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The changing impact of regional inequalities in mortality on individual variation in lifespan

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Introduction

Despite progress at reducing mortality, systematic gaps in life expectancy persist for many national population subgroups including socioeconomic groupings, regions, race, and gender. Subpopulation age-at-death distributions can differ from one another because of differences in average lifespan (between-group inequalities) as well as differences in how individual lifespans are distributed within the group (within-group variation). Preliminary evidence suggests that groups disadvantaged in life expectancy tend also to have higher dispersion in the age at death (Edwards and Tuljapurkar, 2005, Shkolnikov et al., 2003, Van Raalte et al., in prep). Using additive subgroup decomposition techniques, the individual lifespan variation of the national population can be decomposed into these between- and within-group components (van Raalte, Kunst and Mackenbach, 2009). The contribution of the stratifying variable being examined, for example socioeconomic status, smoking, or region, is simply the between-group inequality component divided by the total individual variation.

In this paper I apply additive decomposition techniques to measure the contribution of regional inequalities in mortality to individual lifespan variation in the United Kingdom, Germany and Canada. My aims are: to separately examine and compare inter- and intraregional inequalities in age-at-death in the three countries and over time; to quantify the contribution of regional inequalities on individual lifespan variation; and to determine whether changes to this contribution are due to direct changes in within-region variation, changes in relative mean lifespans or compositional changes to the between- or within-group components. By separately examining changes to these two components of lifespan variation, we get a different, but complementary picture to traditional methods that focus on regional inequalities as being average differences between regions. Reducing regional inequality requires both raising the average lifespan of disadvantaged areas as well as reducing the dispersion around this average.

Data and Methods

I use broad regional demarcations in three countries: the United Kingdom (Scotland, Northern Ireland, England & Wales), Germany (East and West Germany) and Canada (the provinces). Using data from the Human Mortality Database (HMD) and the Canadian Human Mortality Database (CHMD), I respectively decompose the male and female lifepan variation into its between- and within-region components, for each year from 1950-2006 (only 1991-2006 for Germany).

Variation in age-at-death was measured from the life table death densities. Data from both the HMD and CHMD is designed so as to be optimal for each population (national and regional) but without the explicit aim of consistency between the sets of life tables. Thus calculating and decomposing inequality from the given national and regional life tables will involve a slight residual. To get around this (resulting in exact decompositions), I created my own regional life tables (ages 0-110+), using the lifetable male and female death rates (m_x) from each region, and the average number of life years lived in the interval by those who die (a_x) from the corresponding national population life table. The resulting death densities are those used in the decomposition. For the national population, the death densitiy is calculated by summing the deaths at each age from all of the regions.

Lifespan variation was measured using the mean logarithmic deviation (*MLD*) developed by Theil (1967). This is an entropy measure commonly used in economic inequality research. The primary advantages to this measure are that it is both additively decomposable such that total inequality is the sum of its between-group (*BG*) and within-group (*WG*) components, and it is decomposable over time to reflect whether changes in individual level variation resulted from changes in relative mean lifespans, from changes within the subgroup distributions, or from changes in the educational composition of the population.

From the life table death density, van Raalte et al. (2009) showed that the *MLD* of lifespan inequality is calculated by:

$$MLD = \frac{1}{l_0}\sum_{x=0}^{\omega} d_x \left[\ln\left(\frac{e_0}{\bar{x}_x} \right) \right], \qquad (1)$$

where $\bar{x}_x$ is the average age at death and d_x the death density in the age interval x to x+1. The initial population size is l_0 and e_0 is the average age-at-death. The greater is the value of the index, the greater the variation in age-at-death. The additive decomposition becomes:

$$MLD = \sum_{i=1}^{n}\left[w^i \ln\left(\frac{e_0^T}{e_0^i}\right)\right] + \sum_{i=1}^{n}\left[w^i MLD^i\right], \tag{2}$$

where *w* is the population share of subgroup *i* to the total population *T.* The first term measures the *BG* component by assuming that everyone in each subgroup dies at the subgroup's average age-at-death. In other words, it calculates the inequality in the distribution of subgroup average lifespans. The second term in equation 2 measures the *WG* component, and is the population-weighted sum of the lifespan variation calculated for each subgroup. The contribution of the *BG* component to total lifespan variation is simply the *BG* component divided by the *MLD* in lifespans of the whole population.

Decomposing the change in the *MLD* over the two time periods can be done using the dynamic decomposition of Mookherjee and Shorrocks (1982). In demography, this decomposition analysis has been used to decompose whether inequalities in world life expectancy changed because life expectancies changed at different rates across countries or because populations grew faster in countries with unusually low or high life expectancies (Goesling and Firebaugh, 2004). To my knowledge it has never been applied to examine changes in the death density. Applying this formula to the lifetable age-at-death distribution we get,

$$\Delta MLD \approx \sum_{i=1}^{n}\overline{w^i}\Delta MLD^i + \sum_{i=1}^{n}\left(\overline{v^i} - \overline{w^i}\right)\Delta\ln\left(e_{30}^i\right) + \sum_{i=1}^{n}\overline{MLD^i}\Delta w^i + \sum_{i=1}^{n}\left(\overline{\frac{e_{30}^i}{e_{30}^T}} - \overline{\ln\frac{e_{30}^i}{e_{30}^T}}\right)\Delta w^i, \tag{3}$$

where *v* represents the life expectancy share, and *w* the population share for subgroup *i* or the total population *T.* An overbar represents the average of a variable over the two periods, while the Δ operator represents the difference in the variable over the periods. The first component represents the impact of mortality changes on within-group variation, the second component represents the impact on relative mean lifespans, while the third and fourth terms are respectively the effect of changes in population shares on within-group and between-group inequality levels. The first two changes would be considered survival effects, while the latter two are compositional effects.

Expected Results

In a previous study on socioeconomic inequalities, I found that educational differences in mortality were contributing about 0.6-10 percent of individual level variation in Europe. I would expect regional differences to contribute less, given the smaller average differences between areas and provinces in the United Kingdom, Germany and in Canada. Nevertheless, preliminary analysis shows that though this contribution is small, its value has mostly decreased over time. This is perhaps surprising given that total individual variation in age-at-death has decreased substantially in the last 50 years (Vaupel, Zhang and van Raalte, 2009, Smits and Monden, 2009, Wilmoth & Horiuchi 1999). For the between-group contribution to decrease, this means that lifespan inequalities have been reduced more quickly between regions than within regions. Decomposition analysis will answer the question of whether this is due to direct or compositional effects.

Potential Extensions

To date, only the mean logarithmic deviation has been decomposed in the style of Mookherjee and Shorrocks (1982). However there are a number of other additively decomposable measures such as Theil's Index and the variance in age-at-death. Their suitability for this type of analysis will be assessed.

References

Canadian Human Mortality Database. Department of Demography, Université de Montréal (Canada). Available at www.demo.umontreal.ca/chmd/.

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org.

EDWARDS, R. D. & TULJAPURKAR, S. (2005) Inequality in life spans and a new perspective on mortality convergence across industrialized countries. *Population and Development Review,* 31**,** 645-674.

GOESLING, B. & FIREBAUGH, G. (2004) The Trend in International Health Inequality. *Population and Development Review,* 30**,** 131-146.

MOOKHERJEE, D. & SHORROCKS, A. (1982) A Decomposition Analysis of the Trend in UK Income Inequality. *The Economic Journal,* 92**,** 886-902.

SHKOLNIKOV, V., ANDREEV, E. & BEGUN, A. Z. (2003) Gini coefficient as a life table function. Computation from discrete data, decomposition of differences and empirical examples. *Demographic Research,* 8**,** 305-358.

SMITS, J. & MONDEN, C. (2009) Length of life inequality around the globe. *Social Science & Medicine,* 68**,** 1114-1123.

THEIL, H. (1967) *Economics and Information Theory,* Amsterdam, North-Holland Publishing Co.

VAN RAALTE, A., KUNST, A. E. & MACKENBACH, J. P. (2009) How much are educational differences contributing to individual lifespan disparities? *Paper presented at the XXVI IUSSP International Population Conference, in session 196: "Socio-economic inequality and mortality". Marrakech, Morocco.*

VAUPEL, J. W., ZHANG, Z. & VAN RAALTE, A. (2009) Life expectancy and disparity. *Paper presented at the 74th Annual Population Association of America meeting, in session 15: "Life expectancy". Detroit MI.*

WILMOTH, J. R. & HORIUCHI, S. (1999) Rectangularization Revisited: Variability of Age at Death within Human Populations. *Demography,* 36**,** 475-495.