The Biostatistics of Aging: From Gompertzian Mortality to an Index of Aging-relatedness

by Gilberto Levy and Bruce Levin
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Levy and Levin's book is, at once, not at all what a reader expects from the title and also exactly what the title implies. It is a study about the substantive implications of common survival models used when studying human mortality.

The book starts with the note that aging literatures make substantial assumptions about the mechanisms and aetiology of aging without consistently defining the term *aging*. Indeed, the literature as a whole has bounced around between substantively *opposed* definitions of aging. The review portion of the book concisely considers and expands upon social, demographic, and biological theories to inform the reader and justify the analysis. The theory shifts rapidly to a formal treatise on features of human survival curves. It further provides a practical explanation about the theory of extreme values, and well describes Weibull and Gompertzian survival models, among others.

The authors' motivating observation is that when modeling survival, Gompertz coefficients (θ) are oddly consistent ($\theta \sim 0.1$), whereas Weibull's model, which more appropriately models wear and tear due to exposure to environmental agents (also called *systemic degradation*), does not as reliably estimate human survival. The authors sought to answer why it might be that aging, so often defined as "the wear and tear of a human system," is best approximated by a survival model that does not formally model degradation.

The authors promote a solution that incorporates both processes, creating an eight-parameter survival model that not only incorporates elements of both models but also models the degree to which each process is active. Specifically, they derive a parameter (π) of aging-relatedness that is defined as a weight, indicating the probability that aging is due to "aging" (a score of 1 indicates full aging), or "degradation" (a score of 0 indicates full degradation).

The authors apply their model to data from a prospective cohort located in Israel (N = 10,059) in order to examine the aging-effects of smoking. They find that mortality in never-smokers is more consistently dominated by aging ($\pi = 0.58$ [0.004, 1.00]), while mortality in current smokers is defined by degradation ($\pi = 0.02$ [0.01, 0.05]). This is a theoretically compelling conclusion.

Despite my inherent interest in the book's premise, I was disappointed with a small number of concerning issues; once resolved, I feel that they could improve the impact of the project. A central issue is that the theory proposed requires differentiating *aging* from *degradation* but ignores the fact that degradation is a core component of what we consider to be aging. I would propose that the authors go forward by thinking of this model as one that determines the relative influence of *two types of aging*. This issue may have been avoided by relying on current aging theory rather than on evolutionary theory; the latter also seemed uninformative, as the model did not really require, nor did it seek to extend, evolutionary theory.

Furthermore, the analyses are interesting but require more power to derive π than was available in these analyses. This is confusing, given the preponderance of large studies on mortality. The book would also benefit from having a central location wherein the interpretation of each parameter in the model was made distinct from all other parameters.

In truth, this book represents an enormous effort by the authors to propose a novel and intriguing way to examine our assumptions about the nature of aging, and to redefine the way that we model aging-related mortality. Their analyses warrant further examination, as the resulting models might help us to resolve to what extent smoking and other exposures might actually degrade the body and promote aging.