A low mortality benchmark for the United States

Summary

We calculate a preliminary series of best-possible lifetables for the United States from 1959 to 2004, defined on the basis of the age-specific aggregate of the lowest observed age-cause specific death rates among the 50 states and the District of Columbia.

The resulting highest-possible life expectancy shows a gradual increasing trend over the period, on average 1.9 and 2.2 years higher than the highest state life expectancy in each year for males and females, respectively.

The US low-morality lifetable is a useful gauge of future mortality trends. We compare state mortality patterns to benchmark life expectancy to quantify the potential for immediately acheivable improvement.

The next iteration of this project will run through 2013, adding 10 years to the results presented here.

It looks like someone thinks to do this about every 30 years: Whelpton (1947), Munich (1970), Vallin & Meslé (2000). We're not backing the trend, but we've got some methodological tweaks in the pipeline, and a novel dataset.

We will also compare with simple cause-deletion of diseases amenable to medical treatment, as these are similar concepts in the end.

Data and Method

All death count data come from restricted NCHS mortality microdata files. Single-age population denominators and complete state lifetables come from a beta version of the U.S. States project of the HMD. Death counts by causes of death are first grouped into 11 large cause groups and then converted to fractions in abridged age groups.

In the next iteration we'll experiment with using the same 34 causes used by Vallin & Meslé (2008)

Fractions are then multiplied into single-age all-cause death rates to produce a first estimate of single-age cause-specific death rates. In order to eliminate stochastic zeros, cause-specific schedules are then smoothed over age and time using the method proposed by Camarda (2012), and then constrained to sum to the independently-smoothed all-cause mortality rates for each state.

This means we used the `MortalitySmooth` package in R.

We then produce the minimum mortality rate schedule $m(x)^{min}$ by summing the lowest-observed cause-specific rates within each age and sex:

$$m(x)^{min} = \sum_{c=1}^{C} min(m(s,x,c))$$

within each of the 11 causes within age x from among 50 states & DC

The minimum mortality schedule is then used to compute benchmark low-mortality life expectancy.

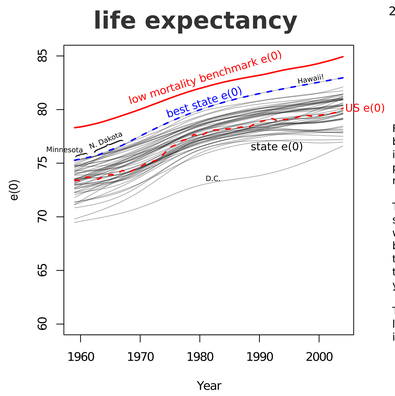
The difference between each state and the benchmark life expectancy of each year is then decomposed by age and cause using the generic decomposition method proposed by Horiuchi et. al. (2008).

There are plenty of options for this decomposition. It is nice since it will be easy to adapt to decompose indices of state inequality.

Second thoughts

Clearly this procedure is not scale-invariant: If we were to repeat the same exercise for US counties rather than states, it would produce a higher benchmark life expectancy, and likewise if we increase the number of causes. In this way we can arbitrarily push the value higher or lower. For this reason, we are going to try modeling select quantiles from a latent distribution of rates. (hat tip to Jutta Gampe)

Females



For females low mortality benchmark life expectancy has increased a fairly steady 1.5 years per decade, slightly faster than national life expectancy.

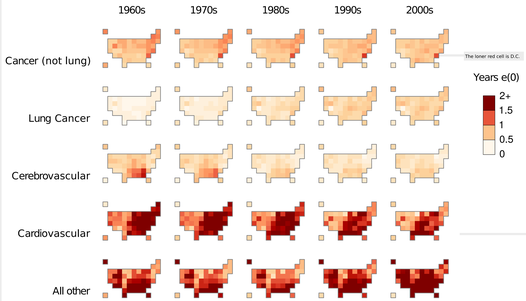
The gap is decreasing with record state life expectancy, and the gap with national life expectancy has been steady in recent decades. At this rate, national life expectancy tends to catch up in around 30 years

The 2004 LMB was about 0.6 years less than Japanese life expectancy in the same year.

these details will change, of course, in future iterations of this exercise.

There were countervailing state trends in the 1960s for both males and females.

LMB improved steadily in the 1960s, even as national life expectancy stagnated.

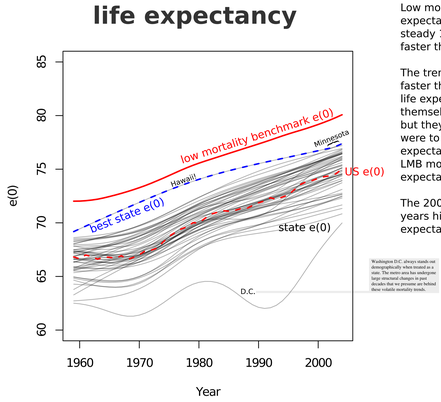


This decomposition is quite different from results you'd get from cause-deletion: no causes are deleted here, we're just comparing with the best-observed rates in each cause. If the lowest death rate for a given cause is still high there may or may not be geographic variation.

There is high geographic variation, but not so much absolute variation in lung cancer. The gap between states and benchmark has been growing for both males and females, but more for males.

Cardiovascular disease is unsurprisingly the cause of death that comes into sharpest relief using this decomposition method: It is a major killer, but the between-state spread is also very high. Were we to experience the hypothetical perfect diffusion of "best practices" this would close much of the gap with the low mortality benchmark.

Males

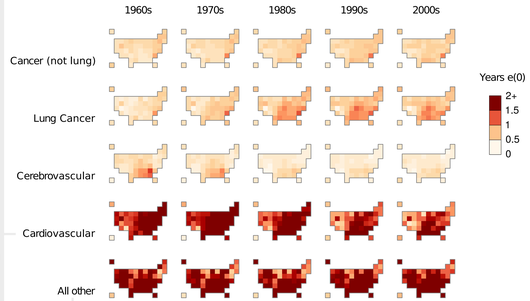


Low mortality benchmark life expectancy has increased a fairly steady 1.8 years per decade, slightly faster than national life expectancy.

The trend in LMB is currently rising faster than the trend in record state life expectancy. Both lines lend themselves to linear extrapolation, but they would diverge greatly if you were to do this. National life expectancy seems to keep pace with LMB more than with record state life expectancy.

The 2004 male LMB value was 1.4 years higher than Japanese male life expectancy in the same year.

Washington D.C. always stands out demographically when treated as a state. The metro area has undergone a dramatic transformation in recent decades that we presume are behind these volatile mortality trends.



Don't worry, the next iteration will break down the 'other' category!

Map key

Thoughts on the grid map?

This is the NPR states grid map. We'll switch to the NYT one, since it's been found to be more accurate and intuitive. See the comparison by Kiral Wongsuphasawat:

This display gives more visual weight to the largest cause-contributions for those causes that have the greatest state variation (which is to say, impacts on e(0)). Attention is drawn to cerebrovascular diseases in the 1960s, and geographic patterns in cardiovascular improvements. Remember, we're always comparing with a moving target: the benchmark trend is kind of like life expectancy inflation.

We don't necessarily see much from those causes with high between-state variation but little absolute impact. Nor do we see much from those causes with high absolute impact but little between-state variation. To pop out on these maps there needs to be at least a little bit of both. Other than all the rest, and the poorly performing states need to be doing quite bad.

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Further material

Low mortality benchmark life expectancy lends itself to comparison with international record life expectancy. At least two papers being presented in this PAA use record life expectancy in an instrumental way to guide mortality projections. We speculate that some version of this benchmark trend could serve a similar auxiliary role in projections. See e.g.,

A. Medford 37-1 (today at 10:15): "Best Practice Life Expectancy and Extreme Value Theory"

M. Pescariu & V. Canudas-Romo 37-2 (today at 10:15): "The Double-Gap Life Expectancy Forecasting Model"

Code

The R code used to process data, produce results, and create figures is in an open repository on github, which also contains the current version of the manuscript.

https://github.com/timriffe/BPLE

Unfortunately, since the data come from restricted files (due to small counts and suppressed geographic information) you need access to a Research Data Center (RDC) from the CDC in order to reproduce these results or do this kind of work in general. See http://www.cdc.gov/rdc/

Conclusions

Low mortality benchmark life expectancy displays a linear trend over the period studied, much more linear than any of the state trends or the national trend. During times of stagnation (1960s) and accelerated improvement (1970s), the benchmark mortality improved at roughly the same steady rate. This benchmark shows us the improvements that can be acheived now, without any technological advancements. Perhaps the linear trend can be used to temper or guide mortality projections as well.