Proportional multi-state multiple-cohort life table model

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Contents

1 Introduction

The proportional multi-state multiple-cohort life table model (PMSLT) is a population level model (macro) approach to simulate health (and economic) implications of changes in exposure to health risk factors (e.g. physical inactivity, air pollution and diet). The PMSLT has been widely used to simulate outcomes for population level interventions for the reduction of chronic diseases.

The model was developed by Jan Barendregt and colleagues (REF ACE prevention and core papers) and has been widely used in Australia and New Zealand (Ref ACE-report and BODE website of key publications).

The basic infrastructure of the model consist of three components: (1) Effect size for the intervention of interest (e.g. intervention to urban design that modifies population levels of physical activity); (2) Calculation of the potential impact fraction (PIF) to derive the change in occurence of disease (indidence rate/mortality rate) attributable to a change in the distrubution of the risk factor (e.g. physical activity); and (3) Use of the PMSLT to simulate health (and economic) outcomes attributable to a change in the distribution of health risk factor/s in the population of interest. Figure 1 summarises the basic infrastructure of the model. ITHIM is included in Figure 1 to show that both approaches share in common steps one and two and differ in the mechanisms of calculation of change in health burden (explain in more details in the next section).

In this first intance (basic model infrastructure), the model is set up as a long script to perform the mathematical calculations. Where possible, we wrote functions and loops to avoid repetition. We set up the basic model infrastucture with Australian data, for Melbourne. In what follows, first, we describe the link the the PMSLT model witht the ITHIMR framework. Second, we describe the mechanism of the PMSLT and input parameters. Third, we present the code with explaining notes. Fourth, we present examples of outcomes and last comments related to implementation. Here we only included the physical activity health pathway. In the comments section, implementation of exposure to air pollution and road trauma is discussed.

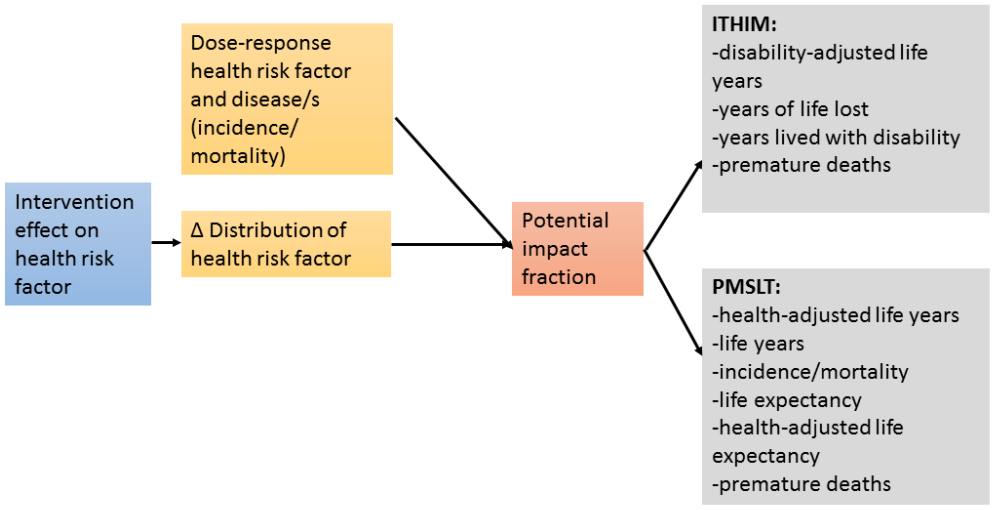


Figure 1: Figure 1. Basic model infrastructure.

1.1 Contribution to ITHIMR

The PMSLT similar to ITHIM is a comparative risk assessment approach that consist of calculating the change in the health burden for a population of interest from a change in exposure to health risks factors (e.g. physical inactivity, air pollution and road trauma).As depicted in Figure 1, both methods need estimates of the potential impact fraction (PIF), which indicates the proportion of the disease burden attributable to a risk factor of interest (e.g. physical inactivity). A step further back, is the development of scenarios that bring about change in the distrubution of the risk factor of interest. For now, we only focus on calculations from the PIF onwards, and provide a hypothetical example of change in population levels of physical activity. Incorporation of additional health risk factor (air pollution, road trauma, NO2 and noise) will be discussed in the relevant code sections.

1.2 Difference between ITHIM and PMSLT

- **Time component** The *PMSLT* follows a population of interest over time. For example, as set up here, we simulate sex and age (5 years starting at 18) cohorts over time until they die or reach 100 years of age. This implies that we can include trends for diseases, time lags between change in exposure to risk factors and change in health and demographic changes (e.g. population growth). In addition, we can estimate yearly changes in the burden of diseases over the life course or for a speficied number of years. The *ITHIM* approach is a snapshot of change in burden for one year.
- **Interaction between multiple diseases** The *PMSLT* accounts for the interaction between multiple diseases, with proportions of the population being able to be in more than one health state. This

avoids overestimation of outcomes as a result of summing health outcomes attributable to each disease individually as done in *ITHIM* (REF BRIGGS 2018).

- **Mortality rate**
- **Impact of disability in increased life expectancy**

Model structure (paste figure). Assign a module. Model inputs. These will be highlighted in the description of the code. Connection with other modules (see github) Examples of outputs ## R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

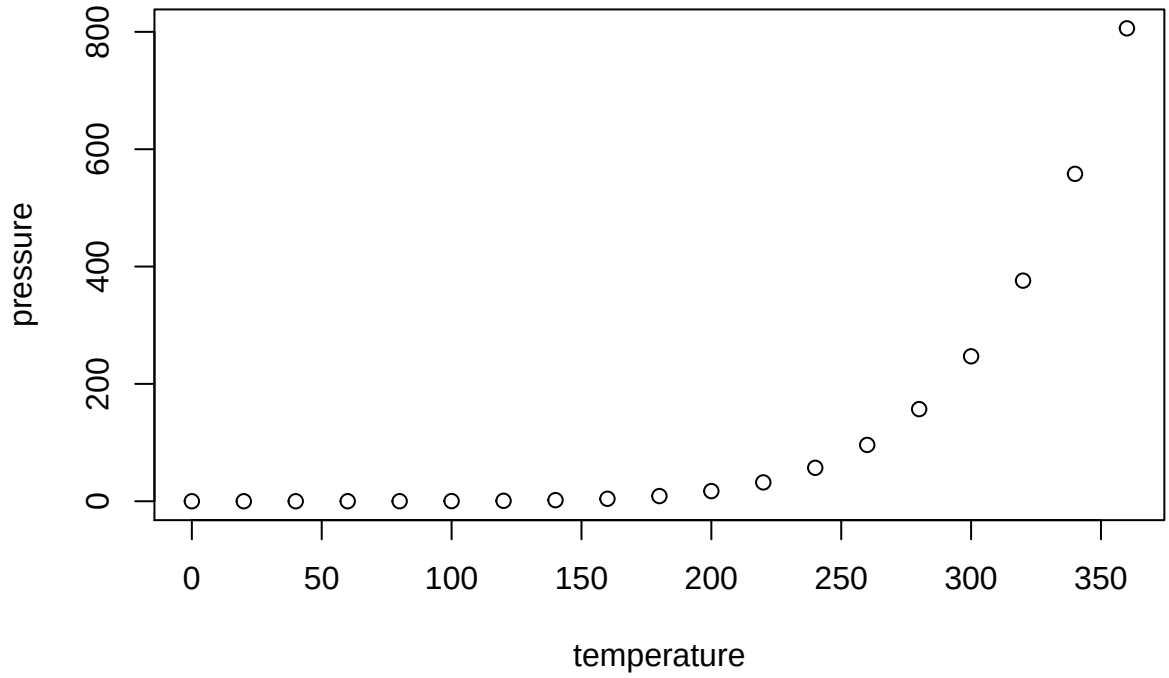
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed           dist
##  Min.   : 4.0   Min.   :  2.00
##  1st Qu.:12.0   1st Qu.: 26.00
##  Median :15.0   Median : 36.00
##  Mean   :15.4   Mean   : 42.98
##  3rd Qu.:19.0   3rd Qu.: 56.00
##  Max.   :25.0   Max.   :120.00
```

1.3 Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.