PAA 2014 Extended Abstract

Projection of ADL-based disability among older Singaporeans: Comparing numbers based on prevalence and on incidence with and without educational attainment

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Introduction

Population aging is a burning global issue that transcends country-level socio-economic profiles.[1] According to projections, the elderly will comprise 16 percent of the world's population by 2050.[1,2] In Singapore, the proportion of elderly aged 60 years and older is expected to grow to over a quarter of its population in 2030.[3] A major concern related to population aging is the associated decline in functional capacity with age being a known risk factor for disability.[4] In fact, population aging is one of the key drivers of the increase in number of years lived with disability over the past 20 years.[5] Furthermore, the elderly have been shown to have the highest disability prevalence.[6] A recent national survey in Singapore reported that the overall prevalence of limitations in activities of daily living (ADL) among community-dwelling elderly Singaporeans was 9.7 percent.[7] Hence, it is likely that aging-related disability will increase the demand for long-term care, subsequently raising healthcare costs for families, communities, and the government.[8] The health and socioeconomic impact of aging-related disability highlight the importance of accurate projections of disability in aging populations. Identifying the relevant potential issues and determining the magnitude of the problem are necessary for effective policy planning. Socioeconomic factors are strong predictors of morbidity and mortality[9] which can potentially explain projection trends in disability among the elderly.[10] Education, in particular, has been shown to be strongly associated with a number of health-related behaviors over the life course.[9,11] More specifically, a higher level of education is associated with lower levels of morbidity, mortality and disability.[9,12] Concurrent with the 2030 projections on aging, the future elderly group in Singapore is also expected to be better educated, with 67.7 percent of Singapore's current resident population aged ≥25 years now having at least secondary level education.[13] In addition, Singapore has fewer males (18 percent) and females (35 percent) without any formal education compared to the respective proportions of 60.7 percent and 83.1 percent in 1990.[3] Given the association of education with health and disability[11,12,14] and the growing number of individuals receiving more years of education,[15,16] accounting for the effect of education in disability projections is crucial.

Despite the availability of prevalence disability projections among the elderly,[17-20] the non-linear variations in prevalence data make prevalence-based projections prone to potential overestimation[21] and may be unreliable in describing the course of aging. Hence, incidence-based projections are the preferred model for population projections by age and gender.[16] However, because of limited incidence data available, relatively fewer studies have investigated incidence-based disability projections.[14,22,23] Even fewer studies have considered the potential educational differentials in their estimates.[12,14,15] Thus, describing the cohort effect of educational attainment may be of particular interest as previous studies suggest that a better educated elderly cohort could partly explain the declining rates of disability observed among the elderly.[12,14] Projecting disability among older Singaporeans may then provide an ideal setting for describing the role of education in incidence-based projections of disability among the elderly. Against this backdrop, this study aims to project to 2040 and compare the number of Singaporean elderly with ADL-based disability, and the severity therein, based on prevalence, incidence and incidence with educational attainment.

Methods

Data sources: Prevalence of moderate disability (i.e., older adults with up to two ADL limitations needing human assistance) and severe disability (i.e., older adults with three or more ADL limitations needing human assistance) by age and gender were estimated from the 2009 Social Isolation, Health and Lifestyle Survey (SIHLS), a nationally representative survey of community-dwelling older Singaporeans aged ≥60 years (N=5,000). The transition and mortality rates by age (single years), gender and educational attainment (low: primary or less; high: secondary or more) were estimated using data from the SIHLS and its follow-up study (Panel on Health and Aging of Singaporean Elderly, PHASE), conducted in 2011–12.

Population model: A population model (Appendix, Figure1) was first developed to project the future elderly population.[24] The model disaggregated the Singapore population into one-year age cohorts by gender. The population cohorts are affected by birth (only for the first age cohort), deaths, immigration, emigration and aging (except for the last age cohort). Births and deaths were then calculated based on the corresponding fertility rates and the female reproductive age group (15–44 years), and mortality rates from life tables by age.

Both birth and mortality rates were held constant over the simulation time, conducting further sensitivity analysis to evaluate the impact of changes in fertility and mortality on the population. Immigration and emigration were estimated from available data and by calibration, respectively. The aging process ensures that at every yearend, the surviving population in each age cohort transitions to the subsequent cohort except for the final age group (i.e., ≥100 years). The non-surviving population in each age cohort is then removed via an outflow that reflects the respective mortality rate for this particular age cohort. The population model was calibrated using publicly available national statistical data.

Prevalence-based disability projection: Using data from the 2009 SIHLS, the prevalence of moderate and severe disability by age cohort (i.e., 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94 and ≥95 years) and gender were estimated. The prevalence estimates were then adjusted to account for the institutionalized elderly who were excluded from the SIHLS. The adjusted prevalence estimates were then applied to the projected elderly population, derived from the population model described above, to determine the future disability estimates.

Incidence-based disability projection: For the incidence projection, a multi-state dynamic disability model (Appendix – Figure 2) was constructed using Vensim DSS (Ventana Inc), which allowed for projecting disability trends among the elderly from individual transition and mortality probabilities by age (single age cohort) and gender. In each of the two waves (SIHLS and PHASE), the following states were used to describe elderly individuals with and without disability in order of increasing severity: (a) low disability—older adults without ADL limitation(s) or with ADL limitation(s) but needing no human assistance; (b) moderate disability; and (c) severe disability. In addition, the second wave had an absorbing state, death. The annual transition and mortality probabilities to and from all states were estimated using the Interpolated Markov Chain software (IMaCH). New members—individuals from the population model as described in the prevalence projection, becoming 60 years of age—into the elderly cohort were assumed to flow into the low disability state. The model configuration allows transition to and from all the states. Deaths in each state were removed via an outflow that reflects the respective mortality rates for each cohort.

Incidence with educational attainment-based disability projection: A multi-state dynamic disability model disaggregated by age, gender and educational attainment was used to project disability trends among the elderly. Similar to the incidence projection approach, low, moderate and severe states were used to describe the natural history of disability. New members into the elderly cohort were assumed to flow into the low disability state from a multi-state population model by age (one-year age cohort), gender and education. The multi-state population model (Appendix – Figure 3) used herein accounted for differential mortality in the population by educational attainment. The model structure allows transition to and from all states. Deaths in each state were expunged via an outflow that reflects the respective mortality rates for that age cohort, state and educational attainment. Annual transition and mortality rates were estimated using the IMaCH.

Preliminary results

Base case results: The prevalence-based projection predicted the number of elderly with functional disability to increase almost fourfold (29,900 to 96,500) between 2010 and 2040. The corresponding numbers for 2040 in the incidence-based projection and the incidence with educational attainment projection were 25 and 34 percent fewer than the prevalence projection, respectively. Using incidence with educational attainment predicted 8.8 percent fewer elderly with disability than the incidence projection. Looking at the severity of disability among those with disability in 2040, while the prevalence-based and incidence-based projections suggested a higher proportion of elderly having severe disability (60 percent), the incidence with educational attainment projection predicted more elderly having moderate disability (60 percent).

Sensitivity analysis: Given a constant prevalence and a change in incidence (at ± 10 percent change in transition and mortality rates by age and gender), it is expected that the prevalence-based projection of disability will overestimate future elderly with disability, relative to the incidence-based projection; the overestimation may range from 13,500 to 34,500 by 2040 (Appendix – Figure 4a). Whereas – if educational attainment does make a difference in disability transition and mortality – given a constant incidence and a change in incidence with educational attainment (at ± 10 percent perturbation of transition and mortality rates by age, gender and educational attainment), there is a 95 percent chance that, not accounting for the cohort effect of educational attainment will overestimate future elderly with disability relative to incidence estimate; the overestimation is likely to be as high as 16,000 (Appendix – Figure 4b).

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Appendix

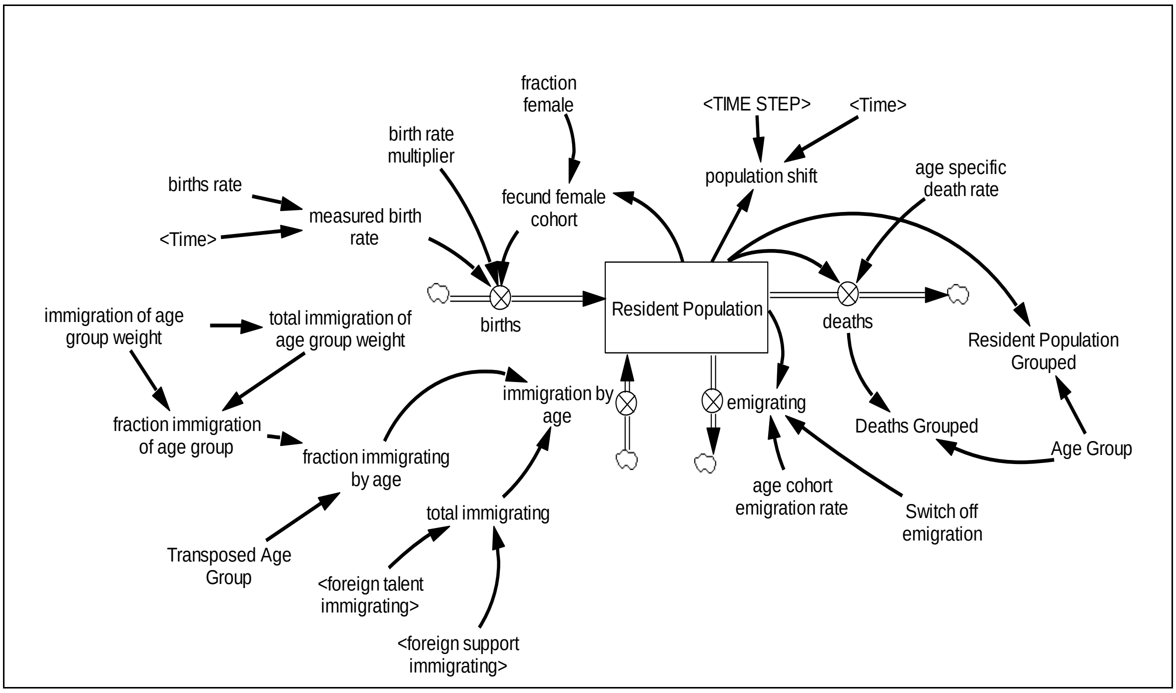

Figure 1. Population model

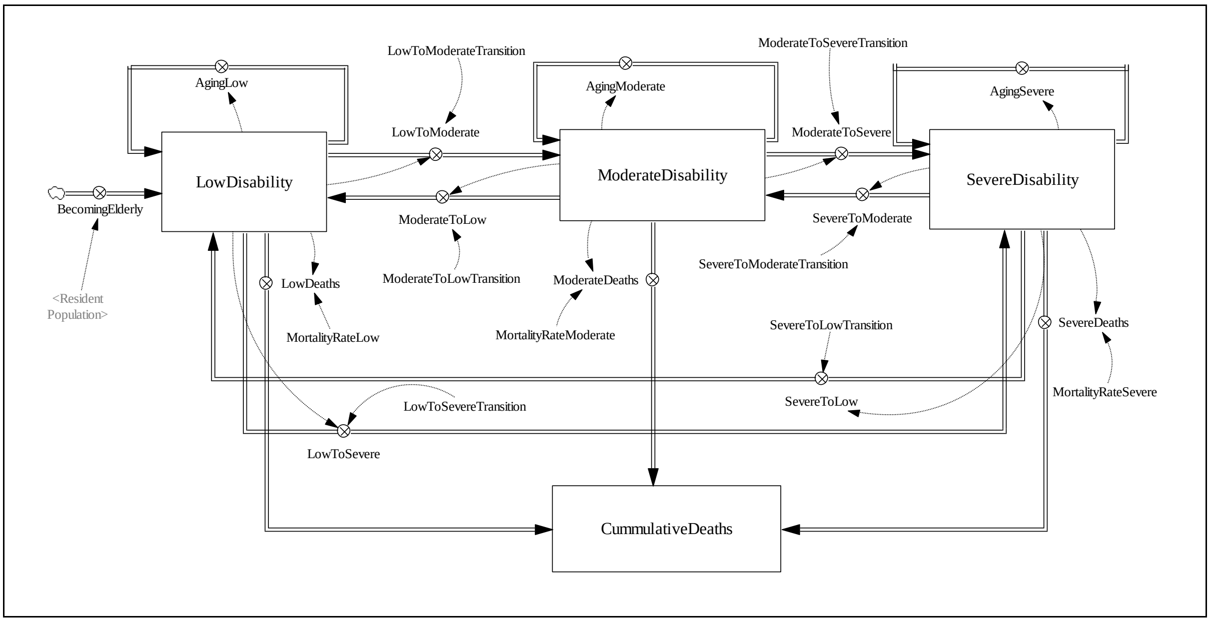

Figure 2. Multi-state disability model

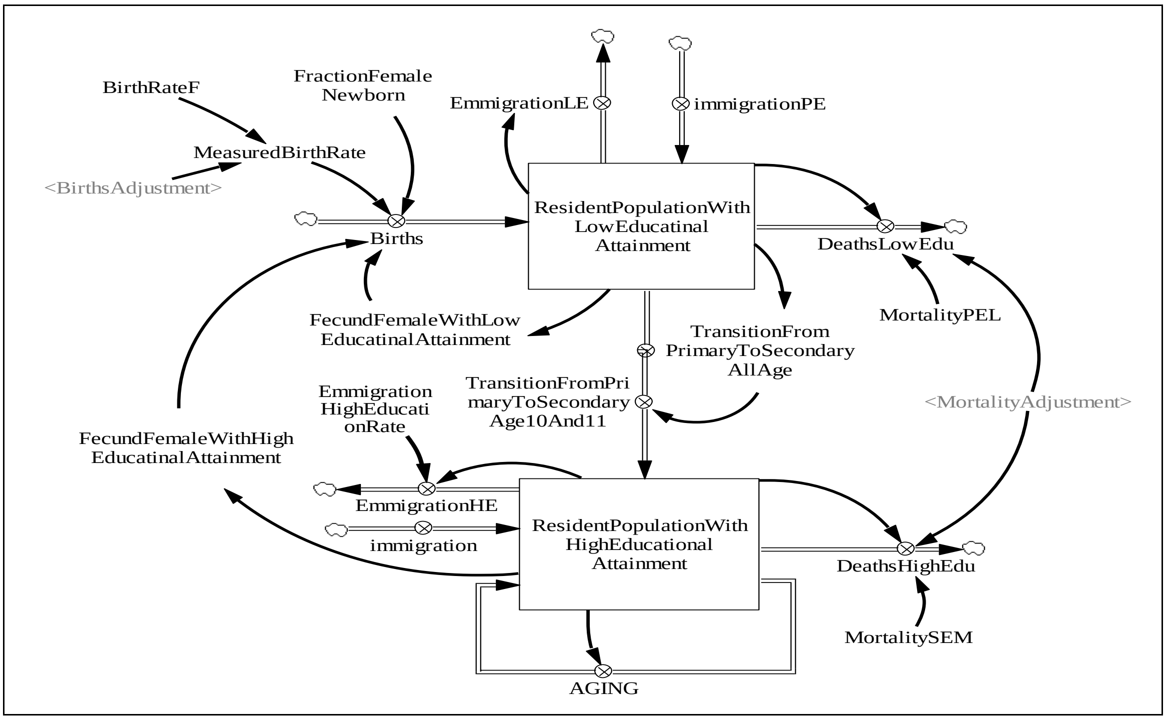

Figure 3. Multi-state population model by education

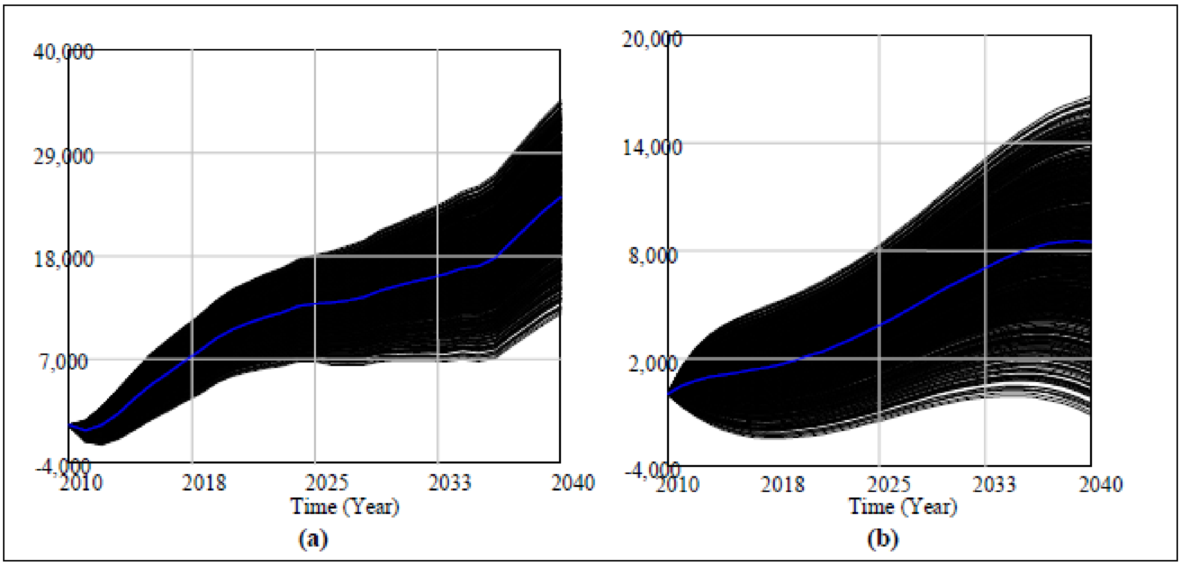

Figure 4. Sensitivity analysis with (a) constant prevalence and change in incidence and (b) constant incidence and change in incidence with educational attainment