"Makeham-Type" Mortality Models

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This paper presents two types of mortality models based on the Makeham Law of Mortality, called the **Inverse-Makeham Model** and the **Modified-Makeham Select Model.**

The Makeham Law of Mortality, given as

$$\mu(x) = Bc^x + A$$

has Inverse-Makeham form as

$$\mu_x = \frac{\left[\frac{1}{\sigma}\exp\left\{-\frac{x-m}{\sigma}\right\}\right]}{\exp\left\{e^{-(x-m)/\sigma}\right\}-1} + e^{-D/\sigma}$$

where σ is the dispersion of the informative parametrization of the Makeham model about its mode m, and the Modified-Makeham Select form, given as

$$\mu'_{[x-t]+t} = s^t\left[\left(B_s c_s^x + A_s\right) - \left(B_u c_u^x + A_u\right)\right] + \left[B_u c_u^x + A_u\right] \text{ or,}$$

$$\mu'_{[x-t]+t} = s^t\left[\mu_{[x]} - \mu_x\right] + \left[\mu_x\right]$$

with u meaning ultimate mortality and s meaning select mortality.

We investigate the effectiveness of these models in exhibiting the pattern of mortality by simulating the nonlinear models and estimating its parameters via nonlinear regression, using the NLIN procedure of the SAS software and comparing the theoretical values given by the models to the actual values in the existing mortality tables. The correctness of these models to exhibit the behavior of mortality gives alternative mortality models that can be used as benchmarks for constructing new ones utilizing other unchartered parametric distributions.