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# Socio-economic inequalities in health-related quality of life and the contribution of cognitive impairment in Australia: A decomposition analysis

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ABSTRACT

*Background:* The distributional effects of cognitive impairment on inequalities in health-related quality of life (HRQoL) are not well studied. This relationship has not been studied in any Australian health inequality literature. Therefore, this study aims to examine how cognitive impairment affects the distribution of HRQoL across various socio-economic classes amongst older Australians.
*Methods:* Data for this study was collected from the Household, Income and Labour Dynamics in Australia (HILDA) survey. The final analysis consisted of 5,247 and 5,614 unique individuals from wave 2012 and wave 2016, respectively. An ordinary least squares (OLS) regression model was used to investigate the relationship between cognitive impairment and HRQoL. Additionally, the Wagstaff-Doorslaer-Watanabe standard concentration index was used to examine socioeconomic inequality in HRQoL.
*Results:* The findings revealed pro-rich inequalities in HRQoL, as indicated by the concentration indices of 0.029 and 0.025 for wave 12 and wave 16, respectively. Additionally, the results showed that mild cognitive impairment accounted for 7.60% and 9.03%, respectively, of pro-rich socioeconomic inequality in HRQoL in 2012 and 2016.
*Conclusion:* People from lower socioeconomic status (SES) groups tend to have lower HRQoL compared to those from higher SES. This leads to a greater disparity in HRQoL based on SES. Cognitive impairment positively contributed to this inequality in HRQoL. Therefore, it is critical to incorporate cognitive impairment into the design of interventions to reduce socioeconomic inequality in HRQoL.

## 1. Introduction

Improving the health of populations and decreasing health disparities across different socioeconomic groups and geographical areas are two of the world's most pressing public health concerns (Marmot, 2005; Rezaei et al., 2018a,b). Assessing the population's overall health and distribution of health outcomes across different socioeconomic strata is an essential first step to evaluate the degree to which these objectives have been met. One important indicator of health status that has been increasingly used to assess health inequalities across various socioeconomic groups is the Health-Related Quality of Life (HRQoL) (Arcaya et al., 2015; Djärv et al., 2013; Rezaei et al., 2018a,b). Prior research has established a positive link between socioeconomic status (SES) and HRQoL (Burström et al., 2001; Djärv et al., 2013; Kind et al., 1998). These studies emphasized the noteworthy effects on HRQoL linked to factors such as age, healthcare coverage, financial status, educational level, having a diagnosed chronic illness, and behavioural variables including physical activity and tobacco smoking. The extant literature mostly addresses the primary determinants that contributed to HRQoL across different social groups. However, there is a dearth of research that specifically investigates socioeconomic inequality in HRQoL. The authors of a recent Iranian study on socioeconomic inequality in HRQoL identified pro-rich inequality in individuals with low HRQoL (Rezaei et al., 2018a,b). The study identified income, a sedentary lifestyle, the

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existence of chronic health conditions, and not having health insurance as the four primary contributors to inequality for people with low HRQoL. In Australia, there has been an increasing disparity in health outcomes along the socioeconomic gradient, indicating a deteriorating inequality (Flavel et al., 2022). Therefore, it is crucial to determine the variables that contribute to the socioeconomic disparities in the HRQoL of older individuals in Australia.

The existing literature has not adequately explored how cognitive impairment contributes to inequalities in HRQoL. Cognitive impairment refers to a reduced ability to comprehend and perceive the environment a person inhabits (Folstein et al., 1985). The spectrum of cognitive impairment spans from mild to severe. While severe cognitive impairment can result in a person being unable to live independently due to challenges in planning and carrying out daily tasks, and applying sound judgment, mild impairment is defined as a state in which there are discernible changes in cognitive functioning, but the person is still able to perform their daily activities (Dhakal and Bobrin, 2022). Previous research from China, Sweden, and Turkey showed a link between cognitive impairment and reduced HRQoL in older people (Akdag et al., 2013; Johansson et al., 2012; Pan et al., 2015). The CDC HRQOL-4 was used to measure HRQoL in the Turkish study, while the EQ-5D was used in the Chinese and Swedish studies. In contrast, other research indicated that cognitive impairment does not affect the HRQoL of people living in nursing homes (Elliott et al., 2009), people living with dementia (Banerjee et al., 2009), and older Canadians residing in institutions (Davis et al., 2015). A recent longitudinal study conducted in Australia used the SF-36 and SF-6D measures to examine the relationship between cognitive decline and HRQoL in older Australians (Keramat et al., 2023). The results indicated a link between cognitive impairment and a decrease in HRQoL. However, the study did not investigate the contribution of cognitive impairment on socio-economic inequality in HRQoL. Understanding this link is crucial for designing health equity strategies and implementation plans to achieve health equality for older Australians.

Although there has been significant progress in the overall health of people worldwide, disparities in health between wealthier and poorer countries, as well as across various socioeconomic strata within each country, have remained stagnant or, in some instances, even deteriorated (Robert et al., 2000; Sibanda and Doctor, 2013). Therefore, the goal of this research was two-fold. Firstly, to identify if there is any inequality in HRQoL among older Australians. Secondly, if inequality exists, what is the contribution of cognitive impairment? Comprehending this association is essential for formulating and implementing health equity strategies to mitigate health disparities among older Australians. This understanding, ideally, can contribute to the implementation of equitable health policies and practices that enhance their HRQoL.

## 2. Methods

### 2.1. Data source and settings

Data were derived from the Household, Income, and Labour Dynamics in Australia (HILDA) survey. The survey, in operation since 2001, gathers annual data from a sample of nationally representative Australians. The study tracks more than 17,000 people across their lifetimes and collects information on various subjects such as family and home dynamics, labour supply and income, levels of education, and health outcomes. A comprehensive grasp of HILDA records and information may be obtained elsewhere (Watson, 2021).

### 2.2. Study participants

This analysis relies on data collected from two waves of the survey—wave 12 (2012) and wave 16 (2016)— as these were the only waves that included questions on cognitive impairment. Wave 12 served as the starting point, while wave 16 served as the subsequent measurement. The analysis focused exclusively on older people in Australia, specifically individuals aged 50 years or above. Participants who lacked complete information on the outcome variables (HRQoL outcomes) or exposure factors (cognitive function test scores) were excluded from the study. The study participants aged 50 years and older numbered 5,247 and 5,614 individuals in 2012 and 2016, respectively. Figure A1 of the Appendix in online supplementary material provides a comprehensive overview of the sample selection process, including the criteria used to exclude certain observations and a detailed breakdown of any missing data.

### 2.3. Outcome variable

The HILDA study gathered information on HRQoL by administering the RAND Corporation-developed 36-Item Short Form (SF-36) survey (Brazier et al., 1992). This survey has 36 standard, easy-to-ask questions that cover four aspects of mental health and four aspects of physical health. The responses of the participants are evaluated using a numerical scale of 0–100, with 0 indicating the worst health status and 100 representing the best possible health status for each component of health. The obtained results are then transformed into two summary component scores: the mental component summary (MCS) score and the physical component summary (PCS) score.

While the SF-36 serves as a reasonably comprehensive assessment tool for evaluating health status, it fails to account for utility. Therefore, this study utilised the SF-6D utility index to measure HRQoL. A modified iteration of the SF-36, the SF-6D generates utility values, making it more economically relevant from an analytical perspective (Ferreira et al., 2013). The six multi-level aspects that comprise the SF-6D scale include physical functioning, role limitations, social functioning, body pain, mental health, and vitality. The SF-6D scale has a range of values from 0.29 to 1, with 1 representing optimal health and 0.29 indicating the most severe state of ill health.

### 2.4. Exposure variable

HILDA assesses participants' cognitive abilities using validated cognitive function tests, which are conveniently implemented and compatible with HILDA's in-person survey design. The relevant markers of cognitive function used are the Symbol Digit Modalities Test (SDMT) (Smith, 1982) and the Backward Digit Span (BDS) test (Lamar et al., 2007). This specific set of tests was previously used to identify cognitive impairment in people diagnosed with multiple sclerosis (Parmenter et al., 2007; Van Schependom et al., 2014) and people who were acutely hospitalised (Leung et al., 2011). In the BDS cognitive assessment test, participants are asked to repeat a series of digits in reverse order (Lamar et al., 2007). The BDS evaluates the capacity of working memory and is graded on a scale ranging from 0 to 8. For the SDMT, respondents are required to match particular numbers with arbitrary geometric figures (Smith, 1982). The SDMT scores between 0 and 110 and evaluates central brain processing.

The threshold for cognitive impairment in this study was established using earlier established criteria: people with mild cognitive impairment (MCI) are defined as having a score $\geq 1$ standard deviation (SD) lower than the mean on the BDS, SDMT, or both, and people with severe cognitive impairment are defined as having a score of SD $\geq 1.5$ below the mean on both tests (Aschwanden et al., 2020; Keramat et al., 2023). As a result, the BDS cut-off score was set at $\leq 3$, and the SDMT cut-off score was set at $\leq 30$. This means that any person who scores at or below the cut-off score on either test is classified as having MCI. However, a score of $\leq 2$ on the BDS and $\leq 24$ on the SDMT tests indicates severe cognitive impairment.

### 2.5. Income

The estimation of SES and the calculation of the concentration index were based on equivalised household disposable income. The total disposable income comprises earnings from a job and self-employment, income generated from investments, and Australian income assistance payments. The research employed the OECD-modified scale to account for variations in income. The equation for equivalised household income is provided by ABS (ABS, 2006):

$$\text{Equivalised Income} = \frac{\text{Household Disposable Income}}{1 \times \text{First Adult} + 0.5 \times \text{Additional Adults} + 0.3 \times \text{Additional Children}} \quad (1)$$

## 2.6. Covariates

This study considered various demographic, SES variables, health-related traits, as well as health-related behaviours, as potential covariates that might be associated with HRQoL. The factors encompassed are age, gender, marital status, educational attainment, annual disposable income of the family, labour force participation, Indigenous origin, area of residence, Body Mass Index (BMI), smoking habits, and alcohol drinking. The variables are categorised and shown in Table A1 of the Appendix in the online supplementary material.

## 2.7. Conceptual framework

To explore the socio-economic inequality in HRQoL and the contribution of cognitive impairment, this study developed a conceptual framework of HRQoL for older people following an earlier established framework (McDool et al., 2024). Figure A2 of the Appendix highlights that factors associated with HRQoL are broadly categorised as health-related behavioural characteristics such as smoking habits, alcohol drinking, health-related characteristics such as cognition status, and Body Mass Index (BMI), socioeconomic status such as level of education, household yearly income, participation in the labour force, area of residence, and demography factors such as age, gender, indigenous status, marital status.

## 2.8. Estimation strategy

This study used the standard concentration index (SCI) to measure socioeconomic inequity in HRQoL where equivalised household income was used as a proxy of the SES. The study also presents socio-economic inequality in HRQoL using the concentration curve (CC). The concentration curve demonstrates the cumulative share of HRQoL (SF-6D) in comparison with the cumulative share of the population ranked by equivalised household income. The CC outlined three key points regarding its position on the 45-degree equality line: inequalities that favour the poor (above the line), inequalities that favour the rich (below the line), and no inequalities (on the line itself).

This study followed the approach used by Hashmi et al. (2020) to identify the inequality that exists in HRQoL and the contribution of cognitive impairment to this disparity (Hashmi et al., 2020).

The study used the Concentration Index (CI), which is a rank-dependent inequality metric that quantifies socio-economic inequality (Wagstaff et al., 1989). CI is mainly based on the CC of two variables; the number is twice the area between the CC and the line of perfect equality. As a result, the CI is constrained between −1 (perfectly pro-poor inequality) and 1 (perfectly pro-rich inequality) and defined as follows (Kakwani, 1980; Kakwani et al., 1997):

$$CI = \frac{2}{\overline{h}} cov(h_i, R_i) \quad (2)$$

$$\Rightarrow CI = \frac{2}{n\overline{h}} \sum_{i=1}^{n} h_i, R_i - 1 \quad (3)$$

Here, a population consisting of n people with varying health levels $h_i$ is ranked by income and some other measure of SES, ordered from the poorest to the richest resulting in a fractional rank $R_i = \frac{2i-1}{2n}$, $\overline{h} = \frac{\sum_{i=1}^{n} h_i}{n}$ and $i = 1, 2, \ldots, n$. A pro-rich distribution is shown by a positive value of the CI; whereas, a pro-poor distribution is shown by a negative value of CI.

In earlier research (Wagstaff et al., 2003), showed that if health is a linear function of K variables (such as demographic, health-related and behavioural factors, and SES), then CI is a weighted sum of socio-economic disparities in these variables.

Therefore, the CI may be broken down based on the following regression:

$$h_i = \alpha + \sum_{j=1}^{k} \beta_j, x_{ij} + u_i \quad (4)$$

where, $\alpha$ and $\beta_j$, $j = 1, \ldots, k$ are coefficients that are required to be estimated, and $u_i$ represents the error term with $E[u_i] = 0$. Through the substitution of (4) into (3) as well as some algebra, Wagstaff et al. showed that (Wagstaff et al., 2003):

$$CI = \sum_k \eta_k CI_k + \frac{GC_u}{\overline{h}} \quad (5)$$

in this context, $CI_k$ represents the concentration index of the factor $x_k$, while $\eta_k = \beta_k \frac{\overline{x_k}}{\overline{h}}$ stands for the average elasticities, or magnitude of the impact of k factors. The initial term, $\eta_k CI_k$, of each component, $x_k$, reveals its contribution to socioeconomic disparities caused by $x_k$. Therefore, $\sum_k \eta_k CI_k$ is the model's overall contribution to explaining socioeconomic disparity. The residual term, $\frac{GC_u}{\overline{h}}$, represents unexplained socioeconomic inequalities.

The following procedures were used to determine the factor decomposition of the concentration index:

Step 1 A regression analysis using Ordinary Least Squares (OLS) was performed to investigate the link between HRQoL and various characteristics including cognitive impairment, age, gender, marital status, highest level of schooling achieved, household yearly disposable income, labour force participation, indigenous origin, area of residence, BMI, smoking habits, and alcohol drinking. The findings of the regression are depicted in Table 3.

Step 2 To compute the average value of all variables, this study employed the mean command.

Step 3 Based on the mean values and coefficients obtained from the OLS regression, elasticities were calculated for all the independent variables.

Step 4 The coindex commands were used to compute concentration indices for all independent variables.

Step 5 The percentage contribution of each variable was derived by multiplying the elasticities and concentration indices of each independent variable.

Step 6 The processes were iterated for each wave.

**Table 1**
Distribution of test scores, cognitive impairment, and other covariates in wave 12 and wave 16.

| Variables | Baseline wave (2012) | | Final wave (2016) | |
|---|---|---|---|---|
| | n | mean (SD/%) | n | mean (SD/%) |
| **Utility score** | | | | |
| SF-6D | 5,247 | 0.74 (0.13) | 5,614 | 0.74 (0.13) |
| **BDS test score** | 5,247 | 4.79 (1.39) | 5,614 | 4.86 (1.40) |
| **SDMT score** | 5,247 | 41.91 (12.07) | 5,614 | 43.09 (11.76) |
| **Cognitive impairment, n (%)** | | | | |
| No | 4,593 | 87.54 | 5,061 | 90.15 |
| Mild | 617 | 11.76 | 507 | 9.03 |
| Severe | 37 | 0.71 | 46 | 0.82 |
| **Age (in years)** | | | | |
| 50–64 | 3,075 | 58.60 | 3,268 | 58.21 |
| 65 and above | 2,172 | 41.40 | 2,346 | 41.79 |
| **Gender** | | | | |
| Male | 2,459 | 46.86 | 2,653 | 47.26 |
| Female | 2,788 | 53.14 | 2,961 | 52.74 |
| **Indigenous Origin** | | | | |
| Non Aboriginal or Torres Strait Islander | 5,162 | 98.38 | 5,503 | 98.04 |
| Aboriginal or Torres Strait Islander | 85 | 1.62 | 110 | 1.96 |
| **Marital Status** | | | | |
| Unpartnered | 1,837 | 35.01 | 1,998 | 35.59 |
| Partnered | 3,410 | 64.99 | 3,616 | 64.41 |
| **Highest level of schooling achieved** | | | | |
| Year 12 and below | 2,318 | 44.18 | 2,261 | 40.27 |
| Professional qualifications | 1,724 | 32.86 | 1,967 | 35.04 |
| University qualifications | 1,205 | 22.97 | 1,386 | 24.69 |
| **Household yearly disposable income (Quintile)** | | | | |
| Quintile 1 (lowest) | 1,049 | 19.99 | 1,123 | 20.00 |
| Quintile 2 | 1,050 | 20.01 | 1,123 | 20.00 |
| Quintile 3 | 1,049 | 19.99 | 1,124 | 20.02 |
| Quintile 4 | 1,050 | 20.01 | 1,122 | 19.99 |
| Quintile 5 (highest) | 1,049 | 19.99 | 1,122 | 19.99 |
| **Participation in the labour force** | | | | |
| Employed | 2,467 | 47.02 | 2,671 | 47.58 |
| Unemployed/Not in the labour force | 2,780 | 52.98 | 2,943 | 52.42 |
| **Area of residence** | | | | |
| Major Cities | 3,368 | 64.19 | 3,544 | 63.13 |
| Regional/remote | 1,879 | 35.81 | 2,070 | 36.87 |
| **BMI** | | | | |
| Healthy weight | 1,712 | 32.63 | 1,750 | 31.17 |
| Underweight | 72 | 1.37 | 64 | 1.14 |
| Overweight | 2,026 | 38.61 | 2,107 | 37.53 |
| Obese | 1,437 | 27.39 | 1,693 | 30.16 |
| **Smoking habits** | | | | |
| Former smoker/never smoked | 4,588 | 87.44 | 4,905 | 87.37 |
| Currently smoking | 659 | 12.56 | 709 | 12.63 |
| **Alcohol drinking** | | | | |
| Former drinker or never drunk | 965 | 18.39 | 1,058 | 18.85 |
| Active drinker | 4,282 | 81.61 | 4,556 | 81.15 |

All analysis was conducted using STATA 16 (Stata Corp LLC).

## 3. Results

Table 1 provides a summary of the distribution of various factors including the outcome variable (SF-6D score), the exposure variable (BDS and SDMT scores, cognitive impairment), demographic characteristics, SES, health-related characteristics, and health-related behaviours in the baseline wave (2012), and the final wave (2016). The mean utility score (SF-6D) remained consistent at 0.74 (SD = 0.13) in both 2012 and 2016 waves. The distribution of exposure measures in the final wave (2016) of the participants was as follows: the mean BDS score was 4.86 (SD = 1.40), the mean SDMT score was 43.09 (11.76), 90.15% had no cognitive impairment, 9.03% had mild cognitive impairment, 0.82% had severely cognitively impaired. Additionally, the data revealed that in wave 16, approximately 41% of the participants were aged 65 years or older, just over half were female (52%), 2% identified as indigenous, 64% were in a relationship with a partner, 24% held a bachelor's degree or higher, around 52% were unemployed or not in the labour force, 36% resided in a regional or remote area, 30% were obese, 12% were current smokers, and 81% were current alcohol drinkers.

Fig. 1 illustrates the findings of SCI to calculate the CC of SF-6D scores by equivalised household income for waves 12 and 16. The CI values of 0.029 and 0.025 in waves 12 and 16, respectively, indicated that socioeconomic disparity in HRQoL is evident in Australia. Additionally, the CCs are below the $45^0$ line, suggesting that the highest income quintiles have higher HRQoL utility scores. The differences in HRQoL across socioeconomic groups warrant an examination of the factors that contribute to these disparities.

Table 2 presents the findings from two distinct OLS regressions conducted for wave 12 and wave 16. All results, except for indigenous origin, highest level of schooling achieved, and area of residence, were statistically significant in both years. The findings indicated that people with mild and severe cognitive impairment had a poorer HRQoL compared to people without cognitive impairment, in both years. Compared to people with no cognitive impairment, people with mild and severe cognitive impairment patients had 0.038 and 0.051 points lower HRQoL, respectively, in wave 12. Likewise, in wave 16, the HRQoL in participants with mild cognitive impairment was 0.047 points lower, while in people with severe cognitive impairment, it was 0.043 points lower, compared to people with no cognitive impairment.

Table 3 depicts the Wagstaff-Doorslaer-Watanabe decomposition estimation of socio-economic inequalities in HRQoL. The mean elasticity, represented in the first column of each wave, indicates the extent to which the exposures contributed to inequality in HRQoL. The second column quantifies the level of inequality through the CI or income-related component. The third column measures the contribution of each factor on HRQoL by multiplying the values from the first two columns. When a health variable, such as the HRQoL utility score, has a higher value indicating better health, a positive (negative) impact of a factor means that higher HRQoL is more prevalent among the wealthy (poor) due to increasing inequality, resulting in a pro-rich (pro-poor) distribution with respect to that factor (O'Donnell et al., 2008).

The results show that the socio-economic disparity in HRQoL varied between 0.025 and 0.029 points during the study period (last row in Table 3). Consistent with the regression results, all cognitive impairment factors in both waves had a negative elasticity indicating the presence of mild and severe cognitive impairment was associated with lower HRQoL. The presence of mild and severe cognitive impairment showed a negative CI indicating a pro-poor distribution of these variables. Resultingly, these factors all had a positive contribution to the overall pro-rich distribution in HRQoL. The cognitive impairment that contributed the most to the overall pro-rich distribution was mild cognitive impairment which explained 7.60% and 9.09% of the inequality in HRQoL in 2012 and 2016, respectively.

Apart from cognitive impairment, household income and lack of employment were major drivers of overall inequality in HRQoL. Compared to the highest income quintile, all other income quintiles reported a negative elasticity. As the poorest (quintile 1) and poor income (quintile 2) quintiles had a negative CI value, these variables contributed to the observed inequality explaining 29.52% and 12.65% of the overall inequality in wave 16. Being unemployed or not in the labour force had a negative elasticity and CI value in both waves, and in wave 16, it explained about 38% of the overall inequality in HRQoL.

The impact of unemployment and not being in the labour force on the inequality in HRQoL may be attributed to the fact that younger people within the older population (aged 50–64 years) are more likely to be employed and earn higher salaries compared to older adults (aged 65 years and over) who may have cognitive impairments and are no longer in the workforce. Therefore, this study conducted a sensitivity analysis that included the concentration index, regression and decomposition analyses, using the average household wealth as a proxy for SES instead

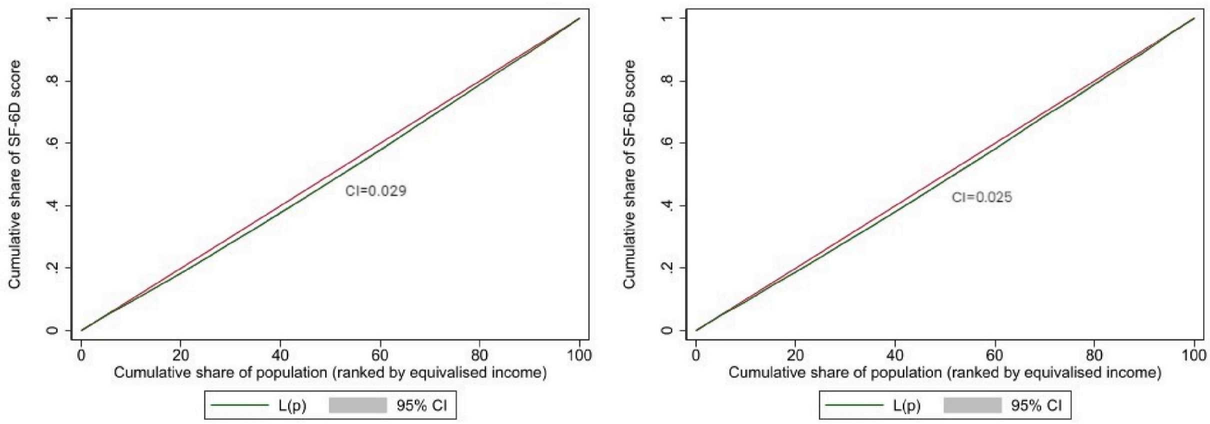


**Fig. 1.** Concentration curve of health-related quality of life using standard concentration index with equivalised household disposable income ranking.
Notes: Abbreviation: CI = Concentration Index; 95% CI = 95% Confidence Interval.

of equivalised household disposable income. Due to the unavailability of wealth data for wave 12 and wave 16, this study imputed wealth values that the HILDA survey collected every fourth wave, beginning with wave 2. Net household wealth within the HILDA dataset is determined by deducting total debts from total assets. A detailed description of the wealth variable calculation methodology can be found in the HILDA User Manual, Release 22 (Summerfield et al., 2023). For this study, the mean wealth values from waves 10 and 14 were allocated to wave 12, while the mean values from waves 14 and 18 were assigned to wave 16. The results of SCI are consistent with our previous findings with CI values of 0.019 and 0.023 for waves 12 and 16, respectively (see Figure A3 of Appendix in the online supplemental material). Moreover, consistent with our prior findings, the regression analysis revealed that people with mild and severe cognitive impairment exhibited lower HRQoL scores, by 0.046 and 0.043 points, respectively, in wave 16 compared to people with no cognitive impairment (see Table A2 of Appendix in the online supplemental material). Finally, decomposition analysis using average household wealth also revealed a pro-rich distribution of HRQoL, with mild cognitive impairment contributing 1.87% and 2.27% to inequality in HRQoL in 2012 and 2016, respectively (Table A3 of Appendix in the online supplemental material). However, the magnitude of the contribution of cognitive impairment in explaining inequality in HRQoL decreased compared to previous findings. In both waves, being unemployed or not in the labour force had a negative elasticity and CI value. In wave 16, it accounted for around 13% of the total disparity in HRQoL. However, there was a significant decrease in the magnitude of this contribution (38%) compared to the previous analysis.

Fig. 2 displays the contribution of board category variables by waves. In wave 12, cognitive impairment (both mild and severe) accounted for 8.45% of the inequality in HRQoL, whereas in wave 16 it accounted for 9.88%. On the other hand, SES explained 88.61% and 80.31% of the inequality in HRQoL in wave 12 and wave 16, respectively.

## 4. Discussion

### *4.1. Key findings*

Using data from the HILDA survey, this research initially investigated if there is any inequality in HRQoL among older Australians. Additionally, the research examined the contribution of cognitive impairment on disparities in overall HRQoL across various socioeconomic strata. In both years, people with mild and severe cognitive impairment had a reduced HRQoL than people with no cognitive impairment. Additionally, mild and severe cognitive impairment was identified as a contributing factor to pro-rich socioeconomic inequality in HRQoL. Furthermore, unemployment and low household income were recognized as significant factors that contribute to overall disparities in HRQoL, alongside cognitive impairment. Several studies conducted in Australia have examined the association of different factors on HRQoL across population groups. These factors include social health and stressful life events (Phyo et al., 2022), body mass index (Renzaho et al., 2010), dietary quality (Milte et al., 2015), and cardiovascular disease (O'Neil et al., 2013). A recent study investigated the link between cognitive impairment and HRQoL in older Australians (Keramat et al., 2023), while another study in Iran decomposed socioeconomic inequality in HRQOL (Rezaei et al., 2018a,b). However, none of the prior research decomposed the contribution of cognitive impairment in the context of HRQoL inequality.

The study found that the prevalence of MCI among older Australians aged 50 years and over was 11.76% and 9.03% in 2012 and 2016, respectively. The results of this study are comparable to those of a previous Australian study, which reported a pooled prevalence of 10.16% for MCI (Keramat et al., 2023). Supporting our findings, research from other countries, including Spain (Lara et al., 2016; Lopez-Anton et al., 2015), China (Lu et al., 2021) and Italy (Ravaglia et al., 2008), also reported an MCI prevalence range of 7–12%. However, according to a prior review study, the reported prevalence of MCI varies significantly across international studies, ranging from around 3%–42% (Ward et al., 2012). The observed variations in MCI prevalence can be attributed to several factors, including heterogeneity in study samples, the application of diverse diagnostic criteria for MCI, variations in study settings, and discrepancies in methodological approaches. For example, a meta-analysis of 53 studies from 17 countries found that the pooled global prevalence of MCI among older adults living in nursing homes was 21.2% (Chen et al., 2023). This finding contrasts with the prevalence of MCI in the general older population, which is typically much lower. The higher prevalence of MCI in nursing homes can be explained by the fact that cognitive impairment is one of the major reasons for admission to nursing homes (Helvik et al., 2014; Kijowska and Szczerbińska, 2018), resulting in a higher concentration of people with MCI residing in these facilities compared to the general, community-dwelling population. The study further revealed low rates of severe cognitive impairment, with 0.71% and 0.82% prevalence in 2012 and 2016, respectively. The findings are consistent with another Australian study that reported a comparable pooled prevalence of 0.72% for severe cognitive impairment (Keramat et al., 2023). The possible explanation for the low prevalence of mild and severe cognitive impairment may be attributed to the study's design, which relied only on cognitive test results (i.e., BDS and SDMT) to define cognitive impairment. According to the Diagnostic and Statistical Manual of Mental Disorders Text Revision (DSM-5-TR), diagnosing cognitive impairment and dementia, also

**Table 2**
Regression results.

| Cognitive impairment, n (%) | Wave 12 | | Wave 16 | |
|---|---|---|---|---|
| | Coefficient (SE) | P-value | Coefficient (SE) | P-value |
| No (ref) | | | | |
| Mild cognitive impairment | −0.0386 (0.0053) | 0.001 | −0.0475 (0.0057) | 0.001 |
| Severe cognitive impairment | −0.0517 (0.0191) | 0.001 | −0.0439 (0.0172) | 0.011 |
| **Age (in years)** | | | | |
| 50-64 (ref) | | | | |
| 65 and above | 0.0227 (0.0041) | 0.001 | 0.0195 (0.004) | 0.001 |
| **Gender** | | | | |
| Male (ref) | | | | |
| Female | −0.0094 (0.0034) | 0.001 | −0.0089 (0.0032) | 0.006 |
| **Indigenous origin** | | | | |
| Non Aboriginal or Torres Strait Islander (ref) | | | | |
| Aboriginal or Torres Strait Islander | 0.0035 (0.0126) | 0.783 | 0.0029 (0.0112) | 0.795 |
| **Marital status** | | | | |
| Unpartnered (ref) | | | | |
| Partnered | 0.0161 (0.0035) | 0.001 | 0.0202 (0.0033) | 0.001 |
| **Highest level of schooling achieved** | | | | |
| Year 12 and below (ref) | | | | |
| Professional qualifications | −0.001 (0.0038) | 0.803 | −0.0039 (0.0037) | 0.293 |
| University qualifications | −0.0002 (0.0044) | 0.970 | 0.0003 (0.0043) | 0.943 |
| **Household yearly disposable income (Quintile)** | | | | |
| Quintile 1 | −0.0573 (0.0059) | 0.001 | −0.0338 (0.0057) | 0.001 |
| Quintile 2 | −0.0332 (0.0055) | 0.001 | −0.029 (0.0053) | 0.001 |
| Quintile 3 | −0.0173 (0.0052) | 0.001 | −0.0089 (0.005) | 0.076 |
| Quintile 4 | −0.0004 (0.0051) | 0.938 | −0.0014 (0.0049) | 0.774 |
| Quintile 5 (ref) | | | | |
| **Labour force participation** | | | | |
| Employed (ref) | | | | |
| Unemployed/Not in the labour force | −0.0515 (0.0042) | 0.001 | −0.0545 (0.004) | 0.001 |
| **Area of residence** | | | | |
| Major Cities (ref) | | | | |
| Regional/remote | −0.0042 (0.0034) | 0.206 | −0.0013 (0.0032) | 0.685 |
| **BMI** | | | | |
| Healthy weight (ref) | | | | |
| Underweight | −0.0245 (0.0139) | 0.077 | −0.0395 (0.0147) | 0.007 |
| Overweight | −0.0146 (0.0038) | 0.001 | −0.0112 (0.0038) | 0.003 |
| Obese | −0.0441 (0.0041) | 0.001 | −0.0493 (0.004) | 0.001 |
| **Smoking habits** | | | | |
| Former smoker/never smoked (ref) | | | | |
| Currently smoking | −0.0185 (0.0049) | 0.001 | −0.0288 (0.0048) | 0.001 |
| **Alcohol drinking** | | | | |
| Former drinker or never drunk (ref) | | | | |
| Active drinker | 0.0223 (0.0042) | 0.001 | 0.0284 (0.0041) | 0.001 |

Notes: 1. Standard errors are in the parentheses. 2. Ref indicates reference group.

known as major neurocognitive disorder, usually requires a thorough clinical examination that includes evaluating functional limits and other relevant clinical criteria (American Psychiatric Association, 2022). This constraint may have resulted in an underestimation of the occurrence of mild and severe cognitive impairment in this sample, as some people with lower cognitive abilities on specific tests may not have met the predetermined scores utilised in this study. However, they might have the potential to meet the diagnostic criteria for these conditions with a more comprehensive assessment.

The results show that cognitive impairment is negatively linked with HRQoL in older Australians. This result is consistent with other studies conducted in older people in Australia (Keramat et al., 2023; Phyo et al., 2021), China (Pan et al., 2015), and Sweden (Johansson et al., 2012). On the other hand, another study discovered no correlation between cognitive decline and HRQoL among older people residing in the community (Davis et al., 2015). However, this discrepancy may be explained using the Euro QOL (EQ-5D) metric as the HRQoL measure, which does not include a cognition-specific category and therefore might not be congruent with the cognitive impairment screening instrument. The contribution of SES on HRQoL in Australia aligns with findings from research conducted in other countries, indicating that those with higher income levels tend to have better HRQoL (Matute et al., 2017; Rezaei et al., 2018a,b).

This research provides a substantial contribution by investigating the inequality in HRQoL, considering cognitive impairment and SES. The negative elasticity of cognitive impairment indicates that increasing exposure to cognitive impairment reduces HRQoL and contributes to inequality in HRQoL. Both mild cognitive impairment and severe cognitive impairment exhibit a negative CI, suggesting that they are distributed in a way that disproportionately affects those with lower SES. One plausible reason is that access to resources is linked to being able to deal with health problems, and being poor makes it harder to get those resources (Lima-Costa et al., 2005), which makes people more likely to experience a lower HRQoL.

The consequences of cognitive impairment are similarly comparable to some of the other socioeconomic factors identified, as both elasticities and CI exhibited negative values. This indicates that being female, belonging to the lowest income quartile group, being unemployed or not participating in the labour force, residing in regional and remote areas, being underweight or obese, and engaging in certain health-related behaviours such as smoking reduce HRQoL and creating pro-poor inequality in HRQoL. Among the socioeconomic determinants, this study found employment and household income had the most significant contribution to poor individuals' HRQoL inequality. This result is consistent with prior decomposition analysis where it was found lack of wealth is a main contributor to poor HRQoL (Rezaei et al., 2018a,b). The inverse association between poor wealth status and HRQoL may be attributed to different factors. For example, wealth disparity may lead to health disparities due to unequal distribution of resources and material opportunities, such as access to nutritious food, adequate housing, and healthcare services (Abbott, 2002; Hajizadeh et al., 2012).

In contrast, being partnered, having university qualifications, and alcohol drinking are distinct in nature in their contribution to inequality. In this scenario, both CI and elasticity are positive meaning wealthy individuals are partnered, have more education, consume more alcohol, and have higher earnings; having higher levels of these traits are indicative of a higher HRQoL. Due to the varying impacts of these factors on HRQoL for people in various socioeconomic categories, the inequality in HRQoL in Australia continues to widen over time.

### 4.2. *Strengths, limitations, and avenues for further research*

The use of a comprehensive population-based longitudinal design and a wide spectrum of older age cohorts constituted a significant strength of this research. This study is the first to decompose the contribution of cognitive impairment to pro-rich inequality in HRQoL from the Australian context. A wide range of socioeconomic characteristics related to health and health-related behaviour were controlled in this study which makes the findings robust. The cognitive impairment measures (SDMT and BDS) are also validated and demonstrate strong efficacy in representing fundamental aspects of cognitive aging and

**Table 3**
Wagstaff - Doorslaer – Watanabe - decomposition analysis.

| Variables | wave 12 | | | | wave 16 | | | |
|---|---|---|---|---|---|---|---|---|
| | η[2] | CI[3] | Co[4] | %Co[5] | η | CI | Co | %Co |
| Mild cognitive impairment | −0.0061 | −0.3573 | **0.0021** | 7.6098 | −0.0058 | −0.3862 | **0.0022** | 9.0369 |
| Severe cognitive impairment | −0.0004 | −0.4895 | **0.0002** | 0.8382 | −0.0005 | −0.4306 | **0.0002** | 0.8451 |
| **Age (in years)** | | | | | | | | |
| 65 and above | 0.0127 | −0.2488 | **−0.0031** | −10.9729 | 0.0110 | −0.2300 | **−0.0025** | −10.2240 |
| **Gender** | | | | | | | | |
| Female | −0.0067 | −0.0381 | **0.0002** | 0.8922 | −0.0064 | −0.0381 | **0.0002** | 0.9791 |
| **Indigenous origin** | | | | | | | | |
| Aboriginal or Torres Strait Islander | 0.0000 | −0.0333 | **0.0000** | −0.0087 | 0.0001 | 0.0264 | **0.0000** | 0.0081 |
| **Marital Status** | | | | | | | | |
| Partnered | 0.0141 | 0.0814 | **0.0011** | 4.0015 | 0.0176 | 0.0755 | **0.0013** | 5.3566 |
| **Highest level of schooling achieved** | | | | | | | | |
| Professional qualifications | −0.0004 | 0.0262 | **−0.0000** | −0.0384 | −0.0019 | 0.0207 | **−0.0000** | −0.1538 |
| University qualifications | −0.0000 | 0.3244 | **−0.0000** | −0.0590 | 0.0001 | 0.2860 | **0.0000** | 0.1170 |
| **Household yearly disposable income (Quintile)** | | | | | | | | |
| Quintile 1 | −0.0155 | −0.7998 | **0.0124** | 43.0629 | −0.0092 | −0.8000 | **0.0073** | 29.5268 |
| Quintile 2 | −0.0089 | −0.3998 | **0.0035** | 12.4479 | −0.0079 | −0.3999 | **0.0031** | 12.6522 |
| Quintile 3 | −0.0047 | 0.0001 | **−0.0000** | −0.0031 | −0.0024 | 0.0004 | **−0.0000** | −0.0034 |
| Quintile 4 | −0.0001 | 0.4002 | **−0.0000** | −0.1480 | −0.0004 | 0.4004 | **−0.0002** | −0.6153 |
| **Labour force participation** | | | | | | | | |
| Unemployed/Not in the labour force | −0.0370 | −0.2540 | **0.0094** | 32.5902 | −0.0388 | −0.2468 | **0.0096** | 38.5113 |
| **Area of residence** | | | | | | | | |
| Regional/remote | −0.0020 | −0.1063 | **0.0002** | 0.7591 | −0.0007 | −0.1027 | **0.0001** | 0.2724 |
| **BMI** | | | | | | | | |
| Underweight | −0.0004 | −0.2537 | **0.0001** | 0.4008 | −0.0006 | −0.1549 | **0.0001** | 0.3805 |
| Overweight | −0.0076 | 0.0153 | **−0.0001** | −0.4057 | −0.0057 | 0.0364 | **−0.0002** | −0.8366 |
| Obese | −0.0163 | −0.0244 | **0.0004** | 1.3883 | −0.0202 | −0.0575 | **0.0012** | 4.6691 |
| **Smoking habits** | | | | | | | | |
| Currently smoking | −0.0031 | −0.0665 | **0.0002** | 0.7279 | −0.0049 | −0.1145 | **0.0006** | 2.2693 |
| **Alcohol drinking** | | | | | | | | |
| Active drinker | 0.0246 | 0.0525 | **0.0012** | 4.4851 | 0.0313 | 0.0555 | **0.0017** | 6.9789 |
| **Total estimate contribution** | **0.0278** | | | | **0.0247** | | | |
| **CI of HRQoL (SF-6D)** | **0.029** | | | | **0.025** | | | |

**Notes:** 1. The 0 values do not represent actual zeros. The values are close to zero. 2. η symbolises elasticity. The equation is defined as $\eta_k = \beta_i \frac{\overline{X}_k}{h}$, 3. The concentration index (CI) is calculated by ranking the row variable based on equivalised household income, 4. Co represents the contribution to the concentration index of HRQoL, 5. The contribution is calculated as a percentage by determining the proportion of the contribution to the actual concentration index. The sum of all Co represents the explained portion of the CI of HRQoL in a given wave.

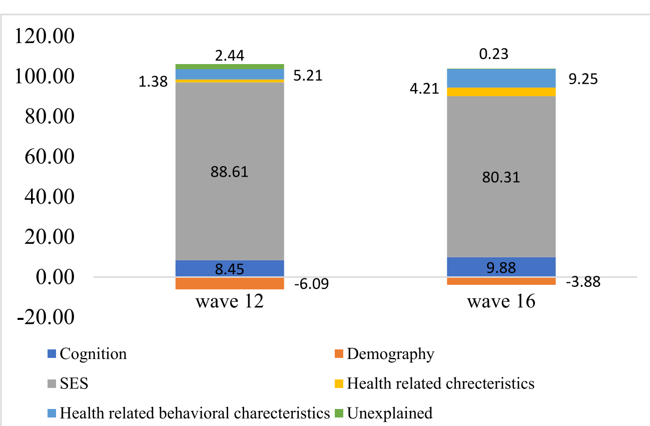


**Fig. 2.** Broad category factors' contribution in CI by wave.

impairment. Utilising validated methodologies enables the direct comparison of the results with earlier studies.

The study is not without limitations. First, one noteworthy limitation of this research was the methodologies employed to obtain data on HRQoL. Due to the self-reported nature of HRQoL, social desirability bias may have contributed to an elevation of HRQoL scores. Second, a distinct consensus regarding the thresholds for scoring for the SDMT and BDS scales to delineate cognitive impairment is lacking. Consequently, these metrics lack diagnostic value for cognitive impairment and might not comprehensively represent the entire range of clinically significant cognitive impairment. Third, due to unavailability of data, the study could not incorporate two important confounders - chronic conditions and pharmacological treatment, which may result in systematic bias, such as unmeasured confounders. Fourth, the observational design of this study precludes the establishment of definitive causal relationships between cognitive impairment and HRQoL. It is possible that lower HRQoL could contribute to the development of cognitive impairment, or that both factors might share a common underlying cause. Fifth, while the BDS and SDMT offer valuable insights into core cognitive processes, they may not fully capture the specific cognitive profile of MCI or dementia, which often entails memory deficits. This limitation may have resulted in an underestimation of the prevalence of mild and severe cognitive impairment in this sample, as some people with lower cognitive abilities on specific tests may not have met the predetermined scores utilised in this study. The use of memory-oriented tests, such as Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), Mini-Mental Status Examination (MMSE) (Folstein et al., 1985), or Saint Louis University Mental Status (SLUMS) examination (Morley and Tumosa, 2002), could have provided a more targeted approach and thus facilitated comparisons with the existing literature. Additionally, this could also reinforce the possibility of reverse causation, whereby pre-existing memory decline could influence working memory and processing speed. Finally, it is crucial to acknowledge that the constraints of the dataset necessitated that the study concentrate on neurodegenerative cognitive impairment. This limits the generalisability of the study's findings to other forms of cognitive impairment, including lifelong learning disabilities. Neurodegenerative cognitive impairment typically progresses over time, potentially explaining the observed associations with HRQoL. Lifelong learning disabilities are generally stable and may not have the same effect on the specific cognitive functions that this study measured. Although the study's focus on the progressive decline is enhanced by their exclusion, future research utilising datasets that enable the differentiation between neurodegenerative and other forms of cognitive impairment could offer a more nuanced understanding.

## 5. Implications for policy and practice

The National Disability Insurance Scheme (NDIS) in Australia is structured to provide funding directly to eligible people, allowing them to purchase the services they require (NSW Health, 2018). Cognitive impairment is recognized as a disability under this scheme. Prior research has demonstrated that challenges in accessing and navigating disability support services are prevalent in Australia and often arise because of socioeconomic and clinical issues (Warr et al., 2017). Recent policy analysis emphasized promoting equity for people living with disabilities in Australia (Olney and Dickinson, 2019). Our results highlight the importance of government policy to focus on supporting these vulnerable populations, especially people with cognitive impairment from low SES groups, given the large contribution to inequality these factors create. The findings also suggest older Australians from disadvantaged SES groups, people who have been unemployed or not included in the labour force, are at risk of much lower HRQoL as a result of cognitive impairment. Government social assistance, such as cash transfers, may be provided to these individuals. Understanding the effect size of a proposed policy or intervention is crucial for making informed decisions. By carefully measuring the magnitude of impact, policymakers can enhance the likelihood of successful and effective interventions (Matthay, 2020). Research findings with large effect sizes are likely to have practical implications, whereas those with minimal effect sizes may have limited real-world applications (Bhandari, 2023). This study used generic preference-based HRQoL measures which are generally less sensitive to detecting improvements in health-related quality of life compared to disease-specific measures (Halme et al., 2015). However, they are still valuable for estimating the overall impact of interventions on quality-adjusted life years, which is essential for cost-effectiveness analysis (Halme et al., 2015).

## 6. Conclusion

The present study adds cognitive impairment as a variable in the investigation of socioeconomic inequality in HRQoL. Our results showed that disparities in socioeconomic inequality exist for older people in Australia. To identify the contribution of cognitive impairment to this inequality, we fit OLS regression to check the association between cognitive impairment and HRQoL. The result showed that both mild and severe cognitive impairment were negatively associated with HRQoL. Furthermore, mild and severe cognitive impairment was identified as a contributing factor to pro-rich socioeconomic inequality in HRQoL. In this study, the cognitive impairment status that contributed the most to the overall pro-rich distribution was mild cognitive impairment. When compared with people in the higher socioeconomic strata, people with mild cognitive impairment who are in the lower SES are more susceptible to inequalities in HRQoL. The results also indicated that socioeconomic variables play a role in driving this inequality, with labour force participation being a significant contributor to the overall inequality. The results have important ramifications for the formulation of future policy, emphasising the need to include cognitive status to construct fair and inclusive policies.

Cognitive decline-induced socioeconomic disparities can be mitigated through the implementation of targeted welfare initiatives, including financial aid, psychological counselling, and the seniors connected program (Department of Social Services, 2023), which aim to alleviate social isolation and loneliness that older Australian's may experience. In welfare states such as Australia, short-term welfare targeting for groups of low-income people with cognitive impairment will enhance HRQoL and reduce the strain on the healthcare system. An assessment of the efficacy of these programs can be conducted by monitoring HRQoL inequality and conducting comparative analyses with other developed countries. Consequently, insights gained from this research can enhance understanding regarding the contribution of cognitive impairment on socio-economic inequality in HRQoL in other developed countries. To design strategies to address cognitive impairment-related disparities in HRQoL, further research is required.

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## Ethical approval

This study used secondary data from de-identified existing unit records from the HILDA Survey, so ethical approval was not required. However, the authors completed and signed the Confidentiality Deed Poll and sent it to NCLD (https://ncldresearch@dss.gov.au) and ADA (https://ada@anu.edu.au) before receiving approval for their data application. The datasets analysed and/or generated during the current study are subject to the signed confidentiality deed.

## CRediT authorship contribution statement

**Rezwanul Haque:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Khorshed Alam:** Writing – review & editing, Visualization, Validation, Supervision, Formal analysis, Conceptualization. **Jeff Gow:** Writing – review & editing, Visualization, Validation, Supervision. **Christine Neville:** Writing – review & editing, Visualization, Validation, Supervision. **Syed Afroz Keramat:** Writing – review & editing, Validation, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

None.

## Data availability

Data will be made available on request.

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## Abbreviations

| | |
|---|---|
| BDS | Backward Digit Span test |
| CC | Concentration Curve |
| CI | Concentration Index |
| HILDA | Household, Income and Labour Dynamics in Australia |
| HRQoL | Health-related quality of life |
| MCI | Mild Cognitive Impairment |
| OLS | Ordinary Least Squares |

SE Standard Error
SDMT Symbol Digit Modalities test
SES Socioeconomic Status

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.117399.

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