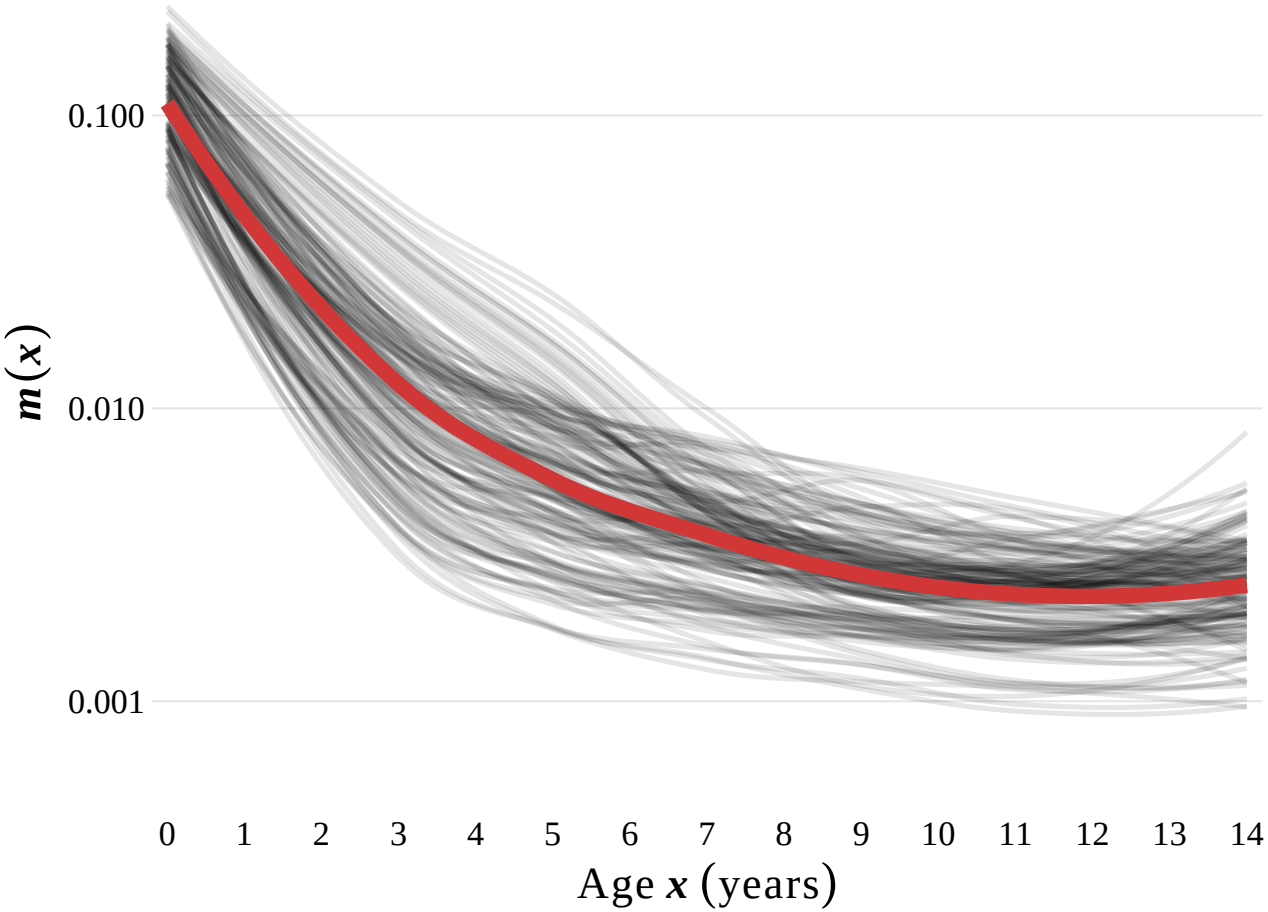
Human Early Life Mortality

Adaption or Selection?

Jonas Schöley
schoeley@demogr.mpg.de

European
Doctoral School
of Demography

The Age Pattern of Early Life Mortality



Early life mortality rates
Various countries and years.
Data: HMD.

Adaption Models of Early Life Mortality

$$m(x) = A^{(x+B)^C}$$

Heligman and Pollard infant mortality term

Double exponential distribution.

"C measures the rate of mortality decline in childhood (the rate at which a child adapts to its environment)."

Heligman and Pollard 1980.

$$m(x) = ae^{-bx}$$

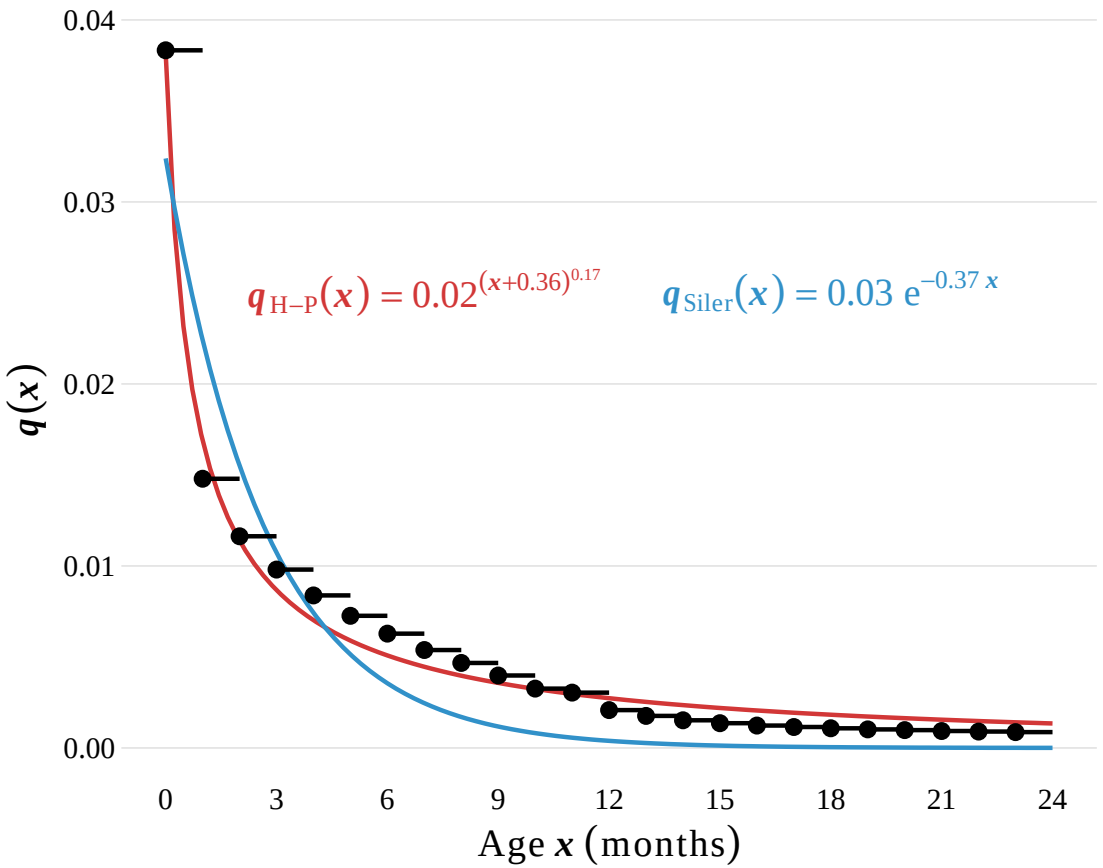
Siler infant mortality term

Negative-b-Gompertz hazard.

"While the most common use of this decreasing hazard would be to account for the hazard due to immaturity, it can also be used [. . .] for other hazards to which an animal adjusts successfully."

Siler 1979.

Adaption Models of Early Life Mortality



Adaption models of infant mortality

Observed versus predicted probabilities of dying. Heligman and Pollard 1980 and Siler 1979 model infant mortality terms.

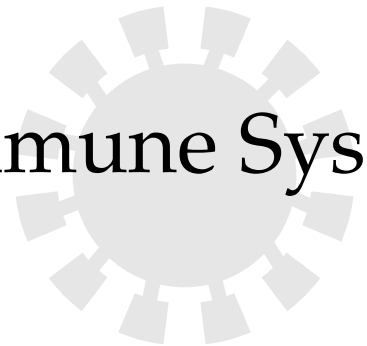
Data:
Statistiske Departement Danmark 1920. 1911–1915 period of Danish males.

Mechanisms of Adaption

Growth

Learning

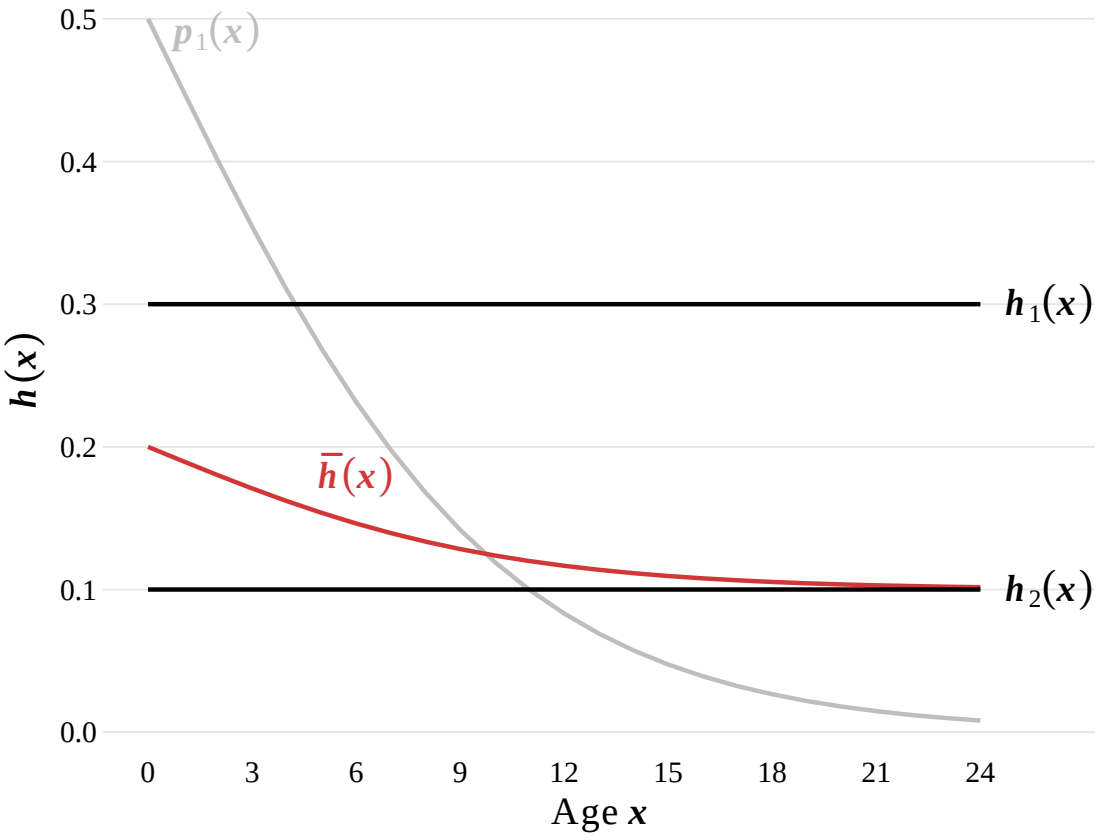
Adaption



Immune System

Digestive System

A Selection Model of Early Life Mortality



The selection effect of heterogeneous mortality

$h_{1,2}(x)$: Baseline mortality rates for two groups.

$\bar{h}(x)$: Population mortality rate.

$p_1(x)$: Share of group 1 on the total population.

See Vaupel and Yashin 1985 for more of "Heterogeneity's Ruses".

A Selection Model of Early Life Mortality

The Frailty Model: James W. Vaupel, Kenneth G. Manton, and Eric Stallard (1979). "The impact of heterogeneity in individual frailty on the dynamics of mortality". In: *Demography* 16.3, pp. 439–454

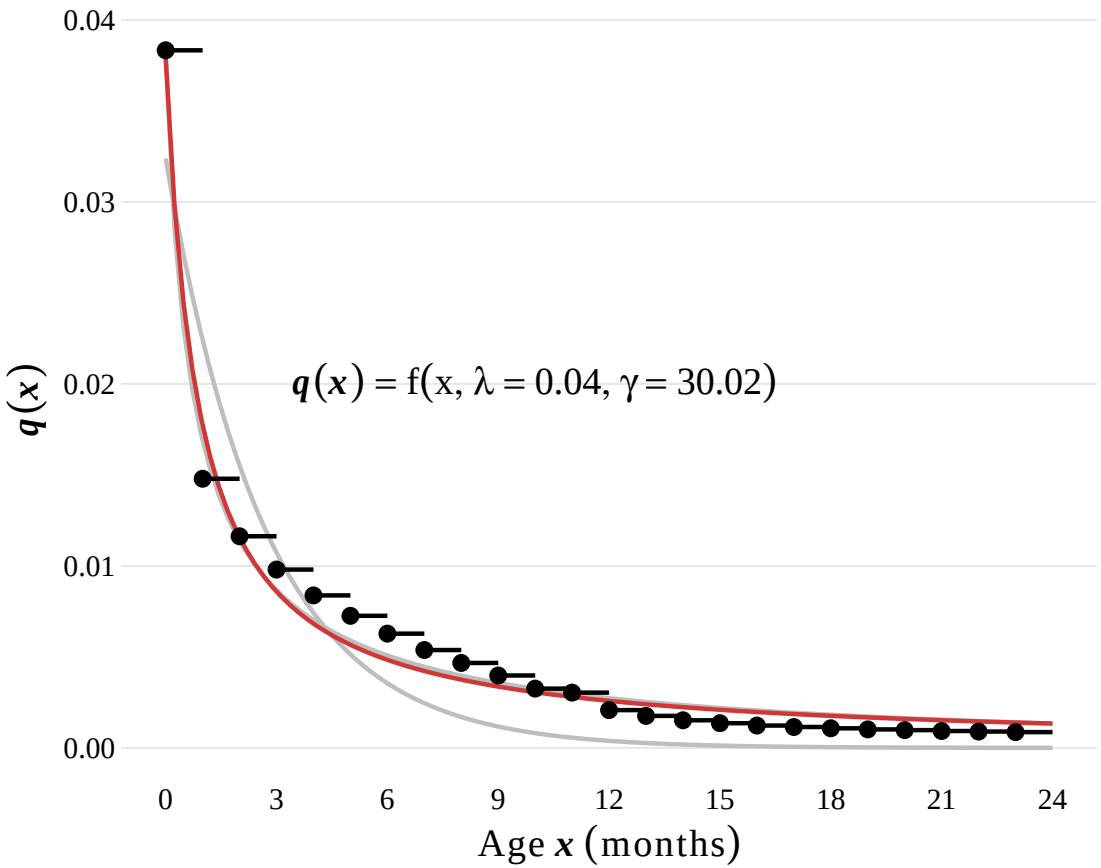
$$\mu(x|z) = \underbrace{z}_{\text{Frailty}} \cdot \underbrace{\mu_0(x)}_{\substack{\text{Baseline} \\ \text{hazard}}}$$

Individual hazard with frailty
Mortality at x for single individual with given frailty factor z.
ibid.

$$\bar{\mu}(x) = \frac{\mu_0(x)}{\gamma M_0(x) + 1}$$

Mean population hazard with frailty
Mean mortality in population at x
ibid.

A Selection Model of Early Life Mortality



A selective model of infant mortality
Observed versus predicted probabilities of dying. Exponential-Gamma frailty model.
Data:
Statistiske Departement Danmark 1920. 1911–1915 period of Danish males.

References

Heligman, L. and J.H. Pollard (1980). "The Age Pattern of Mortality". In: *Journal of the Institute of Actuaries* 107.1, pp. 49–80.

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Siler, William (1979). "A Competing-Risk Model for Animal Mortality". In: *Ecology* 60.4.

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