Methods for Summarizing Projected Mortality Rate Changes

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Motivation

- Measures that summarize projected mortality impacts in wide demand
- Dizzying array of approaches (and variants of each approach)
- Missing
  - A coherent understanding of the linkages between the array of approaches and
  - An ability to intuit the ramifications of choosing one variant over another
- Black-box nature of calculations is road-block.
- Mission: crack open the black boxes

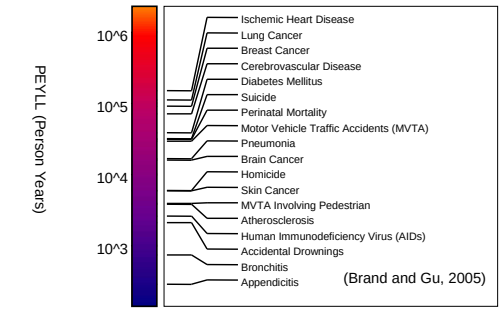
Towards a Manageable Problem

- Focus on mortality
- Focus on life table summaries and use them as proof of principle. Namely to demonstrate that simplifying relationships are
  - obtainable
  - Useful (perform well)
  - enlightening
- (How does this link with DALY type measure)

Types of Metrics

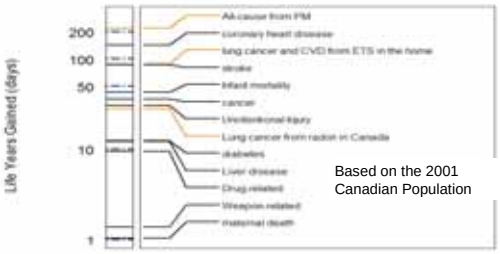
- Counts of events (incidence, mortality counts, averted [deferred] deaths)
- Time-based units
  - Health Expectancy (e.g., LE, HALE, DALE, HALYs)
  - Health Gaps (e.g., DALYs, PYLL, PEYLL, SEYLL and etc)

A `Barometer' of Health



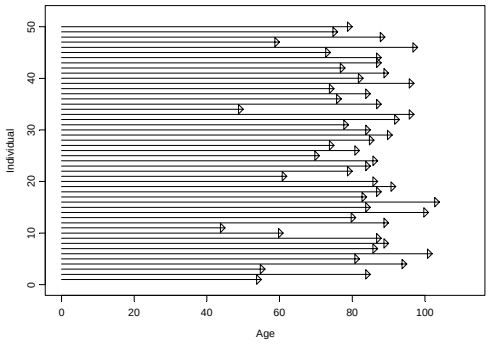
Data: Canadian Female Outcomes, 2002

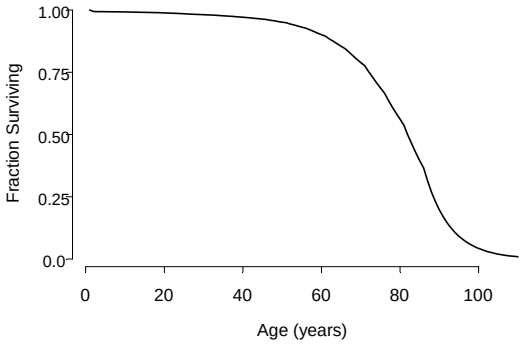
LYG as A `Barometer': Leverage

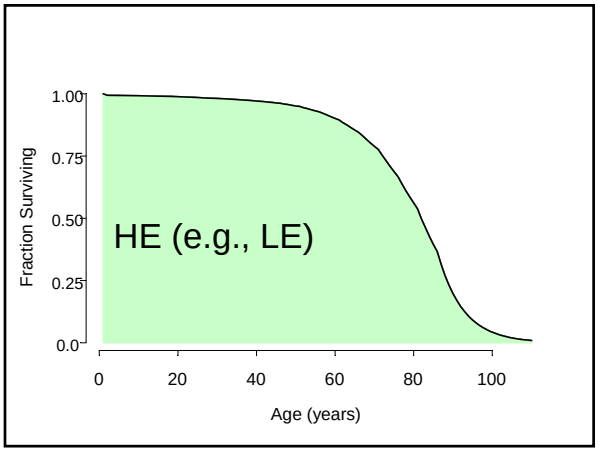


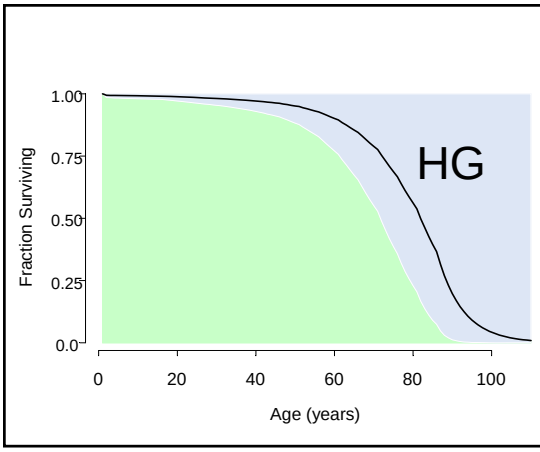
(Gower and Brand, 2007)

Tracking Mortality

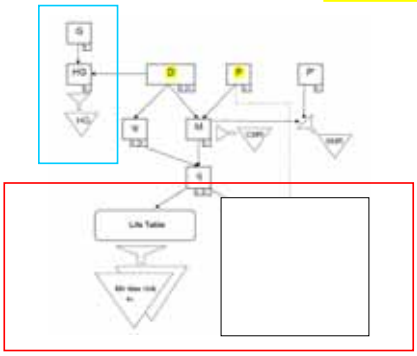


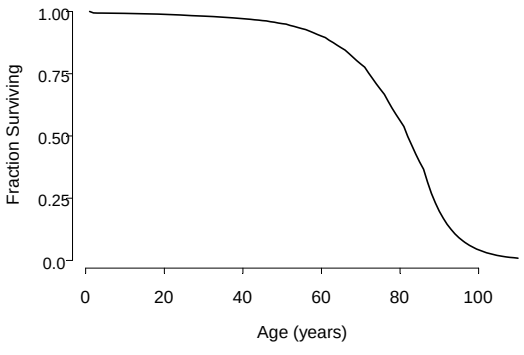


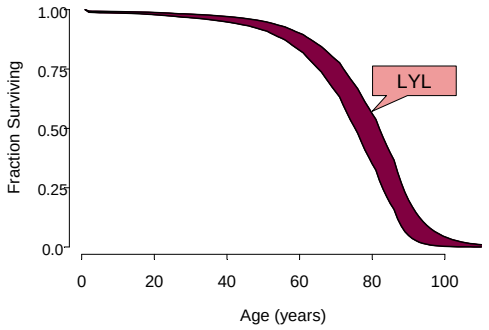




Indices with Common `Roots'







The Cause-Modified Life Table (CMLT)

- Used to predict change in life expectancy (LE):

$$LYL = LE - \sum_{i=1}^{N}\left[\prod_{k=1}^{(i-1)}(1-(1-q_k)^{(1+\psi_k\varepsilon)})\right] * \left(1-(1-q_k)^{(1+\psi_k\varepsilon)} * (1-\alpha_i)\right) * \omega_i$$

- Imagine if there was an easier equation, that made more sense intuitively…

Approximations and Heuristics for the "Cause-Modified" Life Table

Kevin P. Brand*

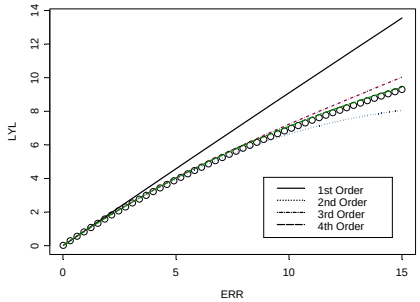
One CMLT "Rule of Thumb"

(Brand, K. 2005. Risk Analysis, 25(3):695-709)

- Three variables required instead of 220!

$$LYL = LE - \sum_{i=1}^{N}\left[\prod_{k=1}^{(i-1)}(1-(1-q_k)^{(1+\psi_k\varepsilon)})\right] * \left(1-(1-q_k)^{(1+\psi_k\varepsilon)} * (1-\alpha_i)\right) * \omega_i \Rightarrow \approx LE\ \Lambda_2\varepsilon$$

Performance of Approximation: LYL



Canadian 1994 Mortality rates; LYL from ERR applied to Lung Cancer. [from Brand, 2005]

Approximations for the CMLT

Index	First Order Approximation
$ELRR = \frac{LR_M}{LR} - 1$	$\approx (1-\Lambda_1)\varepsilon$
$PAR = 1 - \frac{LR}{LR_M}$	$\approx \frac{(1-\Lambda_1)\varepsilon}{1+(1-\Lambda_1)\varepsilon}$
$LYL = LE - LE_M$	$\approx LE\Lambda_2\varepsilon$
REID	$\approx LR\varepsilon$

(Brand, 2005)

Performance of Approximations

- Performance for approximations of ELRR and REID comparable to that for LYL
- Error is predictable (easy for user to determine if accuracy is adequate for their purposes)
- Similar performance for wide array of mortality patterns (tested for 191 countries)
- Provides reliable bounding estimates

Heuristics for the CMLT

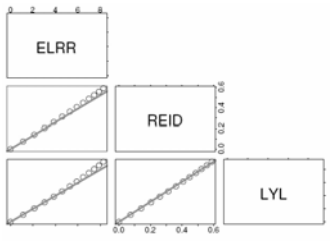
Translation Between indices		Extrapolation Btwn causes or populations	
Ratio	Scaling constant	Index	Scaling constant
$\frac{ELRR}{LYL}$	$\frac{1-\Lambda_1}{LE\Lambda_2}$	LYL	$\frac{LE^{I}\Lambda_2^{I}}{LE^{II}\Lambda_2^{II}}$
$\frac{REID}{ELRR}$	$\frac{LR}{1-\Lambda_1}$	ELRR	$\frac{1-\Lambda_1^{I}}{1-\Lambda_1^{II}}$
$\frac{LYL}{REID}$	$\frac{LE\Lambda_2}{LR}$	REID	$\frac{LR^{I}}{LR^{II}}$

LR = Lifetime risk (cumulative incidence) of death for specified cause

LE = Life expectancy of population

(Brand, 2005)

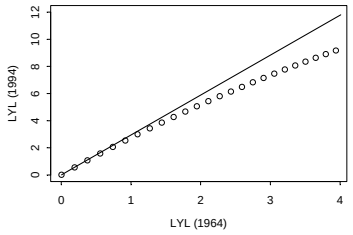
Translation Heuristics



Results suggest that desired index can be obtained provided that at least one of three indices is reported

(Brand, 2005)

Extrapolation Heuristics



Results suggest that an analysis done in 1964 could be updated to1994 mortality patterns using a scaling coefficient (Extrapolation quotient taken from Table). *[Brand, 2005]*

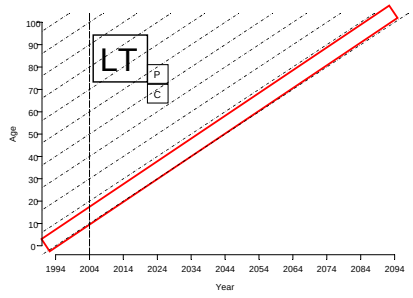
Usefulness of the Heuristics

- Translation heuristics
  - Perhaps impacts reported as ELRR but interested in LYL
  - Quotient can translate ELRR estimate into LYL using readily available information (e.g., LE of population)
- Extrapolation heuristic
  - Perhaps a stellar analysis recently done for UK. No analysis as yet for Canada.
  - Quotient can extrapolate UK result, adjusting for the different mortality patterns affecting the two populations
  - Note adjustments for other attributes is possible (Brazil example)

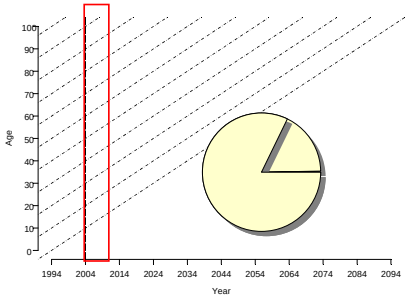
What's the Connection with DALY based Approaches?

- WHO's DALY yardstick is widely used even for computing change in health
- Recall this is `the counting your losses approach' as compared to counting your blessings (as per Life expectancy)
- Unlike CMLT indices change in DALYs is not calculated by difference but rather relies on the construct Attributable Fraction
- Cross-sectional nature of DALY yardstick contrasts with CMLT

Conceptualizing life-table calculation: Lexis Diagram



Cross-sectional Nature of Health Gap Measures



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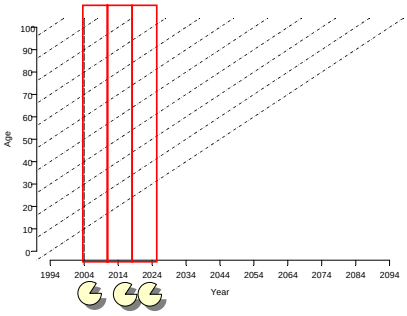
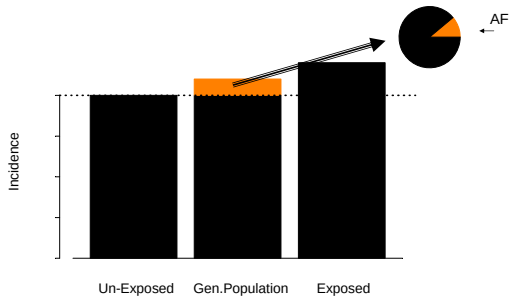


"Comparative Risk Assessment"

- Framework proposed by Murray and Lopez (1999) and Murray et al (2003).
- Two steps:
  1) Calculate status-quo burden
  2) Forecast proportion eliminated after mitigation
- Second step hinges upon ***Attributable fraction (AF)***

Conceptualizing an Attributable Fraction (AF)



Challenges to AF Approach

1. RR must be ratio of (Cumulative) Incidence estimates
2. CRA requires **Extrapolation** of AF (study=>target population)
3. Capturing temporal trends
4. Clarifying the interpretation of result

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