2. A Review of Epidemiological Approaches to Forecasting Mortality and Morbidity

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Abstract

This chapter discusses epidemiological models that take disease processes and related risk factors as the basis for modelling mortality and morbidity. These models can be roughly divided into two groups: statistical regression models and dynamic multistate models. For each group of models, examples are given for infectious and chronic diseases. Strong and weak aspects of each group of models are summarised in the context of their aims and data requirements.

The chapter consists of four sections. Section 2.1 is an introduction. In Section 2.2, devoted to the regression models, the Alderson and Ashwood model for prediction of lung cancer mortality in England and Wales and the Murray and Lopez study of the global burden of disease are discussed. Section 2.3 focuses on dynamic multistate models. In Section 2.3.1 the (macrosimulation) method of back-calculation of HIV/AIDS-related mortality, and a (microsimulation) model of the spread of two sexually transmitted diseases, gonorrhoea and chlamydia, are given as examples of the multistate models for infectious diseases. The Dutch model PREVENT and the risk factor intervention models of Manton and colleagues are reported in Section 2.3.2 as examples of the multistate models of chronic diseases. Finally, the models MISCAN (Erasmus University, Rotterdam) and POHEM (Statistics Canada) illustrate the microsimulation approach in multistate modelling of chronic diseases. The final section (2.4) discusses the use of epidemiological models for research and health policy purposes.

2.1 Introduction

In the previous chapter, several demographic models for projecting mortality were reviewed. From an epidemiological point of view, patterns of morbidity and mortality are primarily ‘explained’ by the distribution within populations of risk factors, such as smoking, dietary habits or physical inactivity (lifestyle), socioeconomic variables or environmental exposures. Quantitative models have been developed for statistical analysis of the associations between explanatory variables and the risks of morbidity and mortality in epidemiological studies. These models can be generalised to predict mortality and morbidity risks in other populations, for instance to assess the effects of risk factor prevention programmes or treatment interventions. Figure 2.1 gives an overview of classes of the explanatory variables distinguished (Ruwaard and Kramers, 1998).

Over the last 150 years, life expectancy has increased substantially in the Western world, from around 30 to around 80 years, mainly as a result of successful prevention of environment-related infectious diseases as an important cause of mortality at younger ages. Concomitant with economic development, safe drinking water facilities and sewage control were introduced, which in turn improved nutrition and personal hygiene. From the third decade of the twentieth century, vaccination and antibiotics added another 20 years to life expectancy. In the present situation, the occurrence of (chronic) disease is postponed to the later stages of life, involving different risk factors. Murray and Lopez have shown that this epidemiological transition from infectious diseases to chronic diseases as the leading cause of death is also taking place in most other countries (McKeon, 1976; Bakkes and Woerden, 1997; Mackenbach, 1988 and Murray and Lopez, 1997d).

Modelling of infectious diseases has a longer history than modelling of chronic diseases. From the end of the nineteenth century, epidemiological research into the etiology of infectious disease has provided insight into the causative agents and determinants of infection. The first generation of simple deterministic infectious disease models emerged between the two World Wars in the first half of the twentieth century. From the 1950s, more complex, stochastic models were developed to deal with the variability of the spread of infectious diseases (King and Soskolne, 1988; Susser and Susser, 1996).