). Reduction of health risks and increased access to health services have resulted in a worldwide average life expectancy of more than 65 years with a simultaneous increase in population size. Although the fertility rates are dropping, for some countries even rapidly, the global population is still growing with 1.5% per year. Presently, world population size in the year 2050 is estimated to be determined for about 50% merely by the present size of the fertile female population. The remaining 50% is thought to be determined for one third by the continuing increase in life expectancy and for two third by fertility levels beyond replacement level (Bulatao, 1989). In addition, ageing societies across the world are confronted with an excess demand for health resources due to the ageing process itself. Investments in health provision in a later stage of life need to be greater as they show diminishing returns (Kane, 1990). In contrast, in the poorer world regions, population increases have caused a pressing need for continuing investments to just maintain health standards (Evans et al., 1981; World Bank, 1993). The awareness has grown that in these regions the environmental assets relevant to human health, especially food and water, are scarce and diminishing (WCED, 1987).

The theory that addresses changes in population size and health in one general frame of reference is that of the health transition (Caldwell et al., 1986; Caselli, 1991, 2002; Bobadilla et al. 1993; Murray et al. 1994; Ness, 1993; Pollard, 1990; Possas, 1995). The health transition is defined as including all these changes as well as the concomitant changes in the organization of social and health-related services (Frenk et al. 1994). Its theory describes how populations may go through typical demographic and health stages (Figure 2.1) when they change from living in pre-industrial conditions to those of post-modern societies (Omran, 1971). High fertility levels and a low life expectancy with an epidemiological pattern of infectious diseases characterize the early stages. In the last recognized stages low levels of fertility are dominant sometimes even below replacement level, life expectancy is high and diseases are postponed until the last years of life. The changes in fertility and mortality often have a different timing. Also specific sub-populations may find themselves in varying stages of these two processes (Robinson, 1992 on Kenya or Bobadilla, 1993 on Mexico). The basic idea of this theory is that in general there is a convergence of developmental directions, with some exceptions (Caselli, 2002).
can be concluded that, on an aggregated level and on a long-term basis, convergence is often the case and can be generalized somehow for at least the various world regions. In case of more specific research or policy questions that are related to a particular period, situation and population, one has to account for particularities and exceptions.

![Figure 2.1. The three stages within the health transition. The left y-axis (-----) shows the change in life expectancy and the right y-axis (----) the change in fertility. Bold numbers are the three transition stages (see 2.3).]

2.3. POPULATION HEALTH ISSUES BY TRANSITION STAGE

Unbalanced socio-economic development and unbalanced investments in social and medical services during the past five decades have lead to the characteristic population and health issues as we outline them (WCED, 1987; World Bank, 1993). They are all related to access and distribution of resources. They can be categorized by their relationship with the three stages of the health transition (Figure 2.1). They are: a first stage of high mortality in the early phases of the health transition, an intermediate stage with declining mortality and health deficits among populations in the midst of the transition with a growth in population size and more competition for resources, and a last stage with low mortality and associated health needs of aged populations in a presumably new steady state with a near zero, or even a negative population growth, with fertility controlled and survival improving even more. We summarize the stages in the next sections.

2.3.1. HIGH MORTALITY STAGE

As said, in almost all countries of the world, mortality and fertility rates are dropping, often fast. Still, there are huge unmet needs for broad and more specific
health measures as concluded by the international agencies (UNDP, 1995: UNFPA, 1995: UNICEF; 1995). Accumulated mortality risks throughout the fertile period still might be ranging from 1 out of 40 in South Asia to 1 out of 20 in Africa (Graham, 1995) and their contribution to the total health burden is large (Figure 2.2). Conditions related to reproduction are mostly preventable and/or curable. Policies that are proposed vary from broader socio-economic interventions such as education and labor to more health service orientated investments related to maternal health and family planning (UNDP, 1995; Hutter et al., 1995). Countries in this stage show many disparities in general health also (Pannenborg 1978; Mosley and Cowley, 1991; World Bank 1993). Agreement seems to be growing that both socio-economic inputs and essential preventive and curative health interventions can contribute to health levels (McKeown, 1976; Preston, 1980; Murray, 1994; Phillips and Verhasselt, 1994). A major complication is that health determinants can be substituting, complementary and synergetic (King, 1990; Niessen and Hilderink, 1997). The effects of single disease interventions tend to be tempered considerably because of this. Preventable and curable diseases form a major part of global total burden of diseases and amount to about 25 million deaths annually (Figure 2.2: about the difference between the two columns). Environmental change, like air pollution and climate change may contribute to the existing damaging health effects of environmental factors. Yet there is a need for the development of methodologies to account for these effects (Martens et al., 1995; Leaf, 1989; Doll, 1992).

Figure 2.2. World-wide distribution of deaths in millions in 1985 (Lopez, 1990).

Health policy makers need analyses of questions on what the effective interventions are to improve prevention of infectious diseases, to improve survival, to improve reproductive health. They also like to know how effective and how efficient the interventions are to reduce morbidity and mortality in these various areas at the population level. Examples of areas in which health benefits are to be gained are
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(Figure 2.2): infectious/childhood diseases, including AIDS, maternity and perinatal conditions, external causes (accidents and violence) and also cardiovascular diseases (Murray et al., 2002; Niessen and Redekop 2002; World Bank, 1993).

2.3.2. DECLINING MORTALITY STAGE

When mortality improves, population increases. Population growth is related to fertility and mortality changes. In this stage of the demographic transition death rates fall while births rates (yet), do not and population size increases. The interactions between population growth, economic development, and the environment are of vital importance for populations. This has been recognized since the early seventies (WCED, 1987; UNEP, 1997; Kiessling and Landberg, 1994).

Changes in population are important in two ways: by themselves and in relation to resource availability (Haines 1991; McNicoll 1992; Ness, 1993; Possas 1995; Whitmore 1990). These changes depend in an interrelated but different way on socio-economic development and access to services (Vianen, 1994; UNDP, 1995). Population growth is an important pressure on society resources as well as on the basic environmental resources like food, water, air, and space (WRI, 1995). As populations are increasing the net outcome in terms of resource availability per capita will determine if and how quickly they will pass through the transition (Figure 2.1 arrows). An example is the food situation in Sub-Saharan Africa where food production in absolute figures has been rising during the population increase of the last decades (Rosegrant, 1995). Food per capita, however, has been declining with a consequential absolute increase in the numbers undernourished (Figure 2.3).

![Figure 2.3. Absolute number of undernourished (millions) by world region and time period (Mitchell and Ingco, 1995). SSA = Sub-Saharan Africa, MEC = Mediterranean Crescent, E-Asia = East Asia, S-Asia = South Asia and LAC = Latin American and Caribbean](image-url)
2.3.3. LOW MORTALITY STAGE

The intrinsic effect of the demographic transition is an increase in average age and a change in causes of death (McFaden, 1990; Uemura and Pisa, 1988; Ueshima et al., 1987). The elderly themselves are getting older but this contributes less to population growth and aging (Bongaarts, 1995). Simultaneously, the years spent with disease seem to increase (Boshuizen et al., 1991; Crimmins et al., 1989; Fries, 1981; Heuvel van der, 1989; Kane, 1990; Olshansky, 1990; Verbrugge, 1989; Nusselder, 1995). Historical data (Alter and Riley, 1993; Riley, 1993), four modern long follow-up series (Riley, 1990) and cross-national data suggest a general pattern that years with disease increase with development as also the frail survive.

There are some complicating factors in this explanation. Firstly, earlier case finding by medical technology may lead to longer periods living with diagnosed disease, like in cancers (Parkin et al. 1994; Berrinao, 1995) and in chronic conditions such as diabetes and chronic lung disease (Ruwgaard et al., 1993). Secondly, disability weighting of diseases might influence how the increased period with diseases is appreciated. Applying the DALY weights shows a larger disease burden in life years in Sub-Saharan Africa as compared with industrialized regions (Ginneken, 1994). Different disability weighting procedures result in a kaleidoscopic picture of impairment, disability and handicap (McDowell and Newell, 1987) and the assessment of disability is problematic anyhow (Feinstein, 1986). Last, little is known on the dynamics of individual diseases and related disabilities at older ages (Olshansky, 1990; LaPorte, 1993; Barendregt et al., 1994).

As disease burden relates to the demand for health care, one can expect a decreasing demand for health care among the younger age groups. However, there is a necessity to maintain social and health services investments levels related to these groups at a sufficient level (Feacham et al. 1991). In addition to health care, socio-economic conditions and (secondary) prevention may contribute to postponement of severe disability (Heuvel van den, 1991; Fries, 1981; Bonneux et al., 1994; Niessen et al., 1993). Worldwide, also in developing countries, morbidity among the oldest may prove to be the most important factor in the total demand for social and health services (Kane et al., 1990).

2.4. GENERAL RESEARCH POSTULATE: MULTIPLE ROADS TO HEALTH

From the above, we conclude that there is substantial evidence that socio-economic development largely determines population health levels directly by influencing the immediate surroundings of people, their health behaviour and their access to services (Bairagi and Chowdhury, 1994; Kiesling and Landberg, 1994; Pappas et al, 1993; Winkelstein, 1993; Najman, 1993). Important other sectors contributing to improved standards of health, especially in the early stages of the transition, include food availability and drinking water supply (Gumper, 1984; Mertens, 1992; Esrey, 1991). Nutritional status has been an important factor in improving people’s natural resistance as well as by influencing birth outcomes and the survival of water- and airborne childhood infections (Crigg, 1989; Dreze and Sen, 1989; Pelletier, 1993; Alwar, 1992). In the last stage of the health transition, the main health determinants
are related to life style like smoking and hypertension (Bartecchi, 1995; Salonen, 1989; Tuemelito et al., 1991; Dobson, 1994; Casper et al., 1992; Collins, 1990). These risk factors, in turn seem to depend on socio-economic status (Marmot, 1994). Also, in this stage, health services seem to be a major determinant (Mackenbach, 1988). These often show diminishing returns with increasing inputs (Murray, 1995). Politically diverse populations with lower levels of economic growth have succeeded nonetheless in reaching high levels of health despite a low income per capita through high education levels, large scale public health measures and national cohesion e.g. Costa Rica, Kerala, Sri Lanka and China (Caldwell, 1993; Cooper, 1990).

A long-term integrated analysis should include the changing composition of the population, the increase in life expectancy and disability burden, and the demand / supply mechanisms. Presently, aggregated analyses only allow for crude changes in disease and disability (World Bank, 1993; Barendregt et al, 1994). Given broad objectives of the research, we have included a limited number of diseases and only by broad categories.

As these patterns of changes in population health are showing we postulate for our approach that there are multiple roads towards health within each stage of the health transition. This is the core theme of this book. Health determinants may have their impact on different levels of the causal web of disease occurrence (exposure, disease, and death). They may have an effect by themselves and in combination with other determinants and their effect varies in time depending on the presence of other determinants. Three examples are given for three countries in Figure 2.4. One route might be via the increase of physiological resistance, improving nutritional status and survival along the vertical axis, like in the Netherlands and England in the previous century (Gage, 1993; Schofield 1991).

Figure 2.4. A conceptual representation: two pathways in the health transition, based on historical analysis and a semi-quantitative interpretation: the increase in life expectancy (= e on diagonal axis) by two ways of health promotion: prevention from exposure and increase in resistance to disease (adapted from Walle van der et al, 1992)
Another route, along the horizontal axis, in other societies or in other time periods, might be the reduction of health risks by the elimination of causes of ill-health, irrespective of the condition of their members, like in Japan in the beginning of the century. Here, large-scale hygienic measures, such as collective feces collection, took place and prevented people from falling ill. Other paths, or mechanisms, may be possible along other dimensions. Two other pathways might be the improvement of health behaviour in the general by education and promotion (Caldwell, 1993) or the improvement through the increase in personal income status. Both of these may lead to similar changes in the near surroundings and to similar behavior changes, as probably has been the case in Japan, Italy or the UK. The change in income status may, in addition, lead to health damaging changes in life style, such as smoking, like in the present societies in S-E Asia with fast growing economies. When literacy increases without sudden huge increases in income, as in Sri Lanka or the Netherlands around 1900 (Houwaart, 1991), the health damaging effects of socio-economic development may be less. Chapters 3 and 4 study the historical and future changes in health determinants and population health in three countries, for India, Mexico and the Netherlands. Chapter 5 discusses the historical decline in stroke mortality. The following chapters (6-9) will study the health service effects, prevention and treatment, on the occurrence of single diseases, for stroke and diabetes mellitus.

To summarize: the objective of the research is to describe and analyze the changes of (sub-) population and associated changes in health under varying socio-economic and environmental conditions in the past and in the future using demographic multi-state modelling techniques. This may include populations living in pre-industrial societies as well as those living at the highest known health levels. Such a long-term public health approach should account the main input-output relationships related to population health in terms of both environmental and societal resources. Inevitably, a modelling framework is needed to address all the changes in populations and population health at the same time in a consistent framework. It can be, if necessary, adapted to explore and test more specific policy questions, formulated as specific hypotheses in specific fields of medicine or in the treatment of specific diseases. The next chapter describes such a generic multi-state modelling approach that can be used to address the various health issues that have been listed.
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