CHAPTER 10

FINDINGS, DEBATES AND RECOMMENDATIONS

10.1 SUMMARY

Introduction This book describes population health as influenced by its macro- and micro-determinants. Doing so, it uses the possibilities of a lifetime multi-state modelling approach to describe health states and changes in health states. The results are descriptions of the disease process and related health care costs at different aggregation levels in populations.

Results The developed multi-state models allow for analysing dynamic disease processes throughout a lifetime in relation to the actual stage of the health transition. The dynamic components are threefold: 1) the substitution, clustering and synergism of health determinants and diseases, 2) the effectiveness and efficiency of health services, and 3) the effect of ageing of populations in quantitative and qualitative terms as early and also late survival improves. At all stages, there is a trade-off with other diseases when a first disease is treated. The model approach quantifies the effects and allows an analysis in time. Chapter 4 shows that substitution and competition of multiple health risks, at all ages, may partly explain the lack of results of the introduction of health programmes as in international health development. It shows also that multiple, also low cost, roads to population health exist by elimination of health risks and by improvement of disease survival. Computation of optimal pathways is possible. The chapters on stroke and diabetes show the relationship of health intervention mixes, available resources, health benefits, and optimisation options. The stroke analysis shows that, in case of high available budgets, costly clinical interventions for all patients can be more cost-effective than low cost clinical interventions for small groups of high-risk patients. The diabetes chapter shows that, under low available budgets, low cost clinical interventions for small groups of high-risk patients can be more cost-effective than prevention.

The general finding is that multi-state models allow for computation of multiple, optimum paths to health throughout a lifetime, depending on the societal resources available.

Model validation More model calibration is necessary and possible. An important free variable to be used for calibration is the non-attributable incidence of diseases. The population attributable risk approach should be developed further to account for regression dilution bias and the occurrence of multiple diseases and multiple determinants. Another calibration parameter is the effectiveness of prevention and curative services in daily settings. A third group of calibration parameters is disease-specific mortality and morbidity. Transparent presentation of models and assumptions promotes expert validation.

Research areas The issues in health are 1) the development of health budget allocation mechanisms based on intervention effectiveness and efficiency on a lifetime basis, 2) the assessment of the relative contributions of determinants during a lifetime, especially to healthy aging, 3) the assessment of the alleged population effects of health interventions.

Conclusion The research quantifies the effects of health determinants on population health, accounting for uncertainties. It generates information on expected health gains and medical costs throughout a lifetime of health interventions. It enables policy makers to choose those options that, given available resources, maximise health.
10.2. MAIN FINDINGS: ROADS TO HEALTH

This chapter gives the findings, controversies and recommendations related to the results of the modelled changes in population health reported in the previous chapters. Last, some specific recommendations are formulated for ongoing research efforts. The book has described the dynamics of disease occurrence in populations on a lifetime basis. It first gives an overview of the major known health determinants i.e. the health risks and health services that may play a role in determining the transitional changes in population health. Next, it describes the chosen analytic approach in more details and the steps to take, given a research question on changing disease occurrence, disease morbidity, and mortality. The book postulates that a lifetime multi-state modelling approach can be useful to describe disease processes and health care costs in the population and outlines the approach in the second chapter. Next, it studies mortality decline in relation to observed changes in the health determinants in three countries and projects future changes in mortality based on official projections of health determinants. Then, the book reports the allocative options of health interventions on a lifetime basis for two example diseases both presenting with morbidity and mortality i.e. stroke and diabetes mellitus.

After describing various case studies in the five application sections, a number of conclusions can be drawn. Multi-state modelling allows for analysing dynamic disease processes throughout a lifetime in relation to the actual stage of the health transition in a country. The dynamic components are threefold: 1. the substitution, clustering and synergism of health determinants and diseases, 2. the effectiveness and efficiency of health services, and 3. the effect of ageing of populations in quantitative and qualitative terms as early and also late survival improves. At all stages, there is a trade-off with other diseases when a first disease is treated. The model approach quantifies these effects and allows for an analysis in time. Chapter 4 shows the substitution and competition of multiple health risks, at all ages, and this will partly explain the lack of results of the introduction of health programmes in international health co-operation.

Increased disease survival

Figure 10.1. One, conceptual presentation of ‘roads to health’ along two selected dimensions. On the diagonal axis the gain in life expectancy (e) is depicted in time while the x- and y-axis show two dimensions of health improvement i.e. increase in life expectancy.
The conceptual diagram in Figure 10.1 illustrate that for the three countries studied different health determinant clusters may play a role in setting the life expectancy level. The diagram depicts transitional pathways along two axes: an axis of disease survival and one related to protection from health risks i.e. decreasing incidence. On the x-axis the life expectancy gain attributed to increased water supply and sanitation and socio-economic status can be situated and on the y-axis the gain through improved disease survival attributable to food availability, nutritional status and curative health services. Other cluster categories might be possible, however the two chosen have both their typical effect on the occurrence of disease. Decreased incident leads to less disease. Increased survival implies longer periods spent with disease, however maybe of less severity. In the early times improvement came through macro-determinants like nutrition, literacy level and economic development and, if still necessary, through sanitation. In recent times simultaneous improvements in various health determinants may have synergistic effects and can include modern insight in prevention (like immunisation) and treatment (antibiotics). Hence, the results of this same chapter imply that multiple, also low cost, roads to population health exist by elimination of health risks and by improvement of disease survival. Computation of optimal pathways is possible. The chapters on stroke and diabetes show the relationship of health intervention mixes, available resources, health benefits, and optimisation options. The stroke analysis shows that, in case of high available budgets, costly clinical interventions for all patients can be more cost-effective than low cost clinical interventions for small groups of high-risk patients. The diabetes chapter shows that, in case of low available budgets, low-cost clinical interventions for small groups of high-risk patients can be more cost-effective than prevention. The general conclusion is that multi-state models allow for computation of multiple, optimum paths to health throughout a lifetime, depending on the societal resources available.

10.3. THE SCIENTIFIC DEBATE: THE DETERMINANTS OF HEALTH

Controversies in the research on the health determinants complicate the acceptance and the applicability of multi-state model outcomes. They can be grouped in two categories: lack or disagreement of knowledge on the net contribution of each determinant of health (Caldwell, 1991; Cumper, 1986; Rose, 1991; Taubes, 1995) and disagreement among health policy makers on how to improve population health (Niessen et al, 2000). This section sketches deals with the first issues.

Different conceptual approaches to health show disagreements within the determinants of health debate (Frenk, 1993; Ruwaard et al., 1993; Vallin, 1992). The public health uncertainties relate to the estimation of the relative contributions of the determinants to health. This will most likely depend on the transitional stage and they might be substituting or synergetic (Duchene, 1993). The role of ageing process and its influence on the occurrence of morbidity as a health determinant during the last stages is also rather unclear and may depend on the disease studied (Barendregt and Bonneux, 1998). 

Social-economic status as broad determinant of disease There is substantial evidence from studies in the Western European countries that higher income, as well as higher social status, is
correlated with longevity and good health (Townsend, 1990; Cooper, 1990; Marmot and Elliott, 1994; Rowland et al., 1993; Phillips and Verhasselt, 1994). This view states that increased population health follows increased national wealth and development. In other words, individual illness is perceived as an outcome of society's 'ills' (Hurowitz, 1993). Specification of the association between income and health status has led to an increase in the appreciation of other broad health determinants as education, nutrition, water and sanitation. These factors might have their independent contribution in the promotion of health (McKeown, 1972). Present thinking seems to contain a mixture of the former approaches: multi-sector synergism and economic investments (World Bank, 1993; Niessen, 2000). The various determinants can be included within the multi-state modelling approach. The input values for their contribution to disease incidence and survival and mortality depend solely on the presence and quality of empirical research.

Health services as a determinant of health In this view, appropriate use of high quality medical care is seen as contributory to population health. In the eighties more evidence was produced that increased expenditure on medical care is an important intervention to lower mortality and morbidity specially in the later stages of the health transition (Fries, 1981; Pison, 1993; Mackenbach, 1988). In the two decades before this view suffered severe criticism from public health specialists (McKeown, 1976) and in the public domain (Illich, 1974). Within the health sector itself, there is an internal debate: preventive services versus curative services (WHO, 1981; VWS, 1986). Prevention of illness is considered to be less expensive and more effective also in case of chronic diseases (LaPorte, 1993; VWS, 1992) Opponents (Rose, 1992) may state that modern preventive interventions, especially in high-risk groups, can be costly, and less cost-effective, and may cause much unnecessary side effects. Recently, the absolute risk approach has been developed and proven to be more cost-effective than an approach based on single risk thresholds (Niessen en Redekop, 2003; Murray et al. 2002). The studies show that it would be cost-effective to first search for population-based interventions and shifts in the distribution of health risk levels by a number of points to have large impacts. The preceding chapters included so far only the positive effects of (secondary) prevention and cure in the model structure and not the side effects as these are within the culturally determined domains and subject to changes. Therefore, the outcomes of the present research in chapters 6, 7 and 8 confirm only partially Rose's point of view.

Ageing as a health determinant Ageing and its consequences are heavily disputed items within the debate concerning old-age morbidity (Verbrugge, 1989; Olshansky, 1990, 1991). The debate is whether the human life span is inherently limited or whether it can be expanded (Ruwada, 1993; VWS, 1992). The mortality transition that occurred in this century in most countries includes an increase in life expectancy at birth and in remaining life expectancy also for the higher age groups. Some suppose an upper limit to life expectancy at birth not exceeding some 85 years (Fries, 1980) and a remaining life expectancy of 7 years for men and 9 years for women of 80 years old (Murray, 1994). Others state that human life span can be further manipulated by technology. The average human life span could be as high as 99.2 years (Manton et al., 1991). In our rough computation (chapter 4) this is estimated at 90 years at birth, on average.

The question how the health transition influences the disability experience throughout life remains unanswered in this book. There is a tendency to conclude that it increases with the
increase of the life expectancy (Verbrugge, 1984; Crimmins et al., 1989; Olshansky et al., 1991; Barendregt & Bonneux, 1998). The morbidity associated with the fundamental aging process itself might have greater opportunity for expression, but might be less severe as survival improves.

Consequence for the use and structure of the models (1) The uncertainties regarding parameter values are scientific uncertainties. There might be consensus on the modelled structure but not on parameter values related to programme effectiveness. The health effects of health services are modelled through the service-effectiveness functions. In the model, it is assumed that at least part of the historical gains in health is somehow strongly or weakly associated to one or more types of service provision.

The relevance of ageing as a health determinant is twofold: 1) a number of associated health risks in the modes are described as increasing with age, and 2) as the population is aging in later stages of the transition the absolute desired health gain increases and hence the demand for health and health care. The relevant parameters regarding ageing are those that are important at the end of the health transition when the known causes of disease are disappearing. These parameters fall within four categories: 1) the basic, possibly biological, risks of mortality from other causes, 2) the basic risk of becoming incident for one and/or two of the modelled diseases, and 3) the risk of becoming prevalent of another disease not modelled, and 4) the standard risks of becoming disabled due to a particular disease. Model experiments can be done in relation to these four categories of parameters although they are bound to remain explorative. The reduction of e.g. the basic mortality risk to 75% in our model results in a life expectancy of 98 years. More epidemiological research is needed especially among the oldest to collect just the basic disease data to be able to answer questions on the occurrence of disease and death among these groups.

10.4. THE POLICY DEBATE: HOW TO IMPROVE LIFETIME HEALTH?

The policy uncertainties are related to the perceived policy relevance of health as well as the scientific (medical, epidemiological, or health economics) debate on the determinants of health. There are two main related themes: 1) the importance of health services in the society, 2) the type of social or health policy interventions. The issues are parallel to the public health controversies.

Allocation of health resources This debate focuses on whether and how to provide health services within a collective context. The two domains are how large should the health care package be and the role of the cost-effectiveness approaches (Mooney and Creese, 1993). The debate on coverage of cure and care services can easily be associated with those who stand on the pole of ‘health as a human asset’ in the policy relevance debate and those who stand a ‘human capital’ view. In both approaches, costs and effects considerations play a role. In a ‘human asset’ approach more value for money in the health services makes it possible to extend coverage or treat more patient categories (Abel-Smith, 1972; Lee and Mills, 1983). In this view, the “selective” primary health care programs should be favoured based on cost-effectiveness criteria (Walsh et al., 1993; Grosse, 1980).

Comprehensive or selective health policy Comprehensive health care permeates many, also non-medical, aspects, of daily life. Initially it centred on the prevention of illness. When health
care is meant to be comprehensive it includes social elements such as good housing and sanitation, pollution control, road improvements, encouragement of public transport, a safe work environment, stable interpersonal relationships, sufficient income, and education (Hurowitz, 1993; Normand, 1991). Almost all nations at Alma Ata (WHO, 1981) welcomed the broad program of ‘primary health care’ as an operationalisation of comprehensive health care. Selective medical care advocates focus on diagnosing and treating of health risks and diseases usually after they have developed. The notions “selective” primary health care’ (Walsh et al, 1993) or “essential medical care package” (World Bank, 1993) are commonly used referring to this view.

Consequence for the use and structure of the models (2) Both the variations in the provision of services as well as a number of multi-sector approaches can be included in the modelling approach as possible pathways through the health transition. As health priorities setting usually is attempted at national level, expanded use of multi-state models would require more details in relation to health services provision and the effects on the disease dynamics (see examples in chapter 4 and 5) and the literature (Murray et al, 1994; Barendregt & Bonneux, 1998; Murray et al., 2002). In practice, priority setting through health providers and insurance companies might be more feasible (Niessen et al., 2000). In the latter case, multi-state modelling might still play a supporting role, although the research perspective might have to change.

10.5. RESEARCH RECOMMENDATIONS

The objective of this research is the description and analysis of disease occurrence in various stages of socio-economic development in support of health policy (chapter 1). For this, methods are necessary that can describe changes in population health on a lifetime basis because of changes in health determinants. The development of a generic multi-state population health modelling approach has allowed computing changes in population health as the consequence of changes in health determinants (chapter 2). The modelling approach links changes in the main macro- and micro-determinants with changes in disease incidence and survival, such as environmental and socio-economic changes, nutrition, life style, and health interventions. We have applied the approach to a number of case studies populations (chapter 3) and, in a more detailed way, to specific diseases i.e. stroke and diabetes (chapter 4 and 5). In all chapters, we have reported calibration and validation of the models. Uncertainties remain relating the possibilities of validation of the model at more de-aggregated levels, the model structure (chapter 4 and 5) and the usefulness of results for health policy (chapter 6).

This book observes the start of multi-state modelling of population health in epidemiology, demography, public health, and health economics research. Up to now there are relatively few related research efforts. Recently, there is more attention for the lifetime approach (Aboderin I et al, 2001). The designs, implementation, and application of generic multi-state approaches have been initiated. As summarised in the section on controversies, a number of issues remain to be taken care of to improve the quality of the modelling further. This is elaborated in the next section.
10.5.1. FURTHER MODEL VALIDATION

One of the major issues to address is the validity of the model structure and its results. More model calibration and validation can and should take place. Validation can be structural validation (chapter 3) or external validation, using external time series (chapters 4 and 5). The developed models have relatively few free variables that can be used for calibration and reproduction of population-based time series of morbidity and mortality.

An important free variable to be used for calibration is the non-attributable incidence of diseases. In combination with the risk-attributable fraction, it results in the observed disease incidence. The population attributable risk approach should be developed further to account for regression dilution bias and the occurrence of multiple diseases and multiple determinants. Another important calibration parameter is the effectiveness of prevention and curative services in daily settings. Related parameters, such as coverage, are usually based on cross-sectional studies. Incidentally, longitudinal follow-up may be able to give data on day-to-day effectiveness. Also comparison with special population groups that have remained without an intervention may give supportive evidence like studies on religious, cultural groups, on the uninsured, or on ‘natural’ experiments like war or strikes. A third group of calibration parameters is disease-specific mortality and morbidity. This group can be used for the large disease categories that we used for the applications (chapter 3-5). This would be for Mexico for the period 1950-1990 and for India for the period 1980-1990 based on the Federal Sample Registration Survey. Last, disease-specific calibration is possible for The Netherlands 1900-1990 and also, but with more uncertainties, from 1860 onwards.

Expert validation of model structure and assumptions could be more explored and transparency increased. There are good examples of review procedures and panel discussions with researchers, policy makers and the public or its representatives. This also gives more room to account for the more subjective or political choices to be decided upon.

10.5.2. FUTURE RESEARCH

The main characteristic of the multi-state approach is a comprehensive consideration of the quality of life and the cost of disease through a lifetime at the population level. Discussions on these topics cause many heated debates. One can distinguish three groups of important issues in health to be addressed:

1) the development of health budget allocation mechanisms based on proven effectiveness and efficiency of interventions over a lifetime. The basic distributive and priority choices to be made are at the policy and political level. It is here that policy makers can play their important role. They do this by asking the right questions and to state their policy priorities and criteria regarding the involvement of target groups and budgets to be allocated. The involved disciplines, public health, health economics, epidemiology and demography, may all contribute their specific expertise to this important issue.

2) the assessment of the relative contributions of health determinants to lifetime health. The quantitative relationship between the various health determinants, especially socio-economic
status and the health risk factors, is often not clear and changing throughout a life course. It is an area for the epidemiologists and demographers to map out. Important work has been done already. However, in the developed countries there is little information what the determinants are of healthy ageing and how important they are. Also the research of the relationship of genetic information and health is rather limited so far.

3) the assessment of the alleged population effects of prevention and treatment over lifetime (Aboderin I et al, 2001; Ben-Shlomo Y and Kuh D, 2002). There are many confounders and selection biases in the assessment of the effectiveness of preventive or curative health services. Advocates from each area of professional interest (clinical specialists, public health experts, patient groups, health insurance companies, multi-sectoralists, industries, and others) tend to claim a large share in the (potential) declines in mortality and morbidity. Models in health economics and epidemiology can be used to synthesise the information available, define very explicitly the particular health conditions to be improved and to compute health impact and related costs.

10.6. GENERAL CONCLUSION

This book reports the use of the multi-state modelling approach to estimate disease and costs of disease during a lifetime. It is possible to use this method to address general and specific questions on the contribution of the various determinants of population health. Uncertainties can be incorporated in a systematic way in the analyses. The studies on general mortality decline, stroke mortality decline, and the intervention options in stroke and diabetes illustrate the possibilities. They have led to additional understanding of the occurrence of disease and death, of the health effects of health interventions and of the health care costs.

The model outcomes generate information on the expected health gain and medical costs throughout a lifetime of health interventions. It enables policy makers to choose those health options that, given the available resources, maximise population health.
REFERENCES

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