

## **TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**

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## **TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**

### **Trends in Disability-Free Life Expectancy at Age 50 in Australia between 2001 and 2011 by Social Disadvantage**

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### Abstract

*Background.* The aim of this study was to (i) estimate 10-year trends in disability-free life expectancy (DFLE) by area-level social disadvantage, and (ii) examine how incidence, recovery and mortality transitions contributed to these trends.

*Methods.* Data were drawn from the nationally representative Household Income and Labor Dynamics in Australia (HILDA) survey. Two cohorts (baseline age 50+) were followed for seven years, from 2001-2007 and 2011-2017 respectively. Social disadvantage was indicated by the Social Economic Index for Areas (SEIFA). Two DFLEs based on a Global Activity Limitation Indicator (GALI) and difficulties with Activities of Daily Living (ADL) measured by the SF36 physical function subscale, were estimated by cohort, sex and SEIFA tertile using multi-state models.

*Results.* Persons residing in the low-advantage tertile had more years lived with GALI and ADL disability than those in high-advantage tertiles. Across the two cohorts, dynamic equilibrium for GALI disability was observed among men in mid- and high-advantage tertiles, but expansion of GALI disability occurred in the low-advantage tertile. There was expansion of GALI disability for all women irrespective of their SEIFA tertile. Compression of ADL disability was observed for all men, and for women in the high-advantage tertile. Compared to the 2001 cohort: disability incidence was lower for the 2011 cohort of men within mid- and high-advantage tertiles, whereas recovery and disability-related mortality were lower for the 2011 cohort of women within the mid-advantage tertile.

*Conclusion.* Overall, compression of morbidity was more common in high-advantage areas whereas expansion of morbidity was characteristic of low-advantage areas. Trends also varied by sex and disability severity.

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**Keywords:** healthy life expectancy; disability; social inequality;

### **What is already known on this subject?**

Gender and socioeconomic differences in disability-free life expectancies are well documented, and comparisons of health expectancies across different birth cohorts have revealed both compression and expansion of morbidity in different contexts. However, most comparisons have been generated from repeated cross-sectional analysis of national lifetables, and therefore been unable to examine how disability-free life expectancy has changed over time by level of socio-economic position, and identify which underlying transitions have contributed to these trends.

### **What this study adds?**

This is one of the first studies to apply multi-state methods investigate how trends in disability-free life expectancy vary by gender, socio-economic position, and severity of disability. Over a ten year period, there were greater improvements in the years lived free from disability for men than for women, and widening social inequalities.

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The World Health Organisation (WHO) has declared the global public health goal “to live not just long but also healthy lives”, and advocates for healthy life expectancy as a key measure of successful health promotion.<sup>1</sup> When examined over time, healthy and disability free life expectancies (DFLE) reflect the interplay between changing morbidity, disability, and mortality trends, which strongly influence the coping capacities of national health and social care systems.<sup>2 3</sup> Three main scenarios regarding these morbidity-disability-mortality dynamics in later life have been well described and include compression of morbidity/disability<sup>4</sup>, expansion of morbidity/disability<sup>5</sup>, and dynamic equilibrium.<sup>6</sup> By examining trends in health expectancies alongside trends in overall life expectancies we can assess which of these scenarios are occurring.<sup>7</sup> Importantly, divergent patterns of compression or expansion may unfold in different sub-groups of the population.

Motivated by the need to know if we are living longer healthier lives, a growing number of countries are producing trends in health expectancies that compare DFLE at different periods in time.<sup>8-12</sup> The majority of comparisons are based on repeated cross-sectional data, providing no indication of the contribution of underlying transitions (e.g. incidence, recovery, or mortality).<sup>9 13-17</sup> In addition, because national life tables are rarely provided for socio-economic groups, few countries can examine whether trends in DFLE differ across socio-economic strata. Most studies have therefore focused on documenting gender or cross-national differences.<sup>8</sup> Exceptions to this are Scandinavian countries with linked registry data, the UK which routinely reports healthy life expectancy by area-level deprivation,<sup>9 15 18</sup> and one recent US study providing estimates of DFLE trends by education.<sup>17</sup> All these studies used Sullivan’s prevalence based method to calculate health expectancies.

A range of individual and aggregate indicators have also been used to quantify social disparities in health expectancies.<sup>9</sup> There are well established gender differences in health

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expectancies showing longer years lived with disability for older women.<sup>19</sup> However, the extent to which this gender gap has remained stable over time has been shown to depend on national context<sup>15</sup> and the time period under consideration.<sup>20</sup> Other individual markers of social position that are commonly investigated include education<sup>17</sup>, wealth<sup>21</sup>, and occupation.<sup>21</sup> There is also a rich literature examining how area-characteristics contribute to variation in health expectancy outcomes.<sup>9 18 22 23</sup> For example, area disadvantage was recently used to quantify widening social inequalities in health expectancy trends in the UK.<sup>12</sup> This line of research is underpinned by evidence that community contexts are associated with health outcomes independently of individual factors and are therefore significant social determinants with important relevance for public health.<sup>24 25</sup>

National estimates of trends in health expectancies for Australia indicate that after an initial brief period of expansion between 1998 to 2003<sup>26</sup> there has since been a compression of years lived with disability.<sup>20 26</sup> As in most other countries, Australian lifetable data preclude the calculation of trends for different socio-economic groups, and underlying transitions of incidence, recovery, and mortality cannot be estimated. Furthermore, although risk factors such as obesity and smoking are likely to be impacting ages in mid-life,<sup>27</sup> most studies present DFLE trends at birth or age 65.<sup>8 23</sup> Longitudinal approaches to documenting trends in health expectancies are therefore needed as they can be used to examine the contributions of the underlying transitions and while also enabling estimation for different sub-groups in the population groups.<sup>12</sup> For these reasons, we use a unique longitudinal dataset, the Household, Income, and Labour Dynamics in Australia (HILDA) survey, and two indicators of disability (reflecting global and severe activity limitations), to: (i) describe the relative trends in life expectancy and DFLE at age 50 in Australia over the first decade of the 21st century; (ii) examine variation in trends by gender and socio-economic groups at the area level; and (iii) identify which underlying transitions have contributed most to the trends.

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### Methods

HILDA is a nationally representative longitudinal study of Australian households.<sup>28</sup> The survey uses a multi-stage random sampling of households within administrative areas (Census Collection Districts) across Australia. The study commenced in 2001, and there are now available 18 waves of annual follow-up. In 2001 the baseline sample comprised 13,969 individuals aged 15 years and older from 7,682 households, with a household-level response rate of 66%. In response to changes in population structure over time, there was a sample top-up in 2011 to enhance the survey's representativeness. The 2011 sample comprised 17,612 individuals aged 15 years and older from 9,543 households, with a household-level response rate of 71%. The retention rate for the waves occurring in 2002 to 2017 was greater than 85%. The main survey instruments for data collection included a household questionnaire, personal interview, and a self-completion questionnaire. Within responding households, 92% and 95% of eligible persons completed the personal interview in 2001 and 2011 respectively. The corresponding response rates for the self-completion questionnaire were 86% and 82%. The Human Ethics Advisory Committee at the University of Melbourne granted ethical approval for HILDA. We follow STROBE reporting guidelines (See STROBE checklist supplementary file).

Mortality data were obtained from National Death Index (NDI) database, available up to December 2014 and from deaths identified in the field via reports from family and household contacts (up to 2017).<sup>29</sup>

For the current study, we define two birth cohorts, each followed over 7 waves, with baseline occurring in 2001 and 2011, respectively. The older cohort includes respondents who were 50 years of age when they commenced the survey in 2001 and were followed to

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2007. The younger cohort includes respondents who were 50 years of age in 2011 and were followed to 2017.

### *Measures*

A Global Activity Limitation Indicator (GALI)<sup>30</sup> was assessed at each wave with the question “*Do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more? (Yes/No)*”. A large body of international research uses similarly worded GALIs for the estimation of DFLE.<sup>31</sup> The GALI was collected via personal interview, providing a baseline sample of 4,720 and 6,632 individuals in the 2001 and the 2011 cohorts, respectively.

An indicator of mobility limitation disability was derived from the 36-Item Short Form Survey (SF36), a widely used self-report scale of health related quality of life.<sup>32</sup> The physical function (PF) sub-scale of the SF36 assessed limitations with basic daily activities such as walking, climbing stairs, carrying or lifting groceries, dressing and bathing.<sup>32</sup> Consistent with previous Australian research, a threshold of SF36 PF scores  $\leq 40$  indicated Activities of Daily Living (ADL) related disability.<sup>33</sup> The SF36 was collected via self-completion questionnaire, providing a baseline sample of 4,287 and 5,962 individuals in the 2001 and the 2011 cohorts, respectively.

The GALI reflects a broader range of functional limitations relative to ADL disability (SF36 PF scores  $\leq 40$ ), which indicates more restrictive limitations. Compared to respondents with GALI disability, respondents with ADL disability reported more limitations with bending or stooping (99% versus 80%), climbing one flight of stairs (97% versus 59%), carrying groceries (97% versus 67%), or dressing and bathing (59% versus 29%).

A marker of baseline (2001 and 2011 for each respective cohort) area-level socio-economic position was provided by the Socio-Economic Indexes for Areas (SEIFA) for each

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household's place of residence at the time of interview. SEIFA is produced by the Australian Bureau of Statistics as a census-based index ranking areas in Australia according to relative socio-economic advantage and disadvantage.<sup>34</sup> To ensure comparisons are consistent across cohorts we use the 2001 SEIFA index, which is derived from a range of socio-economic variables including income, education, employment, occupation and housing characteristics. SEIFA tertiles were used to reflect low-, mid-, and high-advantage areas, and to provide sufficient group sizes for comparison.

### *Statistical analysis*

We estimated the expected number of years lived with and without disability for men and women in each cohort by SEIFA tertile, initially by continuous time multistate Markov models with the 'msm' package in R to generate transition intensities between two living states (disability free, disability) and one absorbing state (death).<sup>35</sup> To maintain consistent follow-up periods for each cohort, we included deaths recorded prior to February 2008 in the 2001 cohort or February 2018 in the 2011 cohort, other observations being censored. Models were adjusted for age and SEIFA tertile and conducted separately for men, women, cohort, and outcome. Transition intensities were then used as inputs to generate multi-state lifetables using the 'elect' package in R.<sup>36</sup> Relative Risk Ratios (RRR) were calculated to compare transition intensities between cohorts by including cohort as a covariate in a combined analysis. Multi-state lifetables provide estimates of Total Life Expectancy (TLE), DFLE, and Disability Life Expectancy (DLE) for a given age, sex, cohort and SEIFA tertile. Confidence intervals were drawn from simulations with 1000 replications. The age at which 50% of remaining TLE were years lived with disability was also calculated, and consistent with previous studies we refer to this as DFLE50%.<sup>12</sup>

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In sensitivity analyses we repeated the same analyses using Interpolated Markov Chain software (IMaCh version 0.99r19).<sup>37</sup> IMaCh estimates transition probabilities in a discrete time multinomial logistic model, enabling the inclusion of population weights and more flexible assumptions about the final vital status of censored respondents (see supplementary file 2 for further details).

### Results

Descriptive data and transition frequencies are presented in Web Tables A-D (supplementary file 1).

#### *GALI disability at age 50 for men and women*

Over the 10-year period, men's TLE at age 50 increased by 5.0 years, including a 2.3 year gain in DFLE and 2.7 year gain in DLE (Web Table E and Figure 1). Women's TLE at age 50 increased by 4.2 years, these being entirely years of disability, with no gain in DFLE. As a result, the gender gap in DFLE narrowed from 2.6 to 0.3 years over the ten-year period. However, the gender gap in DLE widened from 3.0 to 4.5 years. In relative terms, there was no gender difference in the proportion of TLE lived with disability in the 2001 cohort (men 49%; women 49%), but there was a gender difference for the 2011 cohort (men 49%; women 55%). Across the two cohorts, the age at which 50% of remaining TLE were disability-free (DFLE50%) decreased by two years for men (age 52 to 50) but occurred prior to age 50 for women in the 2011 cohort. The DFLE50% is depicted in online supplementary Figures A and B by the intersection of DFLE and DLE.

To understand the underlying dynamics driving these trends we compare transition intensities across the two cohorts (Web Table G). Relative to the 2001 cohort: for men, the 2011 cohort had 50% lower risk of mortality from a disability-free state and a 10% higher

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rate of recovery from GALI disability; for women there was a 10% lower recovery rate in the 2011 cohort.

### *GALI disability at age 50 by SEIFA tertile*

For men in the low-advantage tertile, TLE increased by 4.2 years, these being predominately years lived with disability (3.1 years), reflecting a 2.9% increase in the proportion of TLE lived with disability (Table 1). Underlying this trend was a 20% higher incidence but 20% higher recovery rate in the 2011 cohort compared to the 2001 cohort (Table 2).

For men in the mid-advantage tertile, TLE increased by 6.5 years, of which 3.1 years were lived with disability, with the 2011 cohort having 30% lower mortality risk from disability. For men in the high-advantage tertile, TLE increased 3.6 years, of which 1.6 years were lived with disability, with the 2011 cohort having a 20% reduction in incident disability. The proportion of life lived disability-free did not change appreciably for men in mid- and high-advantage tertiles.

In terms of women's TLE, the greatest gain was observed in the mid-advantage tertile (6.4 years), compared with the low- (2.6 years) and high-advantage (4.1 years). The proportion of years lived with disability for the low-, mid- and high-advantage women increased by 7.2%, 8.0% and 1.6%, respectively, indicating relative expansion of disability in the bottom and mid-tertile. For women, there was 20% lower recovery in the 2011 cohort for the low- and mid-advantage tertiles relative to the 2001 cohort. Within the mid-advantage tertile the 2011 cohort had 40% lower mortality from disability relative to the 2001 cohort.

Across the two cohorts, the DFLE50% occurred prior to age 50 for men and women in the low-advantage tertile and remained constant at age 50 for men in the mid tertile. For women in the mid tertile DFLE50% occurred more than 5-years earlier in the 2011 cohort

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compared to the 2001 cohort (55 versus <50 years). In contrast, for the high-advantage tertile the DFLE50% occurred one year later in the 2011 cohort for men (57 versus 58 years) but two years earlier in the 2011 cohort for women (52 versus 50 years).

### *ADL based disability at age 50 for men and women*

Men had greater gains in DFLE than women (4.7 versus 2.7 years), resulting in no gender differences in ADL based DFLE among the 2011 cohort (Web Table F). There was no cohort difference in DLE for men, though there was a small increase in DLE for women (1.3 years). The DFLE50% increased from 89 to 93 years for men, and 75 to 77 years for women.

### *ADL based disability at age 50 by SEIFA tertile*

For men, the largest gain in DFLE was again observed for the mid-advantage tertile (7.5 years) relative to the low (2.9 years) and high (3.8 years)(Table 3). The difference in DLE between low- and high-advantage tertiles increased over time from 1.6 years (95% CI: 0.3-2.9) to 2.8 years (95% CI: 1.6-4.0). These trends for men were underpinned by a 10% lower incidence and 20% higher recovery among the 2011 cohort relative to the 2001 cohort, with the largest cohort differences in the mid-advantage tertile (Table 4). Mid-tertile men also had 50% lower mortality from a disability-free state in the 2011 cohort compared to the 2001 cohort. In contrast, in the low-advantage tertile there was no cohort difference in incidence, but the 2011 cohort had 30% lower mortality from a disability state.

For women, the difference in DLE between low- and high-advantage tertiles remained relatively constant across the two cohorts with only small gains in DLE for these two groups. However, women in the mid-advantage tertile had a DFLE and DLE increase of 3.8 and 3.1 years respectively, largely due to a 10% lower incidence and 40% lower risk of mortality from a disability state in the 2011 cohort relative to the 2001 cohort. The only other cohort difference in transitions was observed for high-advantage women, who had a 40%

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higher rate of recovery in the 2011 cohort compared to the 2001 cohort, which meant most (91%) of their gains in life expectancy were years free from ADL based disability.

Across the two cohorts, DFLE50% for men in low-advantage tertile increased by one year (84 to 85), but remained constant at age 70 for women in the low-advantage tertile. For the mid-tertile, DFLE50% occurred 3 years later for men in the 2011 cohort (87 versus 90 years), but occurred one year earlier for women in the 2011 cohort (77 versus 76 years). For the top-tertile, DFLE50% remained constant at 100 years of age for men, and increased by four years for women (80 versus 84 years).

### *Sensitivity Analyses*

Sensitivity analyses conducted in IMaCh were broadly consistent with the estimates presented here (supplementary file 2), as were analyses including a younger age cut-off of age 45 years (results not reported).

## **Discussion**

A fundamental consideration when evaluating the health of ageing populations is whether our extra years of life are disability free.<sup>1</sup> This study reports a comprehensive analysis of 10-year DFLE trends for Australian men and women according to an area level marker of social advantage and disadvantage. We interpret these trends as indicating dynamic equilibrium for men in mid- and high-advantage areas. These groups experienced a proportional increase in the years lived with and without GALI disability, and only marginal increase in years lived with more restrictive ADL disability. In contrast, men in low-advantage areas experienced limited gains in GALI-related DFLE, a trend more consistent with expansion of morbidity. Similarly, any gains in life expectancy were years lived with GALI related disability for women, though a pattern of dynamic equilibrium was observed

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for ADL disability. It is notable that DFLE for women in low-advantage areas reduced over time and there were larger socio-economic disparities in more recent cohorts for both sexes.

For men, these trends were primarily attributable to improvements in recovery rates and lower incidence of disability within mid- and high-advantage areas. Such results likely reflect a combination of primary and secondary prevention, and programs promoting reablement and restoration of independent living. Over the past decade there have been a number of successful reablement interventions<sup>38 39</sup> in Australia, and reablement is now a key feature of the national Commonwealth Home Support Program for older Australians.<sup>40</sup> For women, there were notable improvements in recovery from severe disability for women in high-advantage areas. However, there was a decline in recovery across the two cohorts among women the low and mid-advantage areas. There was also reduced mortality for women living with disability in the middle tertile. The latter findings suggest that, for these women, interventions have been more successful in addressing mortality rather than the functional impacts of disabling chronic health conditions.

National estimates from repeated cross-sectional data present an encouraging picture of trends in DFLE in Australia over the past several decades.<sup>20</sup> This is broadly consistent with our findings in relation to severe disability. However, we note important diverging and less positive trends for men and women residing in areas of greater disadvantage, and when a lower threshold for disability is applied with the GALI. This is comparable with trends internationally. UK census data shows that social inequalities in healthy life expectancies increased between 1991 and 2001.<sup>23</sup> More recent longitudinal analysis of UK data similarly found more favourable trends in DFLE for individuals residing in neighbourhoods with low deprivation, and that the underlying transitions explaining these trends differed for men and women.<sup>12</sup> Our findings also align with an extensive literature documenting disproportionately large years lived with disability among older women and those with limited socio-economic

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resources.<sup>19</sup> Such disparities could be due to inequalities in access to health care in later life and the cumulative effects of exposures tied to social advantage and disadvantage across the lifecourse,<sup>41</sup> or particularly in the case of sex differences, reflect biological and gendered differences in vulnerability and resilience to living with chronic disease.<sup>42</sup>

We acknowledge a number of limitations to the present study. Our indicator of social disadvantage is derived from area characteristics capturing average levels of educational attainment, income, occupational prestige, and housing in the local community. We chose an aggregate area-level indicator as it is similar to other recent studies in this area<sup>12</sup> and community contexts are important social determinants of health. Nevertheless, the socio-economic profile of neighbourhoods can change over time and may not always accurately reflect the life experiences of long-term households, many of whom are older residents.<sup>43</sup> It is therefore important for future research to investigate how individual level characteristics and modifiable risk factors across the life-course also contribute to the overall trends described here. Secondly, there was a broad age range (age 50 years and older) and only a 10-year difference separating each cohort, resulting in 33% of respondents being included in both cohorts. However, this is not unusual for studies of trends in health expectancies and respondents contribute to expectancies at different ages. Finally, not all mortality data for the 2011 cohort were verified against a national register and therefore may be under-reported.

### *Conclusion*

It is important that additional years of life are matched by an increase in the years lived independently in good health, and that gains in healthy ageing are shared across all sectors of society.<sup>1</sup> This is critical not only for the wellbeing of individuals, but also for the ongoing sustainability of national health and welfare systems. Moreover, improvements in the health of older adults will help to maintain their capacity for both paid and unpaid work

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(including provision of care), increasing their productivity as they age. This is one of the first studies to use nationally representative cohort data to show how underlying disability-mortality transitions contribute to trends in DFLE, and to examine the extent to which these trends have been distributed equally throughout the population. Further, estimates at age 50 are not available elsewhere despite the importance of risk factors in mid-life for ageing outcomes.<sup>27</sup> Our results reveal a complex picture of healthy population ageing, highlighting gender differences and widening social inequalities. These trends have occurred during a period of relative prosperity marked by continuous economic growth for Australia.<sup>44</sup> In light of the current pandemic and its anticipated global economic impacts, the challenge for public health is to ensure gains in DFLE are maintained and reductions in the years lived with disability continue, particularly for women and individuals with fewer socio-economic resources.

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### **DATA AVAILABILITY**

HILDA data are not publicly available but can be requested from the Australian Department of Social Services National Centre for Longitudinal Data

(<https://dataverse.ada.edu.au/dataverse/hilda>). Data coding and analysis scripts available at <https://osf.io/tkhyn/>

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### **CONFLICT OF INTEREST**

None declared

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## TRENDS IN DISABILITY-FREE LIFE EXPECTANCY

**Table 1:** Years lived with and without **GALI** disability for men and women at age 50 by area-level advantage

| Table 2. Years lived with and without GPEL disability for men and women at age 50 by area level advantage |            |       |              |       |              |       |              |                           |              |         |
|-----------------------------------------------------------------------------------------------------------|------------|-------|--------------|-------|--------------|-------|--------------|---------------------------|--------------|---------|
| SEIFA Tertile                                                                                             | Cohort     | TLE   |              | DFLE  |              | DLE   |              | DLE % of TLE<br>(DLE/TLE) |              | DFLE50% |
|                                                                                                           |            | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)     | %                         | (95% CI)     | Age     |
| MEN                                                                                                       |            |       |              |       |              |       |              |                           |              |         |
| Bottom tertile                                                                                            |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 28.1  | (26.5, 29.8) | 13.2  | (12.2, 14.2) | 14.9  | (13.6, 16.2) | 53.0                      | (51.7, 54.4) | < 50    |
|                                                                                                           | 2011       | 32.3  | (30.2, 34.4) | 14.2  | (13.2, 15.3) | 18.1  | (16.5, 19.6) | 55.9                      | (54.8, 57.0) | < 50    |
|                                                                                                           | Difference | 4.2   | (1.5, 6.8)   | 1.0   | (-0.4, 2.5)  | 3.1   | (1.2, 5.1)   | 2.9                       | (1.1, 4.6)   | -       |
| Mid tertile                                                                                               |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 27.8  | (26.1, 29.5) | 13.7  | (12.7, 14.7) | 14.1  | (12.8, 15.4) | 50.7                      | (49.3, 52.1) | 50      |
|                                                                                                           | 2011       | 34.3  | (31.8, 36.9) | 17.1  | (15.8, 18.5) | 17.2  | (15.4, 19.0) | 50.1                      | (48.9, 51.3) | 50      |
|                                                                                                           | Difference | 6.5   | (3.5, 9.6)   | 3.4   | (1.7, 5.1)   | 3.1   | (1.4, 4.8)   | -0.6                      | (-2.4, 1.2)  | 0       |
| Top tertile                                                                                               |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 31.9  | (29.7, 34.2) | 18.3  | (17.0, 19.5) | 13.6  | (12.0, 15.2) | 42.7                      | (41.3, 44.1) | 57      |
|                                                                                                           | 2011       | 35.5  | (33.0, 38.1) | 20.3  | (19.0, 21.6) | 15.2  | (13.5, 16.9) | 42.8                      | (41.7, 44.0) | 58      |
|                                                                                                           | Difference | 3.6   | (0.2, 7.0)   | 2.0   | (0.2, 3.8)   | 1.6   | (-0.8, 3.9)  | 0.1                       | (-1.7, 1.9)  | 1       |
| WOMEN                                                                                                     |            |       |              |       |              |       |              |                           |              |         |
| Bottom tertile                                                                                            |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 34.0  | (31.9, 36.2) | 15.9  | (14.8, 17.0) | 18.1  | (16.5, 19.7) | 53.2                      | (52.0, 54.5) | < 50    |
|                                                                                                           | 2011       | 36.6  | (34.2, 39.0) | 14.5  | (13.5, 15.5) | 22.1  | (20.2, 24.0) | 60.4                      | (59.4, 61.5) | < 50    |
|                                                                                                           | Difference | 2.6   | (-0.7, 5.8)  | -1.4  | (-2.9, 0.01) | 4.0   | (1.5, 6.5)   | 7.2                       | (5.6, 8.8)   | -       |
| Mid tertile                                                                                               |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 34.5  | (31.9, 37.0) | 18.2  | (16.8, 19.6) | 16.3  | (14.5, 18.1) | 47.3                      | (45.9, 48.6) | 55      |
|                                                                                                           | 2011       | 40.9  | (38.3, 43.5) | 18.3  | (17.2, 19.4) | 22.6  | (20.4, 24.8) | 55.3                      | (54.2, 56.4) | < 50    |
|                                                                                                           | Difference | 6.4   | (2.8, 10.0)  | 0.1   | (-1.6, 1.9)  | 6.3   | (4.6, 8.1)   | 8.0                       | (6.3, 9.7)   | < -5    |
| Top tertile                                                                                               |            |       |              |       |              |       |              |                           |              |         |
|                                                                                                           | 2001       | 35.0  | (32.5, 37.4) | 18.4  | (17.1, 19.7) | 16.6  | (14.8, 18.3) | 47.4                      | (46.0, 48.7) | 52      |
|                                                                                                           | 2011       | 39.1  | (36.6, 41.5) | 19.9  | (18.8, 21.1) | 19.2  | (17.3, 21.0) | 49.0                      | (48.0, 50.1) | 50      |
|                                                                                                           | Difference | 4.1   | (0.8, 7.6)   | 1.5   | (-0.2, 3.3)  | 2.6   | (0.02, 5.2)  | 1.6                       | (-0.1, 3.4)  | -2      |

**sTLE:** Total Life Expectancy; **DFLE:** Disability Free Life Expectancy; **DLE:** Disability Life Expectancy **GALI:** Global Activity Limitation Indicator;

**DFLE50%:** Age at which 50% of remaining life expectancy are years lived with disability

## TRENDS IN DISABILITY-FREE LIFE EXPECTANCY

**Table 2:** Cohort difference in transition intensities (Relative Risk Ratio: RRR) for **GALI** disability (and 95% confidence intervals) overall and by area-level deprivation for Men and Women

|                | Transition               | Men                   | Women                 |
|----------------|--------------------------|-----------------------|-----------------------|
|                |                          | RRR (95% CI)          | RRR (95% CI)          |
| Bottom tertile | Incidence                | <b>1.2 (1.0, 1.4)</b> | 1.0 (0.9, 1.1)        |
|                | Recovery                 | <b>1.2 (1.0, 1.4)</b> | <b>0.8 (0.7, 0.9)</b> |
|                | Disability-free to death | 0.3 (0.03, 3.2)       | 0.9 (0.1, 16.1)       |
|                | Disability to death      | 0.9 (0.7, 1.2)        | 1.0 (0.7, 1.3)        |
| Mid tertile    | Incidence                | <b>0.9 (0.8, 1.0)</b> | 1.0 (0.9, 1.1)        |
|                | Recovery                 | <b>1.1 (1.0, 1.3)</b> | <b>0.8 (0.7, 1.0)</b> |
|                | Disability-free to death | 0.3 (0.1, 2.1)        | 0.1 (0.0, 6.6)        |
|                | Disability to death      | <b>0.7 (0.5, 1.0)</b> | <b>0.6 (0.4, 0.9)</b> |
| Top tertile    | Incidence                | <b>0.8 (0.7, 1.0)</b> | 1.0 (0.9, 1.1)        |
|                | Recovery                 | 0.9 (0.7, 1.1)        | 1.0 (0.8, 1.2)        |
|                | Disability-free to death | 1.0 (0.2, 4.0)        | 1.0 (0.2, 4.4)        |
|                | Disability to death      | 0.9 (0.6, 1.4)        | 0.8 (0.5, 1.2)        |

## TRENDS IN DISABILITY-FREE LIFE EXPECTANCY

**Table 3:** Years lived with and without **ADL** disability for men and women at age 50 by area-level advantage

| Table 9. Years lived with and without HFLE disability for men and women at age 50 by area level advantage |            |       |              |       |              |       |              |                           |              |          |
|-----------------------------------------------------------------------------------------------------------|------------|-------|--------------|-------|--------------|-------|--------------|---------------------------|--------------|----------|
| SEIFA Tertile                                                                                             | Cohort     | TLE   |              | DFLE  |              | DLE   |              | DLE % of TLE<br>(DLE/TLE) |              | DFLE50 % |
|                                                                                                           |            | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)     | %                         | (95% CI)     | Age      |
| MEN                                                                                                       |            |       |              |       |              |       |              |                           |              |          |
| Bottom tertile                                                                                            |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 28.6  | (26.9, 30.3) | 22.6  | (21.2, 24.0) | 6.0   | (5.2, 6.9)   | 21.2                      | (20.0, 22.4) | 84       |
|                                                                                                           | 2011       | 32.3  | (30.6, 34.1) | 25.5  | (24.2, 26.7) | 6.8   | (5.9, 7.8)   | 21.3                      | (20.3, 22.2) | 85       |
|                                                                                                           | Difference | 3.7   | (1.3, 6.1)   | 2.9   | (1.0, 4.8)   | 0.8   | (-0.4, 2.1)  | 0.1                       | (-1.4, 1.6)  | 1        |
| Mid tertile                                                                                               |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 28.2  | (26.3, 30.2) | 22.9  | (21.3, 24.5) | 5.3   | (4.4, 6.2)   | 18.8                      | (17.7, 19.9) | 87       |
|                                                                                                           | 2011       | 36.6  | (34.3, 38.9) | 30.4  | (28.6, 32.2) | 6.2   | (5.0, 7.4)   | 16.9                      | (15.9, 17.8) | 90       |
|                                                                                                           | Difference | 8.4   | (5.3, 11.3)  | 7.5   | (5.0, 9.9)   | 0.9   | (-1.6, 3.3)  | -1.9                      | (-3.4, -0.5) | 3        |
| Top tertile                                                                                               |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 33.3  | (30.6, 35.9) | 28.9  | (26.7, 31.1) | 4.4   | (3.5, 5.3)   | 13.2                      | (12.2, 14.3) | 100      |
|                                                                                                           | 2011       | 36.7  | (34.4, 39.0) | 32.7  | (30.7, 34.7) | 4.0   | (3.2, 4.8)   | 10.9                      | (10.1, 11.6) | > 100    |
|                                                                                                           | Difference | 3.4   | (-0.1, 6.9)  | 3.8   | (0.9, 6.8)   | -0.4  | (-1.7, 0.8)  | -2.3                      | (-3.6, -1.1) | > 0      |
| WOMEN                                                                                                     |            |       |              |       |              |       |              |                           |              |          |
| Bottom tertile                                                                                            |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 35.1  | (32.2, 37.9) | 24.6  | (22.9, 26.3) | 10.5  | (8.8, 12.1)  | 29.9                      | (28.6, 31.1) | 70       |
|                                                                                                           | 2011       | 37.3  | (35.4, 39.2) | 25.9  | (24.7, 27.0) | 11.4  | (10.0, 12.8) | 30.7                      | (29.6, 31.7) | 70       |
|                                                                                                           | Difference | 2.2   | (-1.2, 5.6)  | 1.3   | (-0.8, 3.3)  | 0.9   | (-1.2, 3.1)  | 0.8                       | (-0.8, 2.4)  | 0        |
| Mid tertile                                                                                               |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 35.3  | (32.8, 37.9) | 26.9  | (25.1, 28.7) | 8.4   | (6.9, 9.9)   | 23.9                      | (22.7, 25.1) | 77       |
|                                                                                                           | 2011       | 42.2  | (39.3, 45.2) | 30.7  | (29.0, 32.4) | 11.5  | (9.4, 13.7)  | 27.3                      | (26.3, 28.3) | 76       |
|                                                                                                           | Difference | 6.9   | (3.0, 10.7)  | 3.8   | (1.3, 6.2)   | 3.1   | (0.7, 5.5)   | 3.4                       | (1.9, 5.0)   | -1       |
| Top tertile                                                                                               |            |       |              |       |              |       |              |                           |              |          |
|                                                                                                           | 2001       | 35.8  | (33.1, 38.5) | 28.0  | (26.2, 29.8) | 7.8   | (6.3, 9.3)   | 21.8                      | (20.6, 23.0) | 80       |
|                                                                                                           | 2011       | 40.2  | (37.6, 42.8) | 32.0  | (30.4, 33.6) | 8.2   | (6.7, 9.7)   | 20.4                      | (19.5, 21.3) | 84       |
|                                                                                                           | Difference | 4.4   | (0.7, 8.1)   | 4.0   | (1.6, 6.5)   | 0.4   | (-1.7, 2.5)  | -1.4                      | (-2.9, 0.1)  | 4        |

**TLE:** Total Life Expectancy; **DFLE:** Disability Free Life Expectancy; **DLE:** Disability Life Expectancy **ADL:** Difficulties with Activities of Daily Living ;  
**DFLE50%:** Age at which 50% of remaining life expectancy are years lived with disability

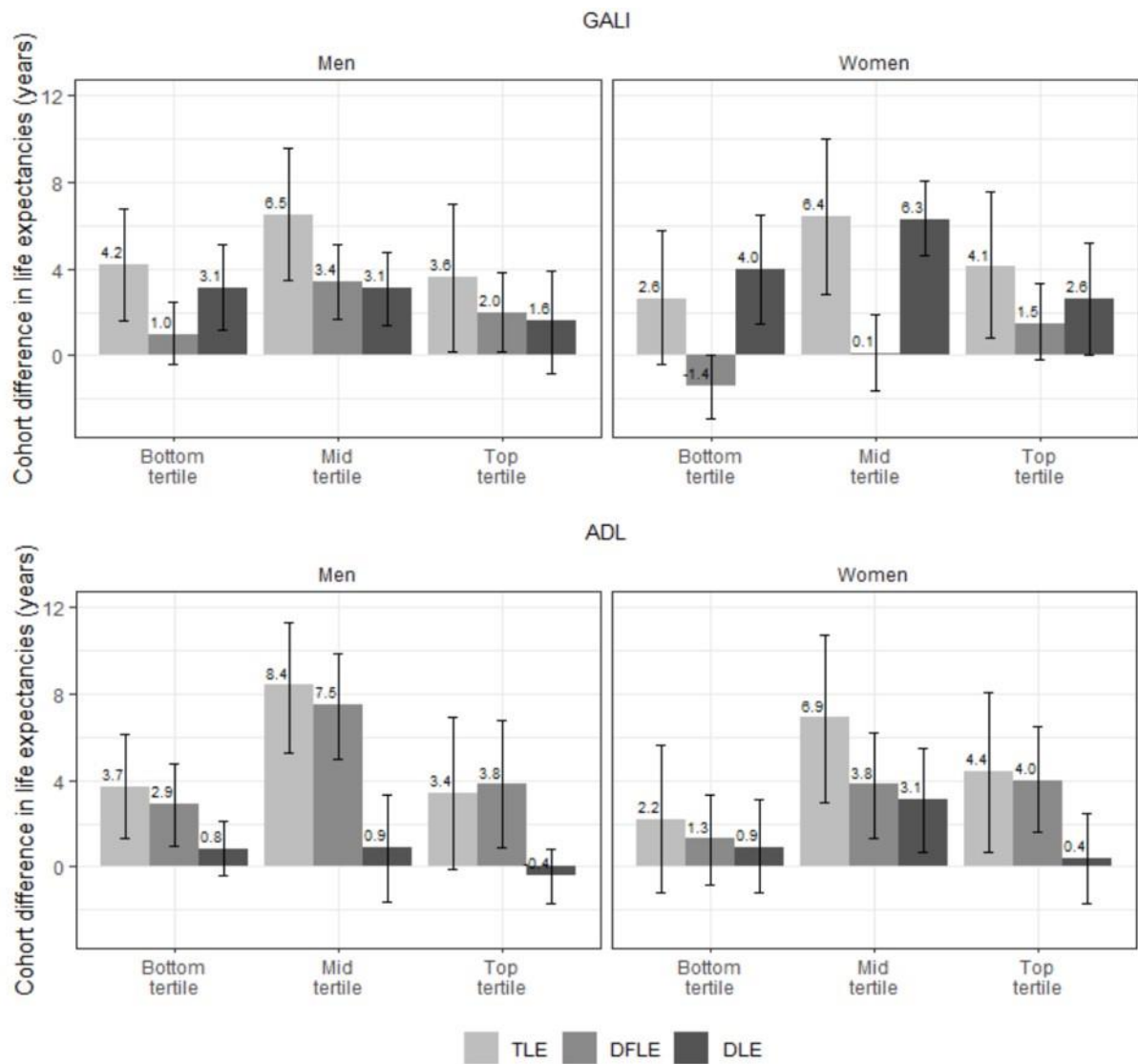
## TRENDS IN DISABILITY-FREE LIFE EXPECTANCY

**Table 4:** Cohort difference in transition intensities (Relative Risk Ratio: RRR) for **ADL** disability (and 95% confidence intervals) overall and by area-level deprivation for Men and Women

|                | Transition               | Men                   | Women                 |
|----------------|--------------------------|-----------------------|-----------------------|
|                |                          | RRR (95% CI)          | RRR (95% CI)          |
| Bottom tertile | Incidence                | 1.0 (0.8, 1.2)        | 1.0 (0.8, 1.1)        |
|                | Recovery                 | <b>1.2 (1.0, 1.4)</b> | 1.0 (0.9, 1.2)        |
|                | Disability-free to death | 1.5 (0.7, 2.9)        | 2.4 (0.4, 15.4)       |
|                | Disability to death      | <b>0.7 (0.5, 1.0)</b> | 1.0 (0.7, 1.5)        |
| Mid tertile    | Incidence                | <b>0.7 (0.6, 0.9)</b> | <b>0.9 (0.7, 1.0)</b> |
|                | Recovery                 | <b>1.3 (1.0, 1.7)</b> | 1.0 (0.8, 1.2)        |
|                | Disability-free to death | <b>0.5 (0.3, 1.0)</b> | 0.4 (0.1, 2.4)        |
|                | Disability to death      | 0.7 (0.4, 1.1)        | <b>0.6 (0.4, 1.0)</b> |
| Top tertile    | Incidence                | <b>0.8 (0.6, 1.0)</b> | 1.0 (0.8, 1.2)        |
|                | Recovery                 | 1.2 (0.9, 1.5)        | <b>1.4 (1.1, 1.7)</b> |
|                | Disability-free to death | 1.5 (0.6, 3.7)        | 1.0 (0.4, 2.4)        |
|                | Disability to death      | 0.9 (0.5, 1.6)        | 0.9 (0.5, 1.4)        |

## TRENDS IN DISABILITY-FREE LIFE EXPECTANCY

**Figure 1:** Cohort differences in Total Life Expectancy (TLE), Disability Free Life Expectancy (DFLE), Disability Life Expectancy (DLE) for Australian men and women at age 50 by area-level dis/advantage tertile (2001 to 2011), GALI (top panel) ADL (bottom panel).



## Trends in Disability-Free Life Expectancy at Age 50 in Australia between 2001 and 2011 by Social Disadvantage

### Online supplementary file 1: Tables A-G and Figures A-D

|                                                                                                                                                                                      |                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Table A:</b> Sample distribution by birth cohort, baseline GALI disability, mortality, sex and area-level disadvantage                                                            | <b>Page 2</b>  |
| <b>Table B:</b> Sample distribution by birth cohort, baseline ADL (SF36 PF≤40) disability, mortality, sex and area-level advantage                                                   | <b>Page 3</b>  |
| <b>Table C:</b> Frequency of GALI Disability transitions by birth cohort and sex                                                                                                     | <b>Page 4</b>  |
| <b>Table D:</b> Frequency of ADL Disability transitions by birth cohort and sex                                                                                                      | <b>Page 4</b>  |
| <b>Table E:</b> Years lived with and without GALI disability for men and women at age 50                                                                                             | <b>Page 5</b>  |
| <b>Table F:</b> Years lived with and without ADL disability for men and women at age 50                                                                                              | <b>Page 6</b>  |
| <b>Table G:</b> Cohort difference in transition intensities (Relative Risk Ratio: RRR) for <b>GALI</b> and <b>ADL</b> disability men and women                                       | <b>Page 7</b>  |
| <b>Figure A:</b> Total life expectancy (TLE), Disability-free life expectancy (DFLE) and Disability Life expectancy (DLE) for <b>GALI</b> disability for ages 50-100 for each cohort | <b>Page 8</b>  |
| <b>Figure B:</b> Expectancies by age for disability defined by GALI for Men and Women by area level disadvantage                                                                     | <b>Page 9</b>  |
| <b>Figure C:</b> Total life expectancy (TLE), Disability-free life expectancy (DFLE) and Disability Life expectancy (DLE) for <b>GALI</b> disability for ages 50-100 for each cohort | <b>Page 10</b> |
| <b>Figure D:</b> Expectancies by age for disability defined by GALI for Men and Women by area level disadvantage                                                                     | <b>Page 11</b> |

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1**

**Table A:** Sample distribution by birth cohort, baseline **GALI** disability, mortality, sex, area-level disadvantage, and age

| Cohort      | Variable           | Baseline disability |        |      |        | Death |        |
|-------------|--------------------|---------------------|--------|------|--------|-------|--------|
|             |                    | No                  |        | Yes  |        | Yes   |        |
|             |                    | n                   | (%)    | n    | (%)    | n     | (%)    |
| 2001 Cohort |                    |                     |        |      |        |       |        |
|             | Sex                |                     |        |      |        |       |        |
|             | Men                | 1299                | (57.9) | 945  | (42.1) | 330   | (14.7) |
|             | Women              | 1546                | (62.4) | 930  | (37.6) | 245   | (9.9)  |
|             | Area dis/advantage |                     |        |      |        |       |        |
|             | Bottom tertile     | 903                 | (53.1) | 799  | (46.9) | 235   | (13.8) |
|             | Mid tertile        | 943                 | (60.5) | 615  | (39.5) | 193   | (12.4) |
|             | Top tertile        | 999                 | (68.4) | 461  | (31.6) | 147   | (10.1) |
|             | Age group          |                     |        |      |        |       |        |
|             | 50-59              | 1294                | (68.5) | 596  | (31.5) | 40    | (2.1)  |
|             | 60-69              | 850                 | (60.2) | 561  | (39.8) | 99    | (7.0)  |
|             | 70-79              | 547                 | (52.7) | 491  | (47.3) | 169   | (16.3) |
|             | 80+                | 154                 | (40.4) | 227  | (59.6) | 267   | (70.1) |
| 2011 Cohort |                    |                     |        |      |        |       |        |
|             | Sex                |                     |        |      |        |       |        |
|             | Men                | 1713                | (55.6) | 1367 | (44.4) | 313   | (10.2) |
|             | Women              | 1905                | (53.6) | 1647 | (46.4) | 253   | (7.1)  |
|             | Area dis/advantage |                     |        |      |        |       |        |
|             | Bottom tertile     | 1048                | (45.0) | 1281 | (55.0) | 257   | (11.0) |
|             | Mid tertile        | 1186                | (55.4) | 956  | (44.6) | 151   | (7.0)  |
|             | Top tertile        | 1384                | (64.0) | 777  | (36.0) | 158   | (7.3)  |
|             | Age group          |                     |        |      |        |       |        |
|             | 50-59              | 1675                | (66.6) | 839  | (33.4) | 30    | (1.1)  |
|             | 60-69              | 1189                | (55.9) | 938  | (44.1) | 87    | (4.1)  |
|             | 70-79              | 529                 | (41.8) | 737  | (58.2) | 137   | (10.8) |
|             | 80+                | 225                 | (31.0) | 500  | (69.0) | 312   | (43.0) |

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1**

**Table B:** Sample distribution by birth cohort, baseline **ADL** (SF36 PF≤40) disability, mortality, sex, area-level disadvantage, and age

| Cohort      | Variable           | Baseline disability |        |     |        | Death |        |
|-------------|--------------------|---------------------|--------|-----|--------|-------|--------|
|             |                    | No                  |        | Yes |        | Yes   |        |
|             |                    | n                   | (%)    | n   | (%)    | n     | (%)    |
| 2001 Cohort |                    |                     |        |     |        |       |        |
|             | Sex                |                     |        |     |        |       |        |
|             | Men                | 1672                | (82.4) | 357 | (17.6) | 284   | (14.0) |
|             | Women              | 1807                | (80.0) | 451 | (20.0) | 203   | (9.0)  |
|             | Area dis/advantage |                     |        |     |        |       |        |
|             | Bottom tertile     | 1148                | (74.7) | 388 | (25.3) | 201   | (13.1) |
|             | Mid tertile        | 1156                | (81.8) | 258 | (18.2) | 163   | (11.5) |
|             | Top tertile        | 1175                | (87.9) | 162 | (12.1) | 123   | (9.2)  |
|             | Age group          |                     |        |     |        |       |        |
|             | 50-59              | 1546                | (88.3) | 204 | (11.7) | 34    | (1.9)  |
|             | 60-69              | 1094                | (84.9) | 195 | (15.1) | 87    | (6.7)  |
|             | 70-79              | 675                 | (72.1) | 261 | (27.9) | 149   | (15.9) |
|             | 80+                | 164                 | (52.6) | 148 | (47.4) | 217   | (69.6) |
| 2011 Cohort |                    |                     |        |     |        |       |        |
|             | Sex                |                     |        |     |        |       |        |
|             | Men                | 2428                | (87.4) | 349 | (12.6) | 251   | (9.0)  |
|             | Women              | 2602                | (81.7) | 583 | (18.3) | 205   | (6.4)  |
|             | Area dis/advantage |                     |        |     |        |       |        |
|             | Bottom tertile     | 1607                | (78.0) | 452 | (22.0) | 213   | (10.3) |
|             | Mid tertile        | 1631                | (84.4) | 302 | (15.6) | 117   | (6.1)  |
|             | Top tertile        | 1792                | (91.0) | 178 | (9.0)  | 126   | (6.4)  |
|             | Age group          |                     |        |     |        |       |        |
|             | 50-59              | 2112                | (92.3) | 175 | (7.7)  | 29    | (1.3)  |
|             | 60-69              | 1679                | (85.8) | 279 | (14.2) | 68    | (3.5)  |
|             | 70-79              | 885                 | (77.8) | 252 | (22.2) | 125   | (10.9) |
|             | 80+                | 354                 | (61.0) | 226 | (39.0) | 234   | (40.3) |

# TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1

**Table C:** Frequency of **GALI** Disability transitions by birth cohort and sex

|                 | 2001 cohort     |            |       |          | 2011 cohort     |            |       |          |
|-----------------|-----------------|------------|-------|----------|-----------------|------------|-------|----------|
|                 | Disability-free | Disability | Death | Censored | Disability-free | Disability | Death | Censored |
| <b>Men</b>      |                 |            |       |          |                 |            |       |          |
| Disability-free | 4390            | 1170       | 70    | 967      | 6799            | 1649       | 47    | 1413     |
| Disability      | 908             | 3694       | 260   | 947      | 1396            | 5728       | 266   | 1354     |
| <b>Women</b>    |                 |            |       |          |                 |            |       |          |
| Disability-free | 5285            | 1434       | 52    | 1146     | 7471            | 1878       | 41    | 1571     |
| Disability      | 1086            | 3909       | 193   | 1085     | 1585            | 7350       | 212   | 1728     |

**Note:** In the older 2001 cohort, there are 15269 transitions for men and 17399 transitions for women. In the younger 2011 cohort, there are 22671 transitions for men and 26415 transitions for women.

**Table D:** Frequency of **ADL** Disability (SF36 PF≤40) transitions by birth cohort and sex

|                 | 2001 cohort     |            |       |          | 2011 cohort     |            |       |          |
|-----------------|-----------------|------------|-------|----------|-----------------|------------|-------|----------|
|                 | Disability-free | Disability | Death | Censored | Disability-free | Disability | Death | Censored |
| <b>Men</b>      |                 |            |       |          |                 |            |       |          |
| Disability-free | 6691            | 477        | 100   | 1336     | 11166           | 650        | 113   | 2046     |
| Disability      | 402             | 874        | 132   | 251      | 506             | 1115       | 99    | 340      |
| Missing         | 221             | 70         | 52    | 158      | 233             | 46         | 39    | 140      |
| <b>Women</b>    |                 |            |       |          |                 |            |       |          |
| Disability-free | 7392            | 653        | 53    | 1463     | 11904           | 947        | 61    | 2219     |
| Disability      | 512             | 1217       | 104   | 406      | 786             | 2007       | 111   | 577      |
| Missing         | 225             | 115        | 46    | 186      | 220             | 94         | 33    | 184      |

**Note:** In the older 2001 cohort, there are 13949 transitions for men and 15210 transitions for women. In the younger 2011 cohort, there are 20693 transitions for men and 23157 transitions for women.

# TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1

**Table E:** Years lived with and without **GALI** disability for men and women at age 50

|                  | Cohort     | TLE   |              | DFLE  |              | DLE   |              | DLE % of TLE<br>(DLE/TLE) |              | DFLE50% |
|------------------|------------|-------|--------------|-------|--------------|-------|--------------|---------------------------|--------------|---------|
|                  |            | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)     | %                         | (95% CI)     | Age     |
| Men<br>Overall   |            |       |              |       |              |       |              |                           |              |         |
|                  | Older      | 29.1  | (28.0, 30.2) | 14.8  | (14.1, 15.5) | 14.3  | (13.5, 15.1) | 49.2                      | (48.4, 50.0) | 52      |
|                  | Younger    | 34.1  | (33.0, 35.3) | 17.1  | (16.5, 17.8) | 17.0  | (16.1, 17.8) | 49.8                      | (49.1, 50.4) | 50      |
|                  | Difference | 5.0   | (3.4, 6.6)   | 2.3   | (1.4, 3.3)   | 2.7   | (1.5, 3.8)   | 0.6                       | (-0.4, 1.7)  | -2      |
| Women<br>Overall |            |       |              |       |              |       |              |                           |              |         |
|                  | Older      | 34.6  | (33.3, 35.9) | 17.4  | (16.7, 18.2) | 17.2  | (16.2, 18.1) | 49.6                      | (48.8, 50.3) | 50      |
|                  | Younger    | 38.8  | (37.6, 40.0) | 17.4  | (16.8, 18.0) | 21.4  | (20.4, 22.4) | 55.0                      | (54.5, 55.7) | < 50    |
|                  | Difference | 4.2   | (2.4, 6.0)   | 0.0   | (-0.9, 0.9)  | 4.2   | (2.8, 5.7)   | 5.5                       | (4.6, 6.5)   | < -1    |

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1**

**Table F:** Years lived with and without **ADL** disability for men and women at age 50

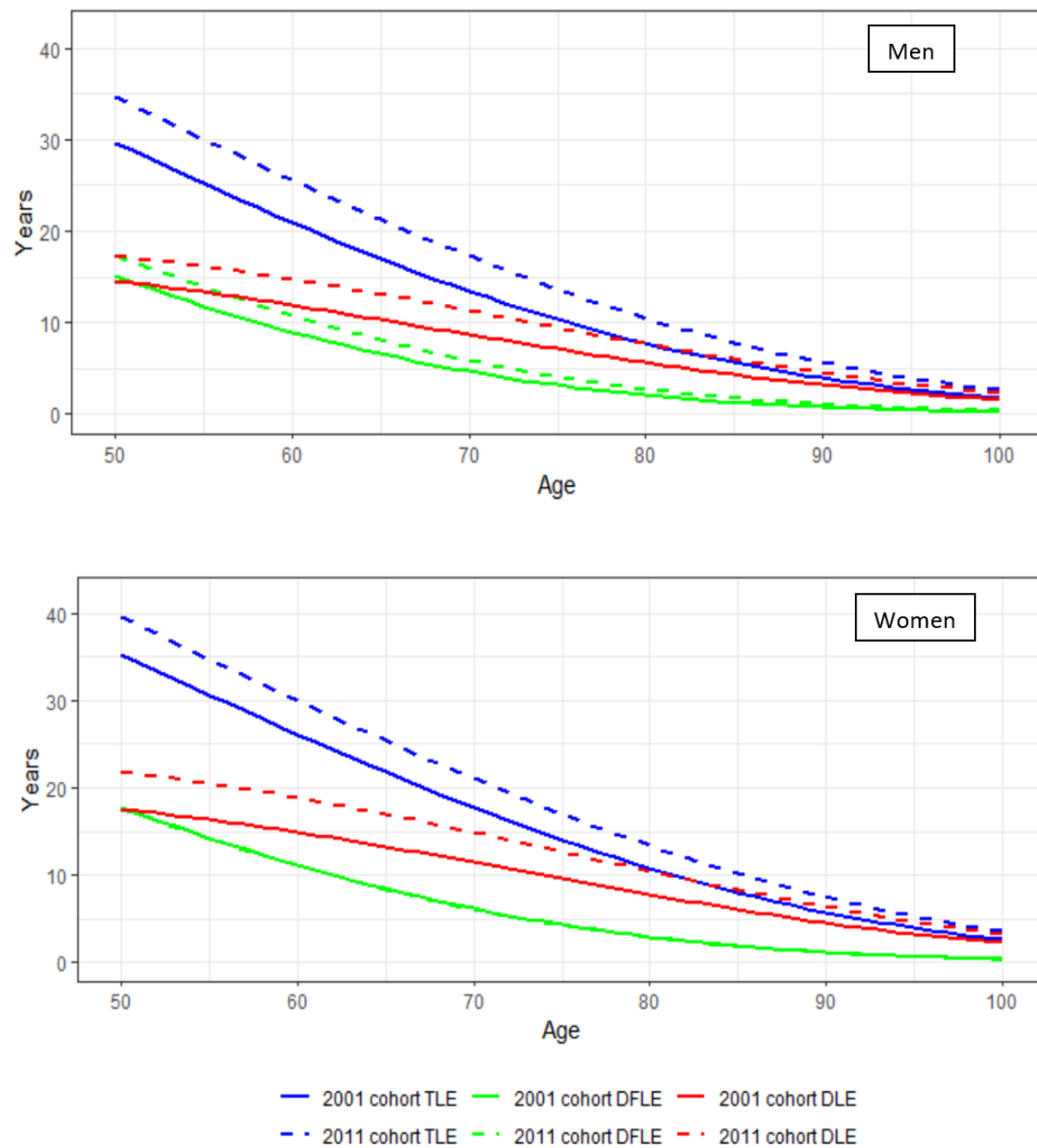
|                  | Cohort     | TLE   |              | DFLE  |              | DLE   |             | DLE % of TLE<br>(DLE/TLE) |              | DFLE50% |
|------------------|------------|-------|--------------|-------|--------------|-------|-------------|---------------------------|--------------|---------|
|                  |            | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)    | %                         | (95% CI)     | Age     |
| Men<br>Overall   |            |       |              |       |              |       |             |                           |              |         |
|                  | Older      | 29.7  | (28.5, 30.9) | 24.4  | (23.4, 25.4) | 5.3   | (4.8, 5.9)  | 18.0                      | (17.3, 18.6) | 89      |
|                  | Younger    | 34.9  | (33.7, 36.2) | 29.1  | (28.1, 30.1) | 5.8   | (5.2, 6.4)  | 16.6                      | (16.1, 17.1) | 93      |
|                  | Difference | 5.2   | (3.5, 6.9)   | 4.7   | (3.3, 6.2)   | 0.5   | (-0.3, 1.3) | -1.4                      | (-2.2, -0.5) | 4       |
| Women<br>Overall |            |       |              |       |              |       |             |                           |              |         |
|                  | Older      | 35.6  | (34.1, 37.0) | 26.5  | (25.5, 27.4) | 9.1   | (8.2, 10.0) | 25.6                      | (24.9, 26.3) | 75      |
|                  | Younger    | 39.6  | (38.2, 41.1) | 29.2  | (28.3, 30.1) | 10.4  | (9.5, 11.5) | 26.4                      | (25.9, 27.0) | 77      |
|                  | Difference | 4.0   | (2.1, 6.1)   | 2.7   | (1.4, 4.0)   | 1.3   | (0.02, 2.7) | 0.8                       | (-0.1, 1.7)  | 2       |

**Note:** Living states are measured by ADL Disability (SF36 PF≤40)

# TRENDS IN DISABILITY-FREE LIFE EXPECTANCY: Supplementary file 1

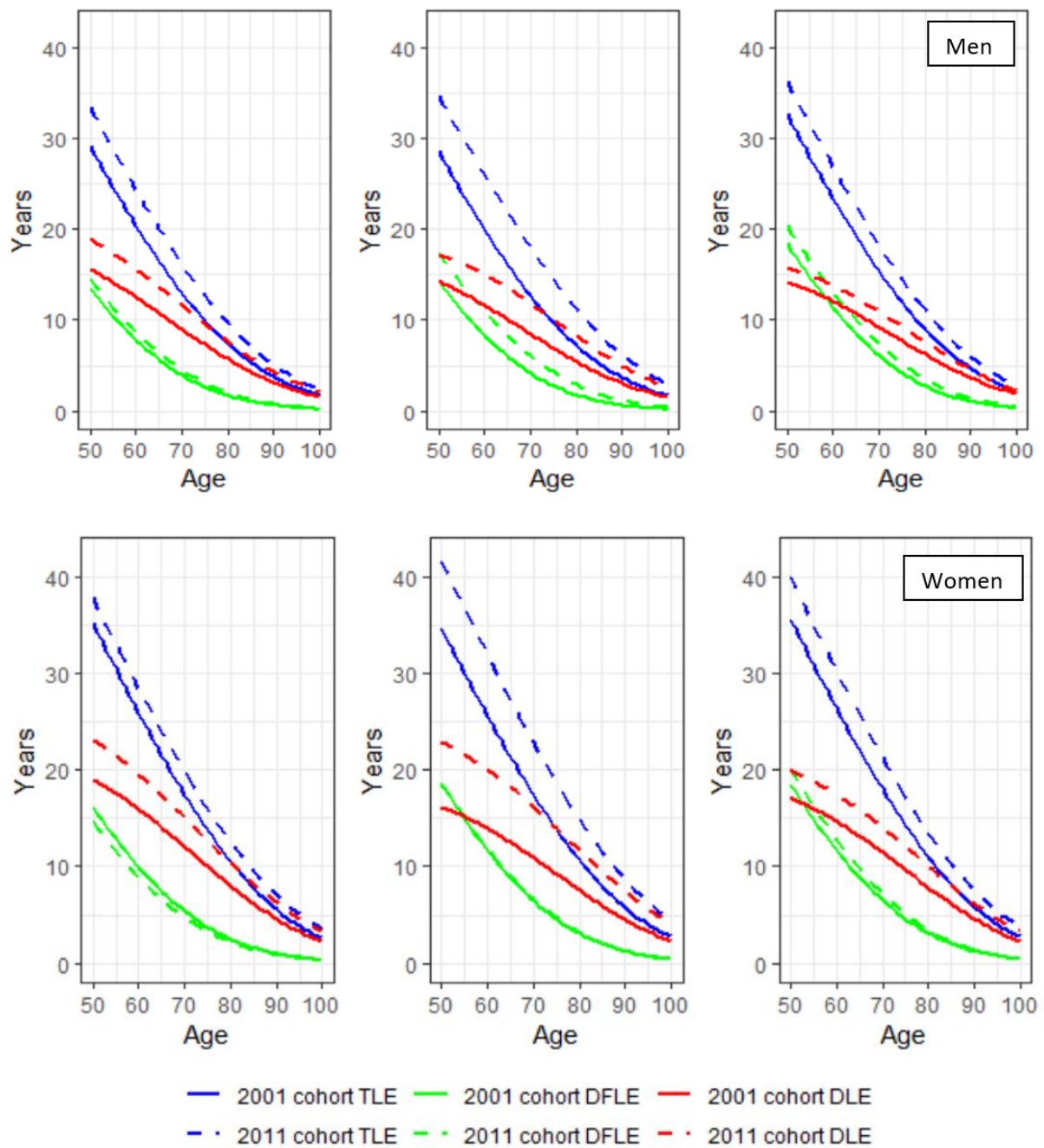
**Table G:** Cohort difference in transition intensities (Relative Risk Ratio: RRR) for **GALI** and **ADL** disability (and 95% confidence intervals) for Men and Women, overall.

|      | Transition               | Men                   | Women                 |
|------|--------------------------|-----------------------|-----------------------|
|      |                          | RRR (95% CI)          | RRR (95% CI)          |
| GALI | Incidence                | 1.0 (0.9, 1.1)        | 1.0 (0.9, 1.1)        |
|      | Recovery                 | <b>1.1 (1.0, 1.2)</b> | <b>0.9 (0.8, 1.0)</b> |
|      | Disability-free to death | 0.5 (0.2, 1.3)        | 0.5 (0.1, 1.9)        |
|      | Disability to death      | 0.9 (0.7, 1.1)        | 0.9 (0.7, 1.1)        |
| ADL  | Incidence                | <b>0.9 (0.8, 1.0)</b> | 1.0 (0.9, 1.1)        |
|      | Recovery                 | <b>1.2 (1.1, 1.4)</b> | <b>1.1 (1.0, 1.3)</b> |
|      | Disability-free to death | 1.1 (0.7, 1.6)        | 1.0 (0.5, 2.0)        |
|      | Disability to death      | <b>0.8 (0.6, 1.0)</b> | 0.9 (0.7, 1.2)        |

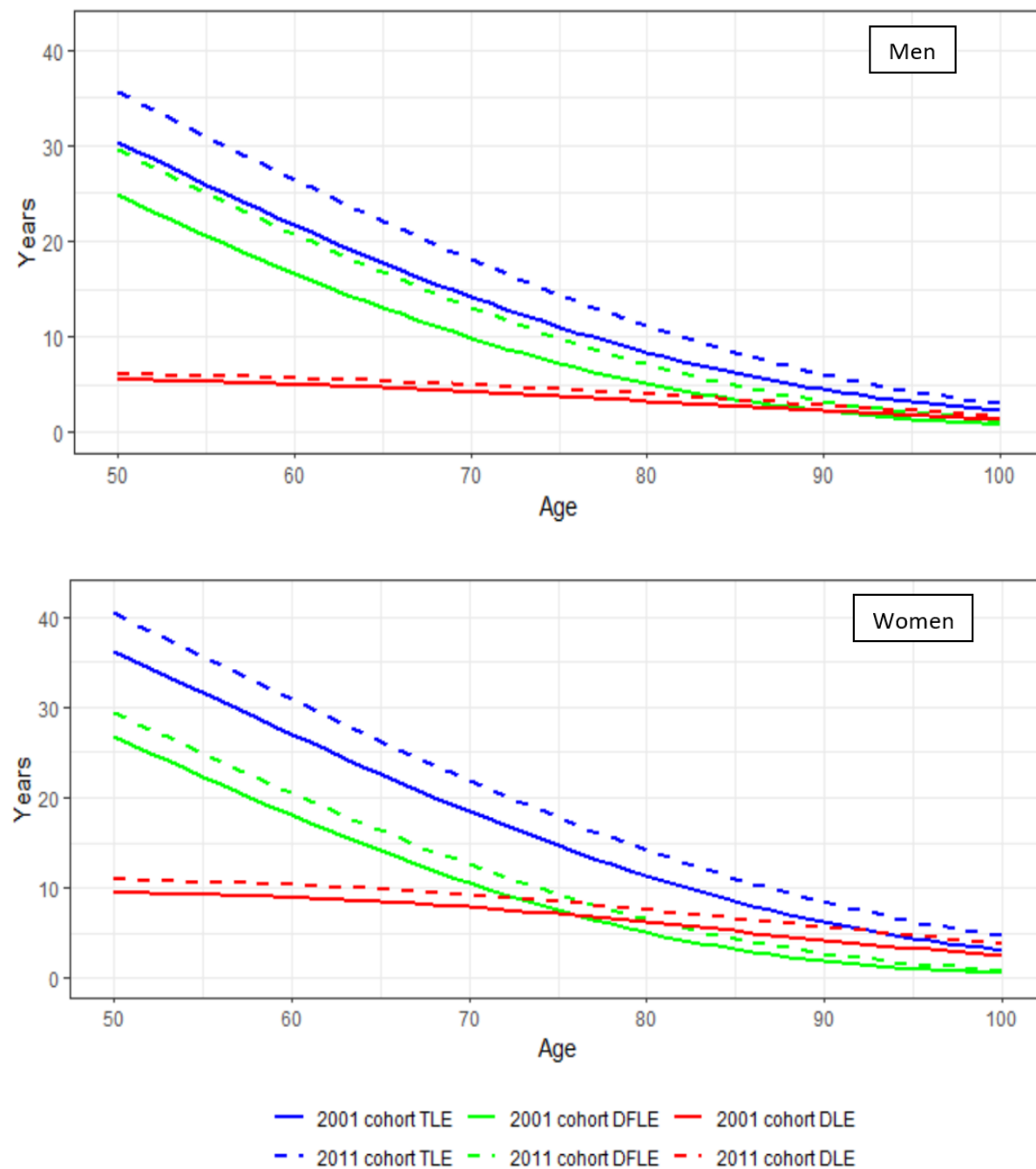


**Figure A:** Total life expectancy (TLE), Disability-free life expectancy (DFLE) and Disability Life expectancy (DLE) for **GALI** disability for ages 50-100 for each cohort. Men (top) and women (bottom).

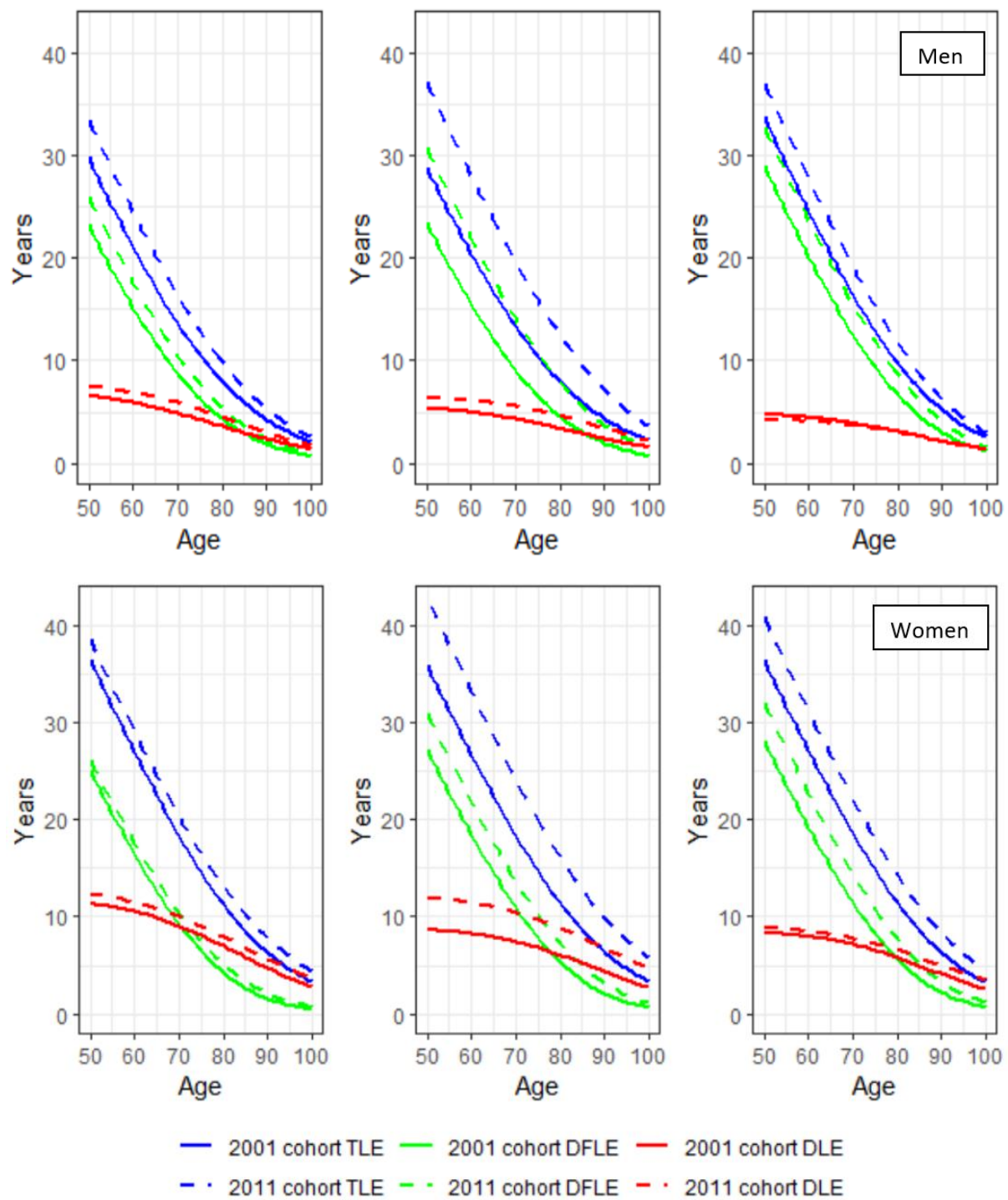
*Note:* For women, DFLE for 2001 and 2011 cohort overlap.



**Figure B:** Expectancies by age for disability defined by **GALI** for Men (top row) and Women (bottom row) by area level disadvantage (1<sup>st</sup> column=bottom tertile, middle column=mid tertile, right column=top tertile).



**Figure C:** Total life expectancy (TLE), Disability-free life expectancy (DFLE) and Disability Life expectancy (DLE) for **ADL** disability for ages 50-100 for each cohort. Men (top) and women (bottom).



**Figure D:** Expectancies by age for disability defined by **ADL** for Men (top row) and Women (bottom row) by area level disadvantage (1<sup>st</sup> column=bottom tertile, middle column=mid tertile, right column=top tertile).

## Trends in Disability-Free Life Expectancy at Age 50 in Australia between 2001 and 2011 by Social Disadvantage

### Methods

#### *Sensitivity analyses using Interpolated Markov Chain (IMaCh) Software*

In a sensitivity analysis, cohort differences in disability free life expectancies were computed using an alternative algorithm implemented by Interpolated Markov Chain (IMaCh) software version 0.99r19. IMaCh uses a multistate Markov model for discrete time data to estimate transitions between health states (see figure 1), and calculate the average number of years lived in each particular health state. Standard procedures for IMaCh analyses were followed whereby observed time intervals were partitioned into 1-month intervals to approximate an underlying continuous time process and to relax the assumption of constant transition intensities over the entire duration between interviews. Transition probabilities conditioned on age and covariates are estimated via multinomial logistic regression (equation 1). One-month transition probabilities are then used as inputs to generate a multi-state life table for each sub-group. Separate analyses were performed by sex (men and women), cohort (2001er and 2011er), and each indicator of disability (GALI, and SF36 PF  $\leq 40$ ).

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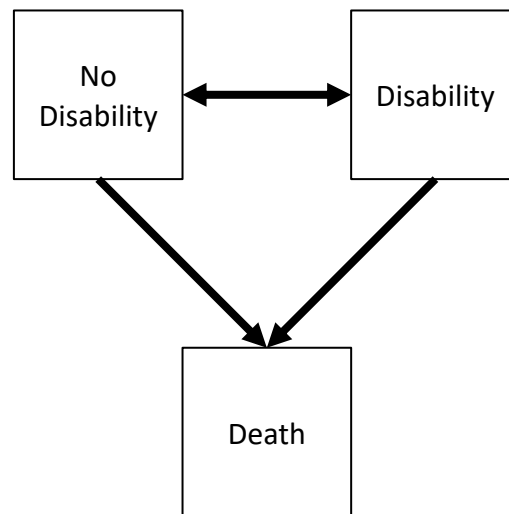

$$\log \left( \frac{P_{jk}(age_i + age_i + h | SEIFA_1, SEIFA_2)}{P_{jj}(age_i + age_i + h | SEIFA_1, SEIFA_2)} \right) = a_{jk}(h) + b_{jk}(h)age_i + c_{jk}(h)SEIFA_1 + d_{jk}(h)SEIFA_3 \quad (\text{Eq.1})$$

Where  $j$  is the health state at  $age_i$  and  $k$  is the health state after time  $h$ .  $SEIFA_1$  is the bottom tertile of area disadvantage,  $SEIFA_2$  is the top tertile for area disadvantage.

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#### *Weights*

Sample weights were included to reflect the characteristics of the national Australian population for each cohort. For the 2001est cohort (born prior to 1950) sample weights were based on characteristics of the national population in 2001. For the 2011est cohort (born prior to 1960) sample weights were based on characteristics of the national population in 2011<sup>45</sup>.



**Figure 1:** Illness death model depicting four possible transitions of (i) disability incidence, (ii) disability recovery, (iii) disability free mortality, and (iv) disability mortality.

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**  
**Supplementary file 2**

**Table 1:** Years lived with and without **GALI** disability for men and women at age 50 estimated by IMaCh

|              | <b>TLE</b>   |                 | <b>DFLE</b>  |                 | <b>DLE</b>   |                 |
|--------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
|              | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> |
| <b>Men</b>   |              |                 |              |                 |              |                 |
| 2001         | 28.8         | (27.8, 29.8)    | 15.0         | (14.3, 15.7)    | 13.8         | (13.0, 14.6)    |
| 2011         | 33.8         | (32.7, 34.8)    | 17.4         | (16.7, 18.0)    | 16.4         | (15.6, 17.2)    |
| Difference   | 5.0          | (3.5, 6.4)      | 2.4          | (1.4, 3.3)      | 2.6          | (1.5, 3.8)      |
| <b>Women</b> |              |                 |              |                 |              |                 |
| 2001         | 34.0         | (32.8, 35.1)    | 17.3         | (16.6, 18.0)    | 16.6         | (15.7, 17.5)    |
| 2011         | 38.4         | (37.3, 39.4)    | 17.8         | (17.2, 18.3)    | 20.6         | (19.7, 21.6)    |
| Difference   | 4.4          | (2.8, 6.0)      | 0.4          | (-0.5, 1.3)     | 4.0          | (2.7, 5.3)      |

**Table 2:** Years lived with and without **ADL** disability for men and women at age 50 estimated by IMaCh

|              | <b>TLE</b>   |                 | <b>DFLE</b>  |                 | <b>DLE</b>   |                 |
|--------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
|              | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> |
| <b>Men</b>   |              |                 |              |                 |              |                 |
| 2001         | 29.1         | (28.1, 30.1)    | 24.1         | (23.3, 25.0)    | 5.0          | (4.5, 5.4)      |
| 2011         | 34.5         | (33.4, 35.5)    | 29.0         | (28.0, 29.9)    | 5.5          | (5.0, 6.0)      |
| Difference   | 5.3          | (3.8, 6.8)      | 4.8          | (3.5, 6.1)      | 0.5          | (-0.1, 1.2)     |
| <b>Women</b> |              |                 |              |                 |              |                 |
| 2001         | 34.4         | (33.3, 35.6)    | 26.3         | (25.4, 27.1)    | 8.2          | (7.4, 8.9)      |
| 2011         | 38.4         | (37.3, 39.6)    | 29.2         | (28.5, 30.0)    | 9.2          | (8.4, 10.0)     |
| Difference   | 4.0          | (2.4, 5.6)      | 3.0          | (1.8, 4.1)      | 1.0          | (0.0, 2.1)      |

**2001 cohort:** Year of birth ≤ 1950

**2011 cohort:** Year of birth ≤ 1960

**TLE:** Total Life Expectancy

**DFLE:** Disability Free Life Expectancy

**DLE:** Disability Life Expectancy

**GALI:** Global Activity Limitation Indicator

**ADL disability:** Disability defined by SF36 Physical Function subscale scores ≤ 40

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**  
**Supplementary file 2**

**Table 3:** Years lived with and without **GALI** disability for **men** by area level disadvantage at age 50 estimated by IMACh

|             | TLE   |              | DFLE  |              | DLE   |              |
|-------------|-------|--------------|-------|--------------|-------|--------------|
|             | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)     |
| <b>Low</b>  |       |              |       |              |       |              |
| 2001        | 27.6  | (26.0, 29.2) | 13.2  | (12.0, 14.3) | 14.5  | (13.1, 15.8) |
| 2011        | 31.6  | (30.0, 33.2) | 13.6  | (12.6, 14.5) | 18.0  | (16.6, 19.4) |
| Difference  | 4.0   | (1.7, 6.2)   | 0.4   | (-1.1, 2.0)  | 3.5   | (1.6, 5.5)   |
| <b>Mid</b>  |       |              |       |              |       |              |
| 2001        | 27.4  | (25.7, 29.1) | 13.7  | (12.6, 14.8) | 13.7  | (12.4, 15.0) |
| 2011        | 34.3  | (32.4, 36.2) | 17.7  | (16.6, 18.8) | 16.6  | (15.1, 18.1) |
| Difference  | 6.9   | (4.4, 9.5)   | 4.0   | (2.5, 5.6)   | 2.9   | (0.9, 4.9)   |
| <b>High</b> |       |              |       |              |       |              |
| 2001        | 31.9  | (30.1, 33.8) | 18.5  | (17.4, 19.7) | 13.4  | (12.0, 14.8) |
| 2011        | 36.0  | (34.1, 38.0) | 21.3  | (20.1, 22.5) | 14.7  | (13.3, 16.2) |
| Difference  | 4.1   | (1.4, 6.8)   | 2.8   | (1.1, 4.5)   | 1.3   | (-0.7, 3.3)  |

**Table 4:** Years lived with and without **GALI** disability for **women** by area level disadvantage at age 50 estimated by IMACh

|             | TLE   |              | DFLE  |              | DLE   |              |
|-------------|-------|--------------|-------|--------------|-------|--------------|
|             | Years | (95% CI)     | Years | (95% CI)     | Years | (95% CI)     |
| <b>Low</b>  |       |              |       |              |       |              |
| 2001        | 33.7  | (31.8, 35.5) | 15.8  | (14.7, 16.9) | 17.9  | (16.3, 19.4) |
| 2011        | 35.9  | (34.3, 37.5) | 14.3  | (13.4, 15.2) | 21.6  | (20.1, 23.1) |
| Difference  | 2.2   | (-0.2, 4.7)  | -1.5  | (-3.0, 0.0)  | 3.7   | (1.6, 5.9)   |
| <b>Mid</b>  |       |              |       |              |       |              |
| 2001        | 33.6  | (31.5, 35.6) | 17.7  | (16.5, 18.9) | 15.9  | (14.3, 17.4) |
| 2011        | 41.2  | (38.8, 43.5) | 18.8  | (17.8, 19.9) | 22.3  | (20.3, 24.4) |
| Difference  | 7.6   | (4.5, 10.7)  | 1.1   | (-0.5, 2.7)  | 6.5   | (3.9, 9.0)   |
| <b>High</b> |       |              |       |              |       |              |
| 2001        | 34.7  | (32.6, 36.8) | 18.5  | (17.2, 19.7) | 16.2  | (14.6, 17.8) |
| 2011        | 39.3  | (37.3, 41.2) | 20.6  | (19.6, 21.6) | 18.7  | (17.0, 20.3) |
| Difference  | 4.6   | (1.7, 7.4)   | 2.1   | (0.5, 3.8)   | 2.4   | (0.1, 4.7)   |

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**  
**Supplementary file 2**

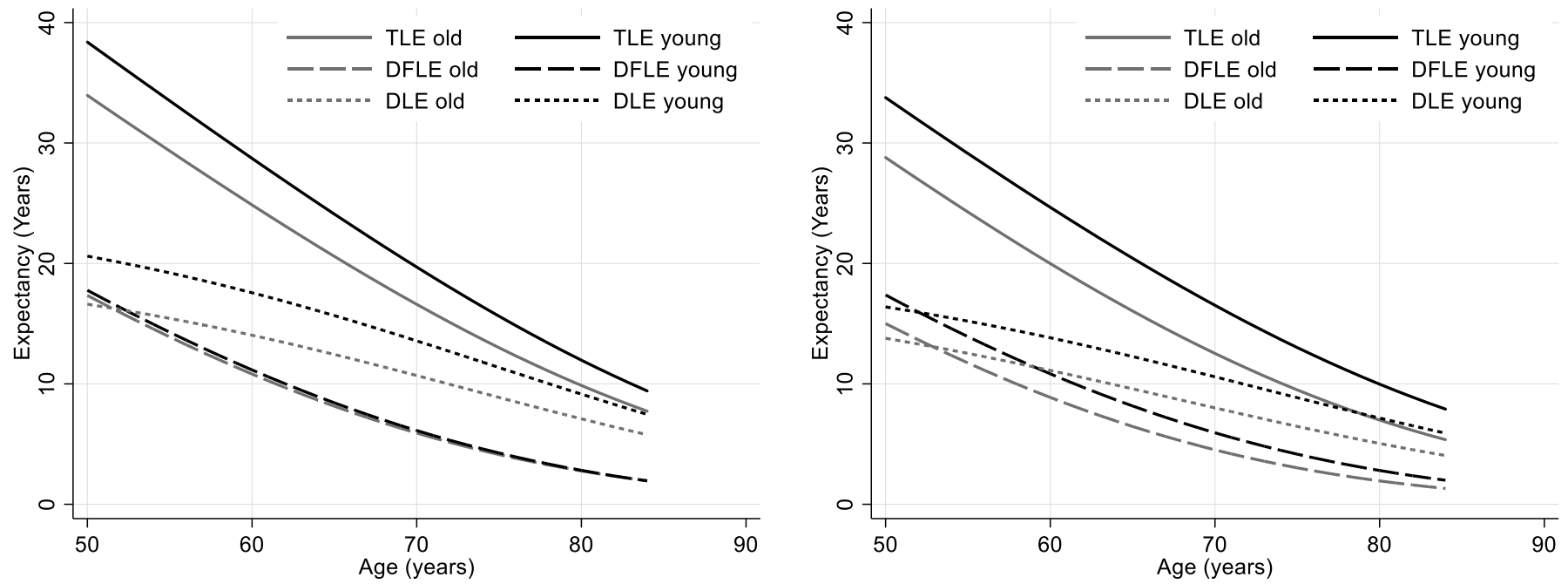
**Table 5:** Years lived with and without **ADL** disability for **men** by area level disadvantage at age 50 estimated by IMACh

|             | <b>TLE</b>   |                 | <b>DFLE</b>  |                 | <b>DLE</b>   |                 |
|-------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
|             | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> |
| <b>Low</b>  |              |                 |              |                 |              |                 |
| 2001        | 27.9         | (26.2, 29.5)    | 22.1         | (20.6, 23.6)    | 5.8          | (4.9, 6.6)      |
| 2011        | 31.5         | (29.9, 33.2)    | 25.1         | (23.7, 26.4)    | 6.5          | (5.6, 7.3)      |
| Difference  | 3.7          | (1.4, 6.0)      | 3.0          | (1.0, 4.9)      | 0.7          | (-0.5, 1.9)     |
| <b>Mid</b>  |              |                 |              |                 |              |                 |
| 2001        | 27.5         | (25.9, 29.1)    | 22.6         | (21.2, 24.0)    | 4.9          | (4.1, 5.7)      |
| 2011        | 36.1         | (34.0, 38.2)    | 30.2         | (28.5, 31.9)    | 5.9          | (4.9, 6.8)      |
| Difference  | 8.6          | (6.0, 11.3)     | 7.7          | (5.5, 9.9)      | 1.0          | (-0.3, 2.2)     |
| <b>High</b> |              |                 |              |                 |              |                 |
| 2001        | 33.1         | (31.0, 35.2)    | 28.8         | (27.0, 30.6)    | 4.3          | (3.5, 5.1)      |
| 2011        | 36.8         | (34.6, 38.9)    | 32.7         | (30.9, 34.5)    | 4.1          | (3.3, 4.8)      |
| Difference  | 3.7          | (0.7, 6.7)      | 3.9          | (1.3, 6.5)      | -0.2         | (-1.4, 0.9)     |

**Table 6:** Years lived with and without **ADL** disability for **women** by area level disadvantage at age 50 estimated by IMACh

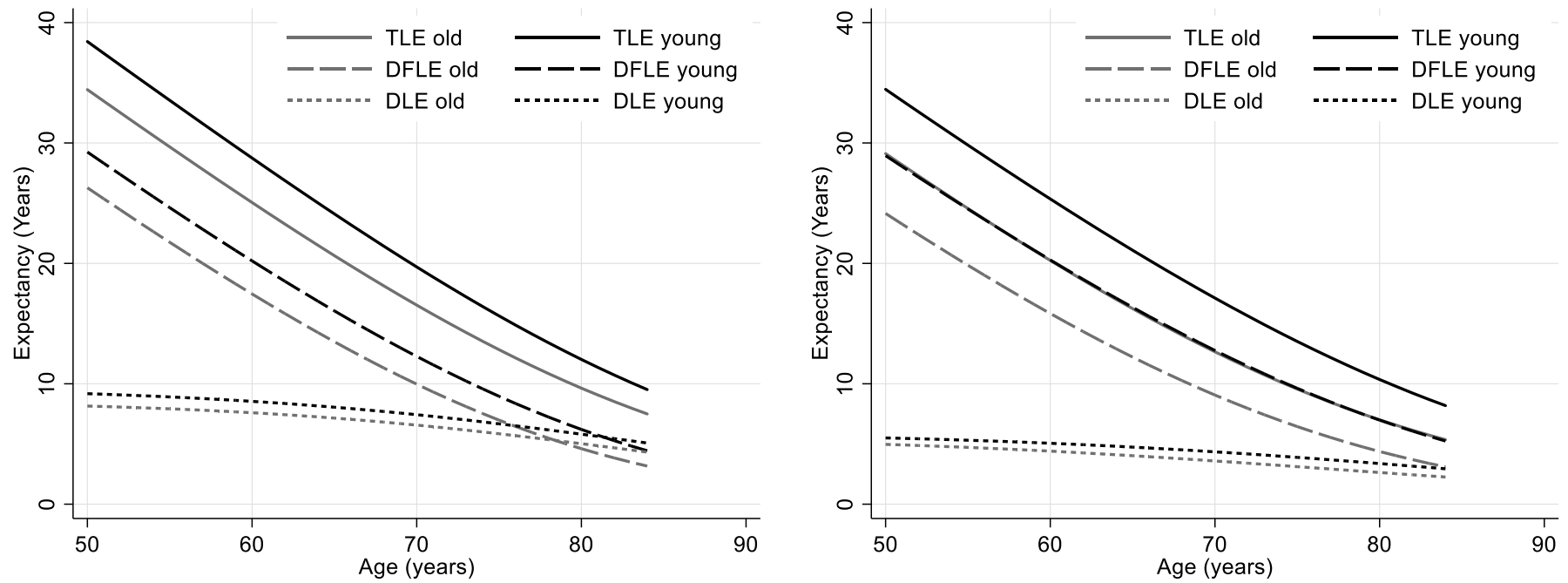
|             | <b>TLE</b>   |                 | <b>DFLE</b>  |                 | <b>DLE</b>   |                 |
|-------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
|             | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> | <b>Years</b> | <b>(95% CI)</b> |
| <b>Low</b>  |              |                 |              |                 |              |                 |
| 2001        | 33.8         | (32.0, 35.7)    | 24.2         | (22.9, 25.5)    | 9.6          | (8.3, 10.9)     |
| 2011        | 35.6         | (34.0, 37.2)    | 25.4         | (24.2, 26.6)    | 10.2         | (9.1, 11.3)     |
| Difference  | 1.8          | (-0.6, 4.2)     | 1.2          | (-0.6, 2.9)     | 0.6          | (-1.0, 2.3)     |
| <b>Mid</b>  |              |                 |              |                 |              |                 |
| 2001        | 33.8         | (31.8, 35.7)    | 26.4         | (24.9, 27.8)    | 7.4          | (6.2, 8.5)      |
| 2011        | 41.3         | (38.9, 43.7)    | 30.8         | (29.3, 32.3)    | 10.5         | (8.8, 12.2)     |
| Difference  | 7.5          | (4.5, 10.6)     | 4.4          | (2.4, 6.5)      | 3.1          | (1.1, 5.2)      |
| <b>High</b> |              |                 |              |                 |              |                 |
| 2001        | 35.9         | (33.8, 37.9)    | 28.6         | (27.0, 30.1)    | 7.3          | (6.1, 8.5)      |
| 2011        | 39.8         | (37.6, 41.9)    | 32.6         | (31.1, 34.2)    | 7.1          | (6.0, 8.3)      |
| Difference  | 3.9          | (0.9, 6.9)      | 4.0          | (1.9, 6.2)      | -0.1         | (-1.8, 1.5)     |

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**  
**Supplementary file 2**



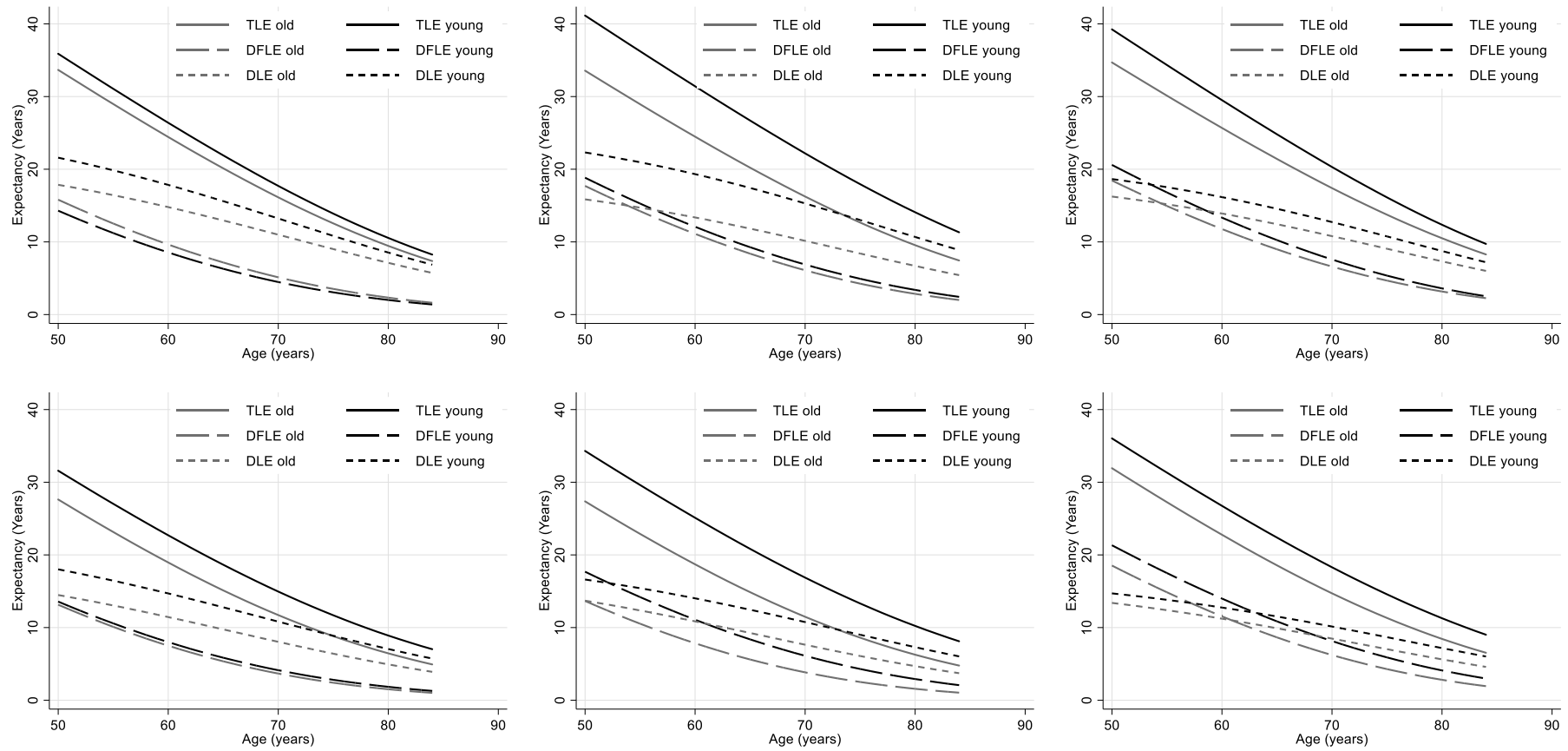
**Figure 2:** Expectancies by age for disability defined by GALI for Women (left panel) and Men (right panel).

**TRENDS IN DISABILITY-FREE LIFE EXPECTANCY**  
**Supplementary file 2**



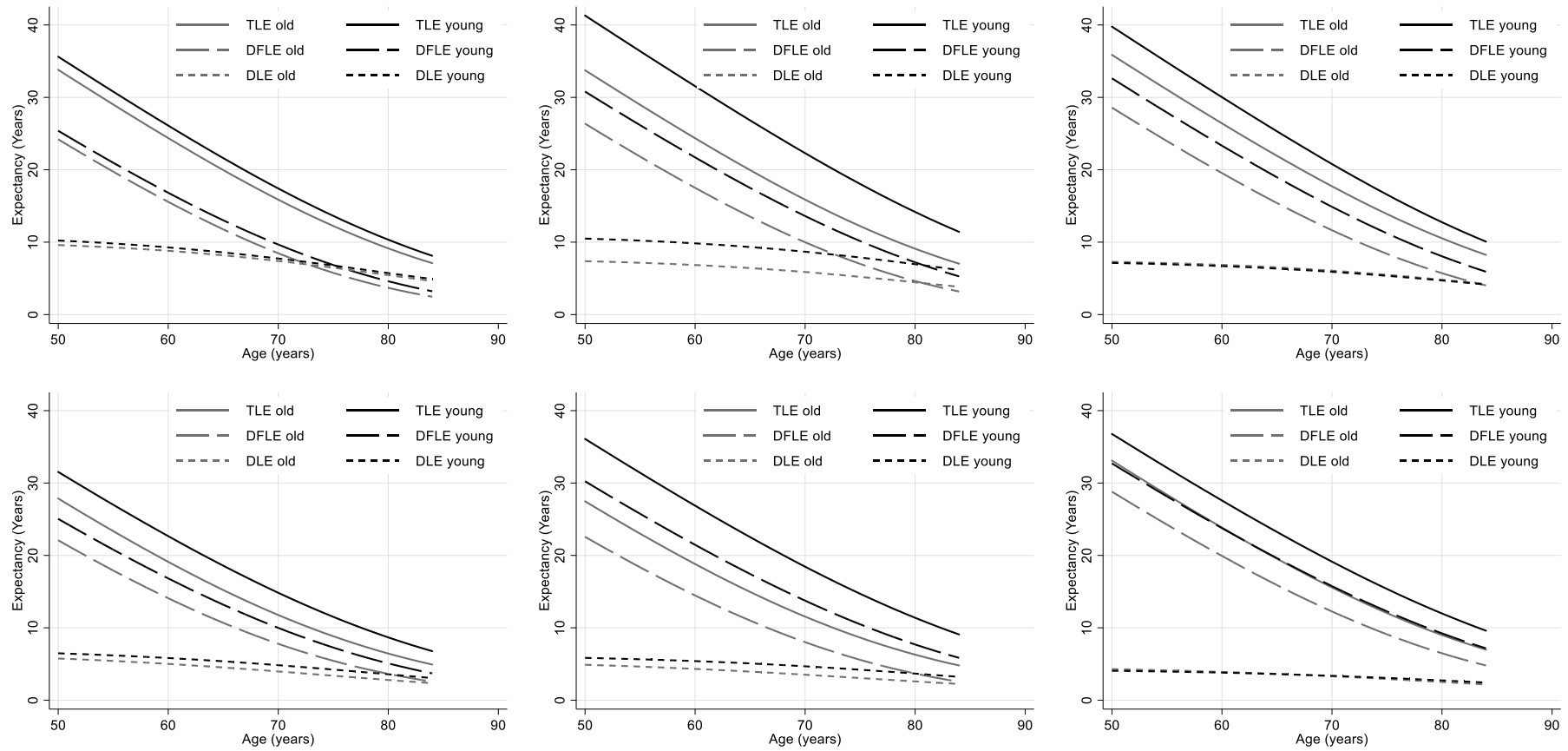
**Figure 3:** Expectancies by age for disability defined by SF36 Physical Function  $\leq 40$  (ADL limitations) for Women (left panel) and Men (right panel).

# TREND IN DISABILITY-FREE LIFE EXPECTANCY Supplementary file 2



**Figure 4:** Expectancies by age for disability defined by GALI for Women (top row) and Men (bottom row) by area level disadvantage (1<sup>st</sup> column=bottom tertile, middle column=mid-tertile, right column=top tertile).

# TREND IN DISABILITY-FREE LIFE EXPECTANCY Supplementary file 2



**Figure 5:** Expectancies by age for disability defined by SF36 Physical Function  $\leq 40$  (ADL limitations) for Women (top row) and Men (bottom row) by area level disadvantage (1<sup>st</sup> column=bottom tertile, middle column=mid-tertile, right column=top tertile).