# Methods for Extrapolating Risk Equations Beyond Their Valid Intervals

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Purpose: Decision models often extrapolate disease-specific risk models that predict over intervals of 5-10 years well beyond this interval. We explore the impact of alternative extrapolation methods on incremental and cumulative disease incidence.

Methods: We applied the coronary heart disease (CHD) risk appraisal model (a Weibull equation) from the Framingham Study (2000) to a hypothetical cohort of typical 50 year-old women to estimate the 1-year incremental CHD risk after age 50. The Weibull equation predicts cumulative risk from 1 to 4 years. By subtracting two sequential cumulative risk values, we approximate the 1-year risk. The CHD risk equation, P(n,t) takes two parameters: age (n) and duration (t). We explored 4 methods for estimating long-term CHD risk, calculating 1 year risk at age n using A) P(n,1), incrementally augmenting age by 1; B) P(n,2)-P(n,1); C) P(50,n-50+1)-P(50,n-50); D) initially calculating P(50,1), then for age 50+m for m = 1, 2, 3, calculating P(50,m+1)-P(50,m); then for age 54 start again with P(54,1), incrementing the starting age every 4 years.

Results: The method chosen has a marked impact on the predicted cumulative or incremental risk of CHD. Method A does not extrapolate beyond the four-year limit, but assumes that the patient's risk factors will be the same at all ages. Method B gives a higher estimate by taking the difference between years' 2 and 1 estimates. Method C extrapolates beyond the valid interval, yielding the highest estimates. Model D applies the Weibull equation most closely to how it was intended for the first 4 years, then increments the age by four years and starts again. Although this model may be most accurate, it results in a discontinuous function.

Conclusion: When extrapolating risk models beyond their valid interval, multiple methods should be compared to understand the effects of different assumptions and the magnitudes of error that may result.