Age-related disease burden as a measure of population ageing

See Articles page e159

Improvements in health care and social circumstances have resulted in people living longer. Still, not all people thrive in good health as they age: the oldest old might be long lived but many suffer from multiple, interacting health problems that can profoundly affect the management of their numerous and often complex health isssues.[1] In population health, common population ageing metrics, such as longevity, do not accurately reflect the state of health in which people who are living longer find themselves.[2]

In *The Lancet Public Health*, Angela Chang and colleagues[3] used the Global Burden of Diseases, Injuries, and Risk Factors Study 2017 to better understand health and longevity. To compare changes in population ageing across 195 countries between 1990 and 2017, they classified 92 diseases as age related, meaning that the incidence rate of each increased quadratically with age. Next, they summed the disability-adjusted life-years (DALYs) from each disease among adults to calculate the age-related disease burden. Remarkably, age-related disease burden, which accounted for 51·3% (95% uncertainty interval [UI] 48·5–53·9) of the total disease burden globally, decreased in all countries between 1990 and 2017. Burden varied between countries, being lowest in Switzerland (104·9 DALYs [95% UI 95·7–115·5] per 1000 adults aged 25 years and older), Singapore (108·3 DALYs [98·6–119·9]), South Korea (110·1 DALYs [100·7–120·4]), Japan, and Italy (110·6 DALYs [101·3–121·7]) in 2017. At the other end of the scale were countries such as Papua New Guinea (506·6 DALYs [452·3–576·1]), the Marshall Islands (396·9 DALYs [358·3–442·7]), and Afghanistan (380·2 DALYs [340·4–423·3]), which notably had a low Socio-demographic Index (SDI; a measure of country income per capita, average years of education, and total fertility rate under 25 years). This combination of low life expectancy and high age-related disease burden challenges the pessimism inherent in viewing poor health as simply the cost of longevity. As Chang and colleagues show, the manifold benefits of improving population health and ageing extend to lower rates of health burden from whichever cause, age related or otherwise.

Even so, ill health and longevity are linked. Death in relation to age-related disease was estimated from the cumulative death rates from the 92 diseases. The authors rescaled their presentation of mortality in relation to age-related disease burden by considering the fraction of country-level deaths in each age group against the country-specific cumulative death rate of the age group 80–84 years (the highest observed life expectancy). They showed that the advantage to being one of the countries with the lowest cumulative age-related death rate for each age group in 2017—the frontier countries Switzerland, South Korea, Singapore, and Kuwait—was most evident at younger ages; across all country-specific SDI levels, death rates converged around the age of 75 years. This convergence in death rates, however, should not blur the clear benefit of a lower age-related disease burden with old age.

On average, poor health in old age increases the risk of death. What is tricky about health in old age is that it involves more than just disease. Health problems that increase with age go beyond what disease alone can capture, such as impairments in cognition, mood, and physical performance. These remain relevant, even when not disabling. This is why many believe that we have reached "the end of the disease era".[2] If so, we can ask whether DALYs can optimally capture population ageing. By contrast, a broader approach to quantifying how health changes with age motivated the frailty index.[4] The frailty index score represents the fraction of health problems of old age—which encompasses diseases, disabilities, clinically observable signs and symptoms, and biomarkers that they have—relative to the number that were measured. This approach recognises that health problems other than diseases are important and that such problems interact on various levels and do not accumulate independently of each other. Although heterogeneous across individuals, over any given time interval, health deficits accumulate characteristically. The accumulation is, on average, gradual and occurs chiefly as a function of the number of baseline deficits. Its characteristic patterns make the frailty index useful in understanding the complexities of ageing,[5] including how age-related deficit accumulation modifies both disease risk and expression for common maladies of old age.[6]

People living with the poorest levels of health commonly use high levels of care and resources.[7] Despite

this heavy use of health care, at least in England and Wales, increases in survival for older people between 1991 and 2011 were not seen for people living with severe frailty, which remained notably lethal.[8] By contrast, a Swedish study comparing survivorship of 70-year-olds between 1970 and 2000 found that the lethality of frailty fell in general but most among those with severe frailty.[9] As such, it would be useful to expand on Chang and colleagues' work[3] to understand country-level estimates of different degrees of population ageing.

It will be crucial to understand how health care and policy can adapt to better serve those with the worst health. Will a focus on prevention offset interventions that can prolong life in old age without improving health? Moving contemporary medical care from the traditional paradigm of seeing diseases individually to a model that appreciates the complexities and heterogeneity of ageing is proving to be incomplete and slow.[2] Whether the public health community can lead this reconceptualisation and offer a quantitative approach to address the complexities of health in ageing will be enlightening.

D Scott Kehler
Division of Geriatric Medicine, Dalhousie University, Halifax, NS B3H 2E1, Canada
scott.kehler@dal.ca

I would like to thank Kenneth Rockwood (Division of Geriatric Medicine, Dalhousie University) for providing his expertise in writing this Comment. I declare no competing interests.

1 Zeng Y, Feng Q, Hesketh T, Christensen K, Vaupel JW. Survival, disabilities in activities of daily living, and physical and cognitive functioning among the oldest-old in China: a cohort study. *Lancet* 2017; **389:** 1619–29.
2 Cesari M, Marzetti E, Thiem U, et al. The geriatric management of frailty as paradigm of "The end of the disease era". *Eur J Intern Med* 2016; **31:** 11–14.
3 Chang AY, Skirbekk VF, Tyrovoras S, Kassebaum NJ, Dielman JL. Measuring population ageing: an analysis of the Global Burden of Disease Study 2017. *Lancet Public Health* 2019; **4:** e159–67.
4 Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. *ScientificWorldJournal* 2001; **1:** 323–36.
5 Rutenberg AD, Mitnitski AB, Farrell SG, Rockwood K. Unifying aging and frailty through complex dynamical networks. *Exp Gerontol* 2018; **107:** 126–29.
6 Wallace LMK, Theou O, Godin J, Andrew MK, Bennett DA, Rockwood K. Investigation of frailty as a moderator of the relationship between neuropathology and dementia in Alzheimer's disease: a cross-sectional analysis of data from the Rush Memory and Aging Project. *Lancet Neurol* 2019; **18:** 177–84.
7 Gilbert T, Neuburger J, Kraindler J, et al. Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic hospital records: an observational study. *Lancet* 2018; **391:** 1775–82.
8 Mousa A, Savva GM, Mitnitski A, et al. Is frailty a stable predictor of mortality across time? Evidence from the Cognitive Function and Ageing Studies. *Age Ageing* 2018; **47:** 721–27.
9 Backman K, Joas E, Falk H, Mitnitski A, Rockwood K, Skoog I. Changes in the lethality of frailty over 30 years: evidence from two cohorts of 70-year-olds in Gothenburg Sweden. *J Gerontol A Biol Sci Med Sci* 2017; **72:** 945–50.