

Multi-state transition model

A novel approach of a multi-state transition model to describe longitudinal changes in health status is presented. The model is based on the parametric Markov chain with a few interpretable parameters. Model can compute the probabilities of improvements, stabilization, worsening and dying as a function of baseline health and the covariates according to modified truncated Poisson distribution. Earlier in 2006 Mitnitski and his colleagues proposed a dynamic model of change in health status based on deficit accumulation during aging [1]. Later in 2008, this model was applied by Middleton et al [10] to cognitive functions assessed as the errors in the Modified Mini-Mental State Examination. Model was developed by Fallah et al [3] to incorporate covariates. In earlier works [1-3] a non-linear least square algorithm was used to estimate the parameters, later model was developed by using maximum likelihood estimation (MLE) to find parameters [4-7] with truncated Poisson distribution frameworks. Figure 1 illustrates the general schema of transitions between the different states ($S_i, i = 0,1,\dots$) including death.

Let $P_{n_i k_i}$ be the probability that individual i in state S_{n_i} transits to state S_{k_i} at the time of the next assessment, modeled here as truncated Poisson, given survival,

$$P_{n_i k_i} = \frac{\rho_{n_i}^{k_i} / k_i!}{\sum_{s=0}^N \rho_{n_i}^s / s!} (1 - P_{n_i D}) \quad n_i, k_i = 0, \dots, N \quad (1)$$

where $P_{n_i D}$ is the probability of dying before the next assessment. The transition probabilities satisfy the evident condition:

$$\sum_{k_i=0}^N P_{n_i k_i} + P_{n_i D} = 1 \quad (2)$$

Here, $\rho_{n_i} = g(n_i)$, where g is an appropriate link function which may be nonlinear. In some of our applications, the identity link seems adequate, with

$$\rho_{n_i} = a_{1i} + b_{1i} n_i. \quad (3)$$

For transitions to state D , we have a parallel formulation,

$$\text{logit}(P_{n_i D}) = a_{2i} + b_{2i} n_i. \quad (4)$$

Each of the parameters $a_{1i}, b_{1i}, a_{2i}, b_{2i}$ are modulated by covariates.

The probabilities of transition between the different states including mortality can also be studied using other approach. These approaches are better suited for a small number of states. Figure 2 contrasts estimates of probabilities of transition obtained by polytomous regression and the truncated Poisson model. There is general consistency in the patterns of these transition entries for the two methods, with greater detail and simpler interpretations accessible for the Poisson model.

Figure 1.

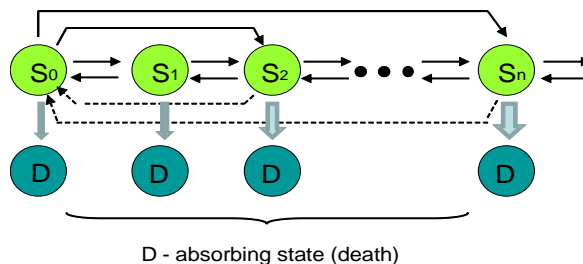
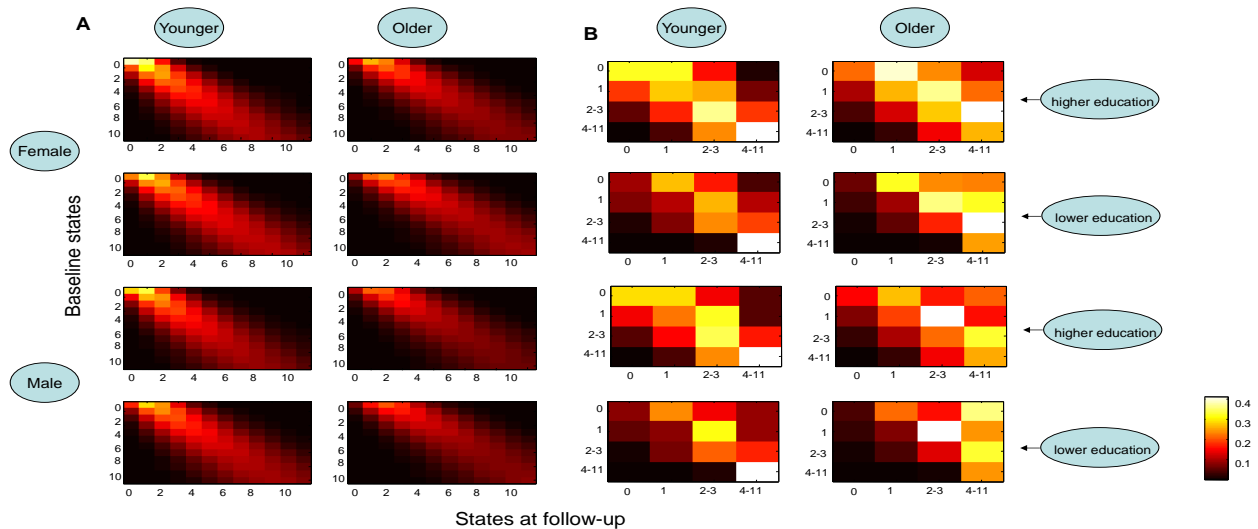


Figure 2.



References:

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