

Background

Projected trends in 'population ageing' have worried policy makers because for every worker paying income tax and national insurance there are likely to be more older, disabled and ill citizens, leading to greater demands on health and welfare systems. However, the extent, speed and impact of population ageing have often been exaggerated because standard indicators such as the Old Age Dependency Ratio do not take proper account of either falling mortality, or the changing relationship between age and employment. We therefore propose several alternatives that do both.

Counting the 'Elderly'

In 1900, mean life expectancy for 65-year old women in current European low-mortality countries was 10-14 years compared to 20-24 years today. This changing significance of age can best be captured by classifying a population into two age components: according to **years lived** and **years left**. In a period of lengthening lifespans, not only does the average age of the population increase, so too does the remaining life expectancy (RLE) that is associated with each age. Like Sanderson & Scherbov [1] we first use the age at which RLE ≤ 15 years as the threshold of 'old age', rather than a fixed age boundary.

Counting 'unhealthy' elderly

This threshold of old age, however, says nothing about the distribution of lifespan: some will die within a year, others will live another 30. We therefore recently proposed to use the information contained in the life table to obtain population counts according to Time to Death (TTD), a.k.a. thanatological age [2]. For the purpose of the current study we assume that the older population with a TTD of <5 years is an indicator of acute health care needs.

Working-age vs. working

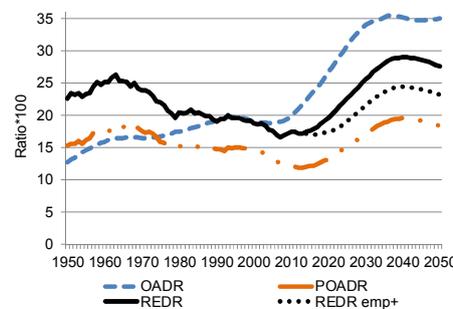
The OADR and POADR assume that everyone of 'working age' actually works despite that youngsters are kept in education for longer and many older workers retire early. Also, greater gender equality and dual career families have added more female than male workers in high-income countries [3]. Using age to define the working population thus makes little sense. Other adjustments considered are hours worked, productivity and government tax revenue.

Method

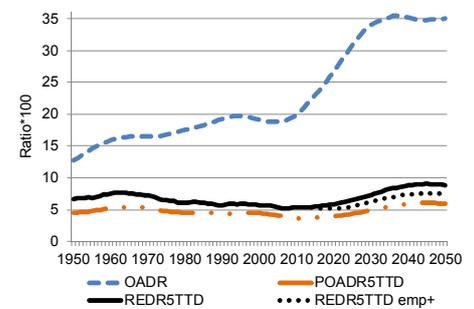
Abbrev [source]	Ageing Indicators	Formula
	Conventional	
OADR	Old-Age Dependency Ratio	$\frac{\text{Population aged 65+}}{\text{Population aged 20-64}}$
	Alternative - known	
POADR [1]	Prospective Old-Age Dependency Ratio	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years}}{\text{Population aged 20+, LE} > 15 \text{ years}}$
REDR [3]	Real Elderly Dependency Ratio	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years}}{\# \text{ of people in paid employment}}$
	Alternative - NEW	
POADR5TTD	Health care need adjusted POADR	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years and TTD} < 5 \text{ years}}{\text{Population aged 20+, LE} > 15 \text{ years}}$
REDR5TTD	Health care need adjusted REDR	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years and TTD} < 5 \text{ years}}{\# \text{ of people in paid employment}}$
RLE15/gdp or tax	Ratio elderly to GDP; to tax	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years}}{\text{GDP; Government tax revenue}}$
RLE15&5TTD/gdp or tax	Ratio elderly in need of HC to GDP; to tax	$\frac{\# \text{ of people in age groups with LEs of } \leq 15 \text{ years and TTD} < 5 \text{ years}}{\text{GDP; Government tax revenue}}$

Results

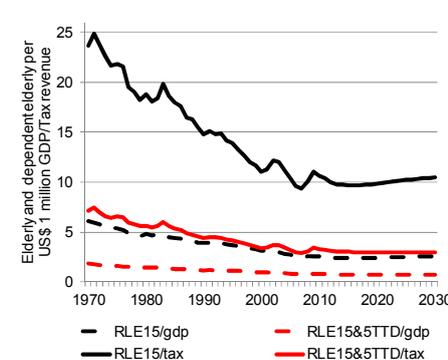
1. Conventional (OADR), Prospective (POADR) & Real (REDR) Old-Age Dependency Ratios. United States (US). 1950-2050.



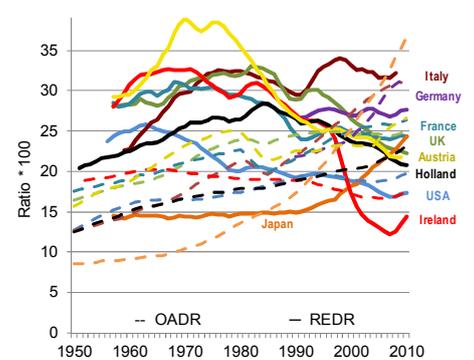
2. OADR vs. POADR & REDR where elderly have a Time to Death of < 5 years (5TTD). US. 1950-2050.



3. 'Elderly' & 'Elderly with Health Care Needs' per US\$ 1 million in GDP & Tax Revenue. US. 1950-2050.



4. REDR & OADR. US & other high-income countries. 1950-2011.



Method: See Table for how the indicators are calculated. **Data:** Sex-specific population and mortality data until 2011 come from the Human Mortality Database (www.mortality.org), the projected data from the US Census Bureau (www.census.gov) and the sex-specific employment data till 2013 from the Labour Force Statistics (www.bls.gov). For 2014-2023 annual increases in LFP rates of 1% are applied to ages 16-64 (to attain rates similar to the recorded maximum for men in the year 2000) as well as for 65-69, 70-74 and 75+ in the anticipation of better health and incentives to work beyond retirement age. The Conference Board (2014) Total Economy Database is the source of the GDP data (1990 US\$ converted at Geary Khamis PPPs) until 2013. For the period until 2030 estimated growth rates in GDP published by the Economist Intelligence Unit (<http://country.eiu.com>) were applied. The government tax revenue data come from the OECD (www.oecd.org) until 2012 and its proportion to GDP was held constant thereafter. See [3] for the data sources used for the international comparison. **Interpretation:** When taking account of increasing old-age survival the proportion elderly is lower than the common standard would suggest (Fig 1) and much lower when only considering those expected to die within 5 years (Fig 2). Increasing employment rates will alleviate the ageing burden. If we consider trends in GDP and taxation the state financial burden to care for dependent elderly may not even be strained (Fig 3). Internationally, the ageing burden is much less in the US than in other high-income countries (Fig 4).

Conclusion

Alternative indicators of population ageing that adapt demographic methods to quantify the population by both remaining years of life and age should be considered because many components of adult health care expenditure have been shown to be driven by proximity to death, not age [4]. This remaining-years perspective has already been applied in the fields of economics [5]. Ageing indicators should also take into account economic booms and busts and changing labour force characteristics, especially the increase in female and older workers [6] that directly affect government tax revenues and thus the financing of health and elderly care.

References

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Corresponding author & funding

Jeroen Spijker: Jeroen.Spijker@oeaw.ac.at
Vienna Institute of Demography (VID) /
Austrian Academy of Sciences (ÖAW)

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