




# Impact of economic factors, social health and stressful life events on physical health-related quality of life trajectories in older Australians

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## Abstract

**Purpose** Physical health-related quality of life (HRQoL) is associated with adverse health outcomes, including hospitalizations and all-cause mortality. However, little is known about how physical HRQoL changes over time in older people and the predictors of this trajectory. This study (a) identified trajectories of physical HRQoL among older people and (b) explored whether economic factors, social health or stressful life events impact physical HRQoL trajectories.

**Method** A cohort of 12,506 relatively ‘healthy’ community-dwelling Australians aged  $\geq 70$  years (54.4% females), enrolled in the ASPREE Longitudinal Study of Older Persons (ALSOP) study and was followed for six years. Economic factors, social health and life events in the last 12 months were assessed through a questionnaire at baseline. Physical HRQoL was measured by using the 12-item short form at baseline and annual follow-ups. Growth mixture and structural equation modelling were used to identify physical HRQoL trajectories and their predictors.

**Results** Four physical HRQoL trajectories were identified—stable low (7.1%), declining (9.0%), stable intermediate (17.9%) and stable high (66.0%). Living in more disadvantaged areas, having a lower household income, no paid work, no voluntary work, loneliness and stressful life events (i.e. spousal illness, friend/family illness, financial problem) were associated with a 10%–152% higher likelihood of being in the stable low or declining physical HRQoL trajectory than the stable high group.

**Conclusion** Specific stressful life events had a greater impact on adverse physical HRQoL trajectories in older people than other factors. Volunteering may prevent physical HRQoL decline and requires further investigation.

**Keywords** Physical health-related quality of life · Economic factors · Social health · Stressful life events · Trajectories · Older people

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## Introduction

The world has an ageing demographic, and globally, the proportion of people aged  $\geq 65$  years is projected to more than double from 9.3% in 2020 to 16.0% in 2050 [1, 2]. Like other high-income countries, the Australian population is

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ageing with the proportion aged  $\geq 65$  years increasing from 12.4% in 2000 to 16.3% in 2020 [3]. However, this increase in life expectancy does not necessarily correspond to an increase in healthy and disability-free years of life among older people [1, 4, 5]. Given that existing health services are not well designed to handle the specific needs of older people, population ageing will increase the burden on the healthcare system around the globe as well as in Australia [1, 6]. As such, government policies need a stronger focus on the promotion of healthy ageing (i.e. the process of creating environments that will enable older people to live independently and maintain their functional capacities as long as possible) [7] and identifying specific groups at higher risk of adverse ageing-related health outcomes is essential for developing preventive intervention strategies.

Physical health-related quality of life (HRQoL) is a self-reported measure that assesses the impact of physical health status on individuals' daily lives [8]. In health sciences, the physical domain of HRQoL has been increasingly identified as an effective indicator of health outcomes, including disability, falls, cancer, cardiovascular disease (CVD), hospitalizations and all-cause mortality [8–13]. Previous studies have investigated disease-specific HRQoL trajectories in patients affected by chronic diseases such as coronary heart disease or cancer [14, 15]. However, no studies have examined how the physical HRQoL changes over time among relatively healthy older people living in the community, or what determinants may have an adverse effect on physical HRQoL.

The social determinants conceptual framework proposed by the World Health Organization (WHO) considers that health is governed by different structural and intermediary determinants, including socioeconomic conditions, social health and stressful life circumstances [7]. Life-course transitions, such as reduced income after retirement, relocation and bereavement or loss of a spouse/partner are common examples of stressors in older people [16]. The impact of these late-life transitions may play an essential role in determining the HRQoL of older people [17–19]. For example, a retiree may experience financial stress and may need to learn to live on a reduced budget, limiting spending on hobbies, entertainment and social activities. Prior cross-sectional studies have demonstrated that people with low income or a lower socioeconomic position are more likely to have poor HRQoL [20–23]. Furthermore, cross-sectional evidence also showed that some life events like being divorced, experiencing relational problems with friends/relatives or limited social engagements are associated with poor physical HRQoL in older individuals [17, 23, 24]. However, there is limited evidence on whether such events can impact the trajectory of physical HRQoL in later life.

In this study, we aimed to identify (a) trajectories of physical HRQoL among relatively 'healthy'

community-dwelling older Australians over time, and (b) whether economic factors, social health or other recent stressful life events (i.e. last 12 months) predict physical HRQoL trajectories.

## Methods

### Study population

This study used longitudinal data from the ASPirin in Reducing Events in the Elderly (ASPREE) study and the ASPREE Longitudinal Study of Older Persons (ALSOP) sub-study, which was conducted in parallel to ASPREE.

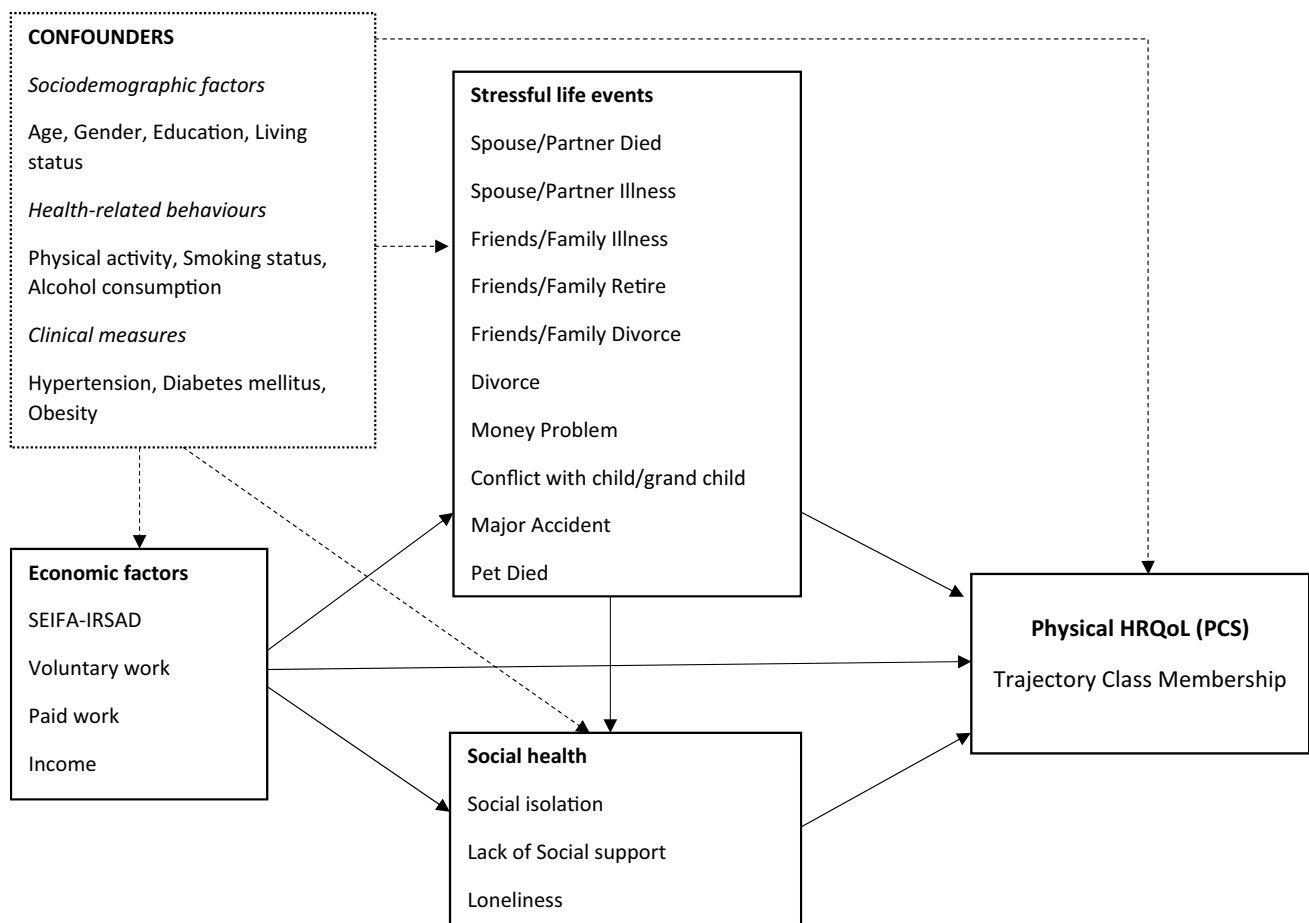
Briefly, ASPREE was a double-blind, randomized placebo-controlled trial, which aimed to determine the effect of low-dose aspirin on primary prevention among the Australian and United States (U.S.) people [25]. From 2010 through 2014, ASPREE recruited 19,114 individuals aged  $\geq 70$  years (or aged  $\geq 65$  years for U.S. minority groups) who were free of serious conditions with a short life expectancy (e.g. cancer, CVD) [25, 26]. ASPREE participants were followed prospectively until June 12, 2017 [26, 27]. The 14,892 (89%) of total 16,703 Australian ASPREE participants agree to participate in ALSOP sub-study (Supplementary Figure S1) [28]. Of these, about 12,506 participants completed the social questionnaire at ALSOP baseline, and the HRQoL assessment at the ASPREE baseline and two or more follow-ups (Supplementary Figure S1), representing the target sample of this study.

### Outcome: physical health-related quality of life

The physical HRQoL was assessed at the baseline and over six follow-ups using the validated Medical Outcomes Study 12-item short form (SF-12, version 2; Cronbach's alpha = 0.86) [29]. The physical component score (PCS) of HRQoL was generated using a norm-based scoring algorithm with a mean of 50 and a standard deviation of 10, with a higher score indicating a better physical HRQoL [30]. Estimation of the PCS considers heavier weighting of physical functioning, role limitation due to physical health, bodily pain and general health domains of SF-12 [30].

### Determinants

Based on the WHO social determinants conceptual framework [7], the hypothesized model was developed and modified to accommodate our research questions and data availability (Fig. 1). All determinants were assessed at baseline.



**Fig. 1** Hypothesized model of economic factors, social health and life events predicting physical health-related quality of life trajectory class memberships, controlling for sociodemographic factors, health-related behaviours and clinical measures. *Physical HRQoL* physical

health-related quality of life, *SEIFA-IRSAD* Socio-Economic Indexes for Areas-Index of Relative Socioeconomic Advantage and Disadvantage

## Economic factors

Using the residential postcodes of participants, we also estimated the Socio-Economic Indexes for Areas-Index of Relative Socioeconomic Advantage and Disadvantage (SEIFA-IRSAD) based on the information from the 2011 Australian Census [31]. The SEIFA-IRSAD index, a macro-economic indicator of socioeconomic status is the summarized score of the economic and social conditions of people and households within an area [32]. The SEIFA-IRSAD index calculation considers annual household income, education, occupation, internet access and rental rate of dwellings within a relative area [32]. The SEIFA-IRSAD deciles were categorized into quintiles and then used as a continuous variable, with a lower score indicating a person lives in a more disadvantaged area [31, 32].

Other economic factors investigated were (a) household gross income; (b) full-time/part-time paid work (yes or no); and (c) voluntary work, not including child minding, baby

sitting or caring (yes or no). Household income was analysed as a binary variable and categorized as, < AU\$50,000 per year or ≥ AU\$50,000 per year (those who preferred not to report their income included in this category).

## Social health

The social health investigated in this study included social isolation, lack of social support and loneliness (Supplementary Table S1). Social isolation and social support were assessed using the Lubben Social Network Scale-Revised (LSNS-R) [33]. The Cronbach's alpha of survey items was 0.77. Social isolation was defined as engaging in community activities less than once per month and having contact with four or fewer relatives or close friends in a month. Lack of social support was defined as having fewer than four relatives or close friends with whom they can call on for help and discuss private matters. Loneliness was assessed using one of the questions of the Center for Epidemiological

Studies-Depression (CES-D-10) [34] and defined as feeling lonely for three or more days in the past seven days.

### Stressful life events

Ten stressful life events over the previous 12 months were assessed with yes–no responses, which included (a) death of a spouse/partner, (b) serious illness in a spouse/partner, (c) death or serious illness in family members or close friends, (d) job loss or retirement in family members or close friends, (e) divorce or partnership breakup in family members or close friends, (f) personal divorce or partnership breakup, (g) major problems with money, (h) major conflict with children or grandchildren, (i) major accidents, disasters, muggings, unwanted sexual experiences, robberies or similar events and (j) having a pet that died.

### Covariates

Baseline demographic, lifestyle and clinical factors associated with the physical HRQoL were considered potential confounders [35]. Demographic factors included age in years, gender, years of education and living situation. Lifestyle behaviours consisted of physical activity levels, smoking status and alcohol consumption [36]. Clinical measures included hypertension [26], diabetes [26] and obesity (body mass index  $\geq 30.0$  kg/m<sup>2</sup> based on measured weight and height) [37]. Depressive symptoms were not adjusted for in the main analysis, given that loneliness was assessed using a question from the CES-D-10 (depression scale) [34] and collinearity between these variables was expected. However, adjustment was performed in sensitivity analysis, removing the loneliness question for the overall depressive symptom score (CES-D-9).

### Data analysis

Analyses were conducted using a three-step approach [38]. In the first step, growth mixture modelling (GMM) was fitted to identify the trajectories (latent patterns of longitudinal change) of PCS over seven time points (i.e. baseline and up to six follow-ups), using the Ram and Grimm's approach [39]. We assessed a series of GMM models that varied in the number of latent patterns and shapes of change (linear, quadratic, or cubic). The final best-fit model was selected using prespecified criteria [39], including (a) whether the model makes sense mathematically (i.e. no negative variances and/or problems in estimation); (b) information criteria: whether Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC) and adjusted BIC model were the lowest scores, which mean the best-fit model for the data; (c) likelihood ratio tests: whether the likelihood ratio tests that assess specific

comparisons between the model of interest and a model with one fewer class had  $p$  values  $< 0.05$ ; (d) whether the trajectories were theoretically justifiable; and (e) using the entropy statistic, how well the final model separated the latent classes. The entropy statistic is a summary indicator of the conditional probabilities of an individual's group membership, and it ranges from 0.00 (low) to 1.00 (high), with a higher value indicating that individuals are classified with greater confidence [40].

In the second step, each individual was assigned to a trajectory class using the latent class posterior probability distribution of our final GMM model [38]. This assigned trajectory was used as the primary outcome variable, with the highest PCS trajectory as the reference group.

In the third step, structural equation modelling (SEM) was used to investigate whether economic factors, social health and having stressful life events predict each PCS trajectory membership [38]. The model was specified based on Fig. 1. Further, sensitivity analyses were performed. The final model was repeated using the categorical income ( $< \text{AU}\$20,000/\text{year}$ ,  $\text{AU}\$20,000\text{--}49,999/\text{year}$ ,  $\text{AU}\$50,000\text{--}99,999/\text{year}$ ,  $\geq \text{AU}\$100,000/\text{year}$ ) as a continuous variable (in which preferred not to answer included as a middle-income category). The final model was also repeated after excluding individuals who died during the follow-up period and lastly after adjustment for CES-D-9 score. All analyses were undertaken using Mplus version 8.6 (Muthén & Muthén, Los Angeles, U.S.).

## Results

The present study included 12,506 Australians aged  $\geq 70$  years (mean age  $75.2 \pm 4.3$  years; 54.4% females). Table 1 shows that at the baseline, most participants had  $\geq 12$  years of education, lived with someone else, had an income of  $< \text{AU}\$50,000$  per year, had positive lifestyle behaviours, hypertension, fewer comorbidities and had not experienced the ten measured stressful life events in the past 12 months.

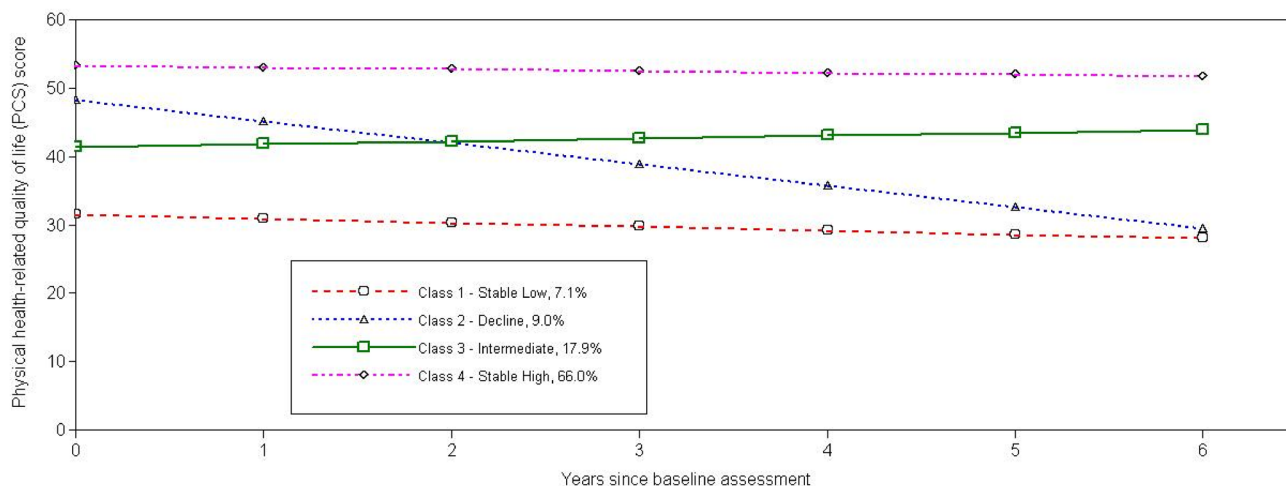
The fit statistics for growth mixture models of longitudinal physical HRQoL (i.e. PCS) data were shown in supplementary table S2. According to our prespecified criteria, the four-class linear model was the best fit for these PCS data. Over time, most of the participants had good PCS and all trajectories except one with a declining trend remained stable in each trajectory. The identified class for PCS trajectories was as follow: a stable low PCS ( $n = 891$ , 7.1%), a declining PCS ( $n = 1125$ , 9.0%), a stable intermediate PCS ( $n = 2240$ , 17.9%) and a stable high PCS ( $n = 8250$ , 66.0%) class (Fig. 2).

**Table 1** Baseline characteristics of participants (N = 12,506)

Characteristics	Frequency (%) or mean $\pm$ SD
<b>Sociodemographic factors</b>	
Age in years (range: 70–95)	75.2 $\pm$ 4.3
Women (vs men)	6801 (54.4%)
Education 12+ years (vs < 12 years)	6482 (51.8%)
Living with someone (vs living alone)	9085 (72.7%)
<b>Economic factors</b>	
<b>SEIFA-IRSAD</b>	
Least advantaged	1994 (15.9%)
2nd quintile	2091 (16.8%)
3rd quintile	2320 (18.6%)
4th quintile	2395 (19.2%)
Most advantaged	3676 (29.5%)
Income < \$ 50,000 per year (vs others <sup>a</sup> )	7986 (67.4%)
No full-time/part-time paid work (vs yes)	11,030 (90.8%)
No voluntary work (vs yes)	7031 (57.4%)
<b>Social health</b>	
Social isolation (vs no)	216 (1.9%)
Lack of social support (vs no)	233 (1.9%)
Loneliness (vs no)	625 (5.0%)
<b>Stressful life events in 12 months prior to baseline</b>	
Spouse/partner died (vs no)	361 (3.0%)
Spouse/partner illness (vs no)	2259 (19.2%)
Friends/family illness (vs no)	5308 (43.6%)
Friends/family retire (vs no)	1625 (13.2%)
Friends/family divorce (vs no)	1767 (14.4%)
Divorce (vs no)	259 (2.1%)
Money problem (vs no)	501 (4.1%)
Conflict with child/grandchild (vs no)	667 (5.4%)
Major accident (vs no)	331 (2.7%)
Pet died (vs no)	1165 (9.5%)
<b>Health-related behaviours</b>	
Physical activities rarely/never/light (vs moderate/vigorous)	4131 (33.6%)
Former/current smoking (vs never)	5477 (43.8%)
High risk alcohol consumption (vs never/former/low risk)	3179 (25.4%)
<b>Clinical measures</b>	
Hypertension <sup>b</sup> (vs no)	9291 (74.3%)
Diabetes <sup>c</sup> (vs no)	1175 (9.4%)
Obesity <sup>d</sup> based on BMI (vs no)	3459 (27.8%)
Depression score <sup>e</sup> (range: 0–27) median (interquartile range)	2 (1–4)

SEIFA-IRSAD Socio-Economic Indexes for Areas-Index of Relative Socioeconomic Advantage and Disadvantage

<sup>a</sup>Other;  $\geq$  \$ 50,000 per year (n = 2638, 22.3%) or preferred not to answer (n = 1228, 10.4%); <sup>b</sup>Hypertension = SBP  $\geq$  140 mmHg or DBP  $\geq$  90 mmHg and/or on treatment for high blood pressure; <sup>c</sup>Diabetes mellitus = self-report of diabetes or fasting glucose  $\geq$  126 mg/dL or on treatment for diabetes; <sup>d</sup>Obesity = body mass index (BMI)  $\geq$  30 according to WHO classification; <sup>e</sup>exclusion of the loneliness item in sum of Center for Epidemiological Studies–Depression (CES-D-10) calculation



**Fig. 2** Physical health-related quality of life trajectory among Australians aged 70+ years from baseline (assessment 1) to follow-up 6 years (assessment 7), N = 12,506

**Table 2** Economic factors, social health and life events predicting physical health-related quality of life trajectory class memberships (N = 11,112)

Comparator: stable high	Intermediate OR (95% CI) <sup>b</sup>	Stable low OR (95% CI) <sup>b</sup>	Decline OR (95% CI) <sup>b</sup>
<i>Economic factors</i>			
SEIFA-IRSAD <sup>a</sup> —lower	1.06 (1.00–1.12)	<b>1.10 (1.03–1.17)</b>	<b>1.11 (1.03–1.20)</b>
Income less than \$50,000 per year—yes	1.09 (0.92–1.30)	1.24 (0.98–1.57)	<b>1.35 (1.06–1.73)</b>
Paid work—no	<b>1.54 (1.13–2.09)</b>	<b>2.42 (1.45–4.04)</b>	1.60 (1.00–2.57)
Voluntary work—no	1.06 (0.91–1.23)	<b>1.42 (1.16–1.74)</b>	<b>1.40 (1.13–1.72)</b>
<i>Social health</i>			
Social isolation—yes	1.36 (0.78–2.39)	1.19 (0.61–2.31)	1.24 (0.59–2.63)
Lack of social support—yes	1.44 (0.83–2.49)	1.50 (0.81–2.79)	1.38 (0.69–2.76)
Loneliness—yes	1.12 (0.79–1.61)	<b>1.64 (1.16–2.32)</b>	1.23 (0.81–1.89)
<i>Stressful life events in 12 months prior to baseline</i>			
Spouse/partner died—yes	0.90 (0.57–1.43)	<b>0.48 (0.25–0.90)</b>	0.95 (0.54–1.66)
Spouse/partner illness—yes	1.07 (0.88–1.32)	<b>1.38 (1.08–1.76)</b>	1.22 (0.94–1.59)
Friends/family illness—yes	1.11 (0.95–1.30)	<b>1.32 (1.08–1.60)</b>	<b>1.45 (1.18–1.78)</b>
Friends/family retire—yes	1.20 (0.97–1.49)	1.08 (0.82–1.42)	1.15 (0.86–1.53)
Friends/family divorce—yes	<b>1.25 (1.01–1.53)</b>	0.78 (0.57–1.07)	1.19 (0.91–1.57)
Divorce—yes	0.75 (0.43–1.30)	1.22 (0.71–2.10)	0.48 (0.18–1.26)
Money problem—yes	<b>1.50 (1.01–2.22)</b>	<b>2.52 (1.74–3.66)</b>	<b>1.89 (1.24–2.88)</b>
Conflict with child/grandchild—yes	0.97 (0.68–1.39)	1.17 (0.80–1.71)	1.02 (0.65–1.60)
Major accident—yes	1.33 (0.89–1.97)	1.51 (0.93–2.46)	1.07 (0.56–2.04)
Pet died—yes	1.11 (0.86–1.44)	<b>1.49 (1.12–1.97)</b>	1.24 (0.89–1.71)

SEIFA-IRSAD Socio-Economic Indexes for Areas- Index of Relative Socioeconomic Advantage and Disadvantage

Bold text, refers to having an association between the related factor and PCS trajectory; <sup>a</sup>categorical SEIFA-IRSAD variable was treated as a continuous variable; <sup>b</sup>adjusted for age, gender, education, living with someone, physical activities, smoking status, alcohol consumption, hypertension, diabetes and obesity



### Predictors of physical HRQoL (PCS) trajectory

#### Economic factors

Table 2 shows lower area-level socioeconomic status (SEIFA-IRSAD) was associated with a 10%-11% higher likelihood of being in the stable low or decline PCS trajectory than the high stable. No paid work and no voluntary work were associated with up to 142% higher likelihood of being in the stable low PCS trajectory. However, no voluntary work was also associated with a 40% higher likelihood of being in the declining PCS trajectory. In contrast, no paid work was associated with a 54% higher risk of being in the intermediate rather than the high stable PCS trajectory. Lower income was only associated with a 35% higher likelihood of being in the declining PCS trajectory.

#### Social health

Table 2 also shows that loneliness was associated with a 64% higher likelihood of being in the stable low compared to the high stable PCS trajectory. None of the other social health measures was associated with the trajectory of PCS.

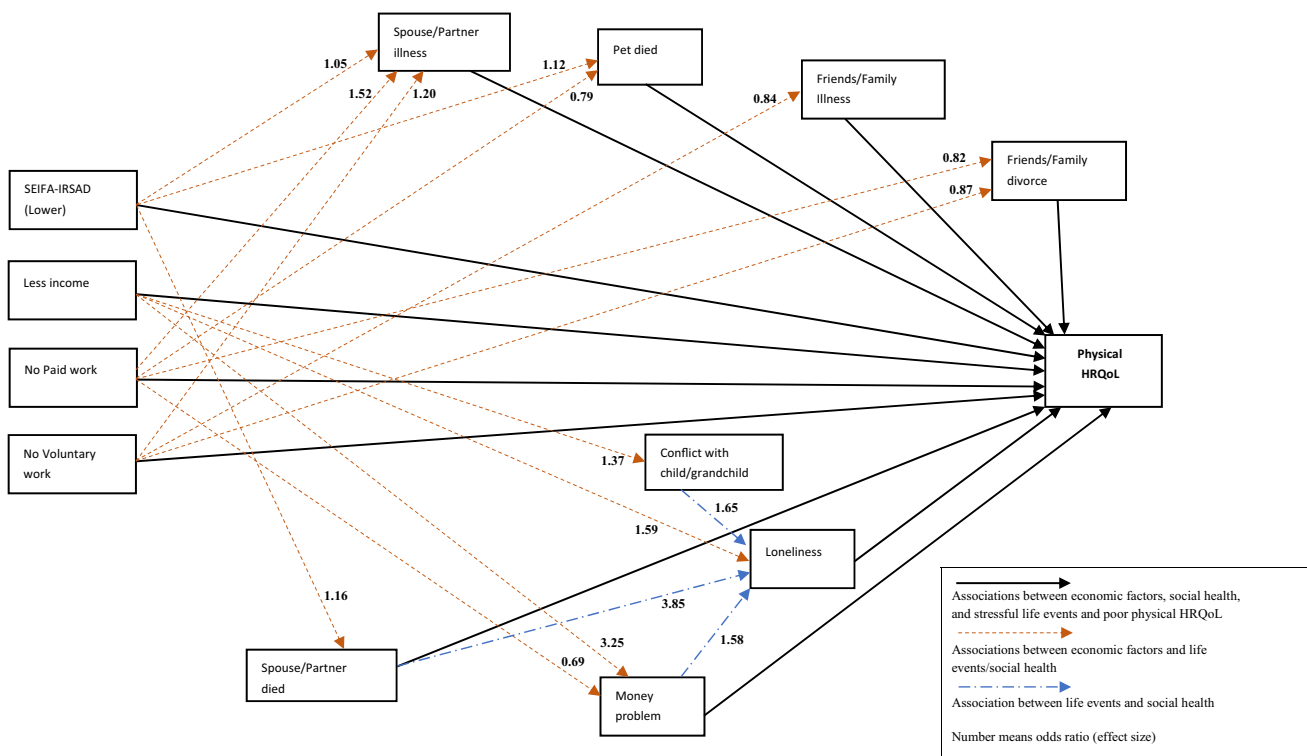
### Stressful life events

Among the stressful life events, the only two conditions associated with a higher likelihood of being either in the decline or stable low PCS trajectories were money problems (up to 2.52 times higher) and friends/family illness (up to 45% higher; Table 2). Additionally, experiencing spousal/partner illness and death of a pet were associated with 38% to 49% higher likelihood of being in a stable low PCS trajectory. Further, experiencing a spousal/partner death was associated with a 52% decreased risk of being in a stable low PCS trajectory.

### Mediating factors

Most economic factors had an indirect effect on the PCS trajectory, either through loneliness and/or stressful life events (especially spousal/partner illness) (Fig. 3 and Supplementary Tables S3–S5).

Spousal death, money problems and conflict with children or grandchildren were additional mediating factors between economic variables and the PCS trajectory. Moreover, the relationship between these three stressful life events and the PCS trajectory was mediated by loneliness, either totally



**Fig. 3** Associations between economic factors, social health, stressful life events and physical health-related quality of life trajectory class membership. *Physical HRQoL* physical health-related quality of life,

*SEIFA-IRSAD* Socio-Economic Indexes for Areas- Index of Relative Socioeconomic Advantage and Disadvantage

(conflict with child or grandchild) or partially (spousal death, spousal/partner illness and money problem).

The other four stressful life events associated with the PCS trajectory (i.e. spousal/partner illness, illness of friends/family, divorce of friends/family, death of a pet) had only direct effects on the outcome.

### Sensitivity analyses

The observed associations were consistent with the main findings when income was used as a continuous variable (Supplementary Table S6) and after excluding individuals who died over the study follow-up (Supplementary Table S7). Moreover, the inclusion of CES-D-9 as an additional covariate in the final model decreased the effect size of some associations (specifically loneliness, spousal/partner illness and friends/family divorce) (Supplementary Table S8).

## Discussion

This study identified different trajectories of physical HRQoL in a large community-based sample of relatively ‘healthy’ older Australians. Two thirds of the cohort maintained high physical HRQoL levels over the six years of the study. Nonetheless, almost two out of ten older individuals had a persistently low or declining physical HRQoL. These adverse physical HRQoL trajectories were more likely among individuals recently affected by economic, social or stressful life events, especially not undertaking paid work, money problems, loneliness and illness of family/friends. Conversely, voluntary work was an activity practised by 43% of older adults in this cohorts that seemed to prevent physical HRQoL decline.

The present study identified that not undertaking paid work and money problems were the two variables with the biggest impact on adverse physical HRQoL trajectories in older people. Our finding substantiates the evidence of previous studies showing that employment and financial security play an essential role in maintaining older individuals’ overall quality of life (QoL) [41–44]. Further, our mediation analysis found that these relationships were mainly mediated through loneliness or some life events such as spousal/partner illness, which adds a new finding to the existing literature [41–44]. Moreover, our longitudinal study showed that low income or living in a more disadvantaged area predicted an increased risk of physical HRQoL decline over time. This finding also aligns with previous cross-sectional studies concluding that lower socioeconomic status is associated with poor physical HRQoL in older people [20, 22]. In addition to individual indicators of economic status, an Australian survey revealed that macro-economic indicators

of relative socioeconomic disadvantage are also associated with physical HRQoL [21]. Therefore, our research, together with previous literature, highlight that higher economic status is advantageous for maintaining better physical HRQoL in older people.

In addition, we observed that people undertaking volunteer work were more likely to maintain a high physical HRQoL over time. This is supported by existing literature showing that engagement in volunteering can promote overall wellbeing [42, 45]. A potential mechanism linking volunteering with better QoL may be related to proactive behavioural adaptations and increased social engagement which can complement and may foster self-efficacy, thereby contributing to having a sense of purpose and maintaining better QoL [46]. Most studies, however, mainly explored the impact of volunteering on overall quality of life or psychological wellbeing [45, 46]. Therefore, our observation demonstrating an association with physical HRQoL specifically, adds novel evidence to the field. Interestingly, we also found that this relationship is mainly mediated by spousal/partner illness. This finding reflects the situation where individuals providing informal care for their chronically ill spouse/partner might experience limited time for themselves and to engage socially [47].

In terms of social health characteristics, our study demonstrated that loneliness was the only variable predicting persistent low physical HRQoL. Our loneliness finding is in line with previous cross-sectional studies using the SF-12 PCS measure in community-dwelling people aged  $\geq 70$  years living in six European countries [48, 49]. They also found that having emotional and social loneliness was associated with a lower physical HRQoL [48, 49]. The potential mechanism linking loneliness with physical HRQoL could involve biological pathways such as diminished immunity, neuroendocrine dysregulation and reduced levels of protective hormones [50]. In particular, loneliness is strongly associated with poor quality of sleep which may have effects on immune, cardiovascular, endocrine and nervous systems. This in turn, could impact general wellbeing and physical health [50]. Furthermore, we observed loneliness as a strong mediator of the associations between money problems, low income or not undertaking paid work and physical HRQoL. This finding reflects the existing literature showing the link between economic factors and social health among older individuals, for example, individuals with financial difficulties are less likely to be able to participate in society [51].

Previous studies reported conflicting findings regarding social support/relationship and physical HRQoL in older people [52–54]. In our study, we also found no evidence of associations between either social isolation or social support and physical HRQoL, however the magnitudes of the odds ratios indicate a potential effect. Hence, these null associations could be possibly due to the low prevalence



(i.e. less than 5%) of social isolation and lack of social support in our relatively healthy sample, affecting study power. Further research in population with greater social isolation and social support variability is needed to investigate this association.

We provide additional evidence that stressful life events, particularly spousal/partner and friends/family illness, were associated with the risk of being either in the decline or stable low physical HRQoL trajectory. This finding aligns with a recent qualitative Swedish study that found individuals living with a chronically ill spouse/partner were physically exhausted [47]. Further, another noteworthy finding is that spousal/partner illness was the most common mediator of the associations between economic characteristics and physical HRQoL trajectories. These findings may be expected given that managing the chronic illness of a family member imposes an economic impact and usually requires the provision of informal care, creating a ripple effect on the wellbeing of caregivers and family members [55, 56]. In some cases, families are even required to move to less expensive areas to balance the out-of-pocket costs of looking after a chronically ill family member, increasing the impact on QoL [55, 57].

Interestingly, we also found that experiencing a spousal/partner death was associated with a decreased risk of poor physical HRQoL. This contrasts with prior findings, which show that spousal loss is one of the most stressful life events that affect everyday life [58] and is strongly associated with physical health impairment and mental disorder among recently bereaved spouses [59]. However, the extent to which spousal loss affects the physical wellbeing of widowed persons may vary based on the time after the loss and the burden associated with caring for a chronically ill spouse before death [60]. For example, a study with 1402 Swedish older people aged  $\geq 60$  years found that losing a spouse has only a small negative impact on life satisfaction, and this relationship reduced over time [61]. So, individuals may learn healthy coping skills or pursue a volunteer role to promote or resume their social interaction and physical activity after recovering from spousal loss [62].

## Implications

Our findings highlight that cross-sectoral policies through grassroots approaches are required to emphasize economic autonomy, social support networks and coping skills in order to support the physical wellbeing of older people. This suggestion also aligns with the Australian Government's existing social services for older people including age pension, work bonus (i.e. opportunities to receive financial benefits from both work and age pension), seniors card scheme (i.e. offering transport concession to stay connected), free access

to broadband internet and personalized mentoring for digital literacy, etc. [63]. Perhaps these existing social services in Australia reflect our results showing most older Australians maintained good physical HRQoL over time. Moreover, within this study, we found a positive impact of volunteer work on the physical wellbeing of older people. Therefore, volunteering programmes could perhaps be considered further as an external social activity which might help reduce the risk of loneliness [51]. Further, our study also identified that experiencing spousal/partner death had the highest risk of loneliness, highlighting the need for intervention.

The current COVID-19 pandemic presents challenges for social interventions such as volunteering, particularly as physical distancing is one of the optimal protective practices to slow the spread of infection [64]. Hence, further innovative technology-based interventions are required, that can increase social interactions through online forums and activities [65].

## Strengths

To the best of our knowledge, our study is the first and largest study exploring the physical HRQoL trajectories in a large cohort of community-dwelling older people with good representation of across the socioeconomic spectrum [28]. Moreover, considering that each life event has its unique effect and severity, our study explored how each of ten adverse life events during the past year rather than the summarized scores predicts the physical HRQoL trajectory. Additionally, we used multi-faceted rather than one-dimensional definitions of social isolation and social support (e.g. exclusively focusing on social network size as social isolation).

## Limitations

This study has some limitations. Given that ALSOP recruited relatively 'healthy' Australian participants mainly through general practices [25], our study sample was not intended to be representative of all Australian older people. However, our sample includes an approximately equal proportion of men and women, from non-institutionalized settings and, fortunately has a diversity in socioeconomic background. Therefore, despite not being representative, it includes good diversity and the results can be extrapolated to healthy older adults who are increasingly being seen in the primary healthcare setting [28]. Moreover, given that a combination of both direct single-item and indirect multi-item scale of loneliness is required to cover a comprehensive picture of loneliness [66, 67], we acknowledged that our single-item loneliness scale and our definition based on 'feeling lonely for  $\geq 3$  of past 7 days' was not optimal. However, the single-item

loneliness scale has been acknowledged as valid and seems to be more appropriate for older people [66–68]. Furthermore, social health variables and six of ten stressful life events investigated in this study had a prevalence lower than 10%, affecting the power of the study to investigate these associations. Nonetheless, the sample was large enough to demonstrate that factors even with relatively low frequency, such as loneliness (5.0%) or money problems (4.1%), had an adverse impact on the physical HRQoL trajectories. Additionally, our determinants were mainly measured by using the self-reports which are inherently biased by the individual's feeling at the time of survey completion. For example, individuals who thought their health was poorer, would respond more negative (i.e. loneliness in this study), which may result in our investigated associations being stronger than they truly are. However, the nature of other determinants such as economic factors and life events are not largely related to personal perception, and social isolation and social support were assessed using the validated LSNS-R tool [33] to minimize the self-report bias. Finally, we acknowledge the limitation that only 75% of the total Australian ASPREE participants were included in this analysis. However, between included and excluded participants, we generally observed statistically significant differences with small effect sizes for demographic characteristics (Supplementary Table S9). The main difference was for education as included participants being more highly educated (51.8% had  $\geq 12$  years) than excluded participants (43.4%,  $p$  value  $< 0.001$ ).

## Conclusion

Our study followed longitudinal changes in the physical HRQoL of older individuals for six years and identified that most older adults maintain their good physical HRQoL over time, although some experience a persistently low or declining physical HRQoL. Older individuals who experience economic burden, loneliness or stressful life events are more likely to experience an adverse physical HRQoL trajectory. Additionally, this study also supports prior evidence that provision of volunteering work programmes for older people living in the community may prevent further physical HRQoL decline, reduce age-related healthcare burdens and benefit society. Further research is needed to explore which kinds of voluntary work have the greatest positive impact on physical HRQoL.

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**Author contributions** RLW designed and conceptualized the ASPREE study. NPS provided major role in the health-related quality of life component of ASPREE study. SAW, CJB and AJO provided major roles in the acquisition of ALSOP data. RFP and JR conceived the current study. AZZP had full access to all the data in the study and analysed the data. AZZP, RFP and JR interpreted the data, with input from DAGC, JF, TT and AJO. AZZP wrote the initial manuscript draft and undertook revisions. All authors provided critical comments and approved the final version.

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**Data availability** All individual participant data (re-identifiable) that underlie the results reported in this manuscript, are available upon request to qualified researchers without limit of time, subject to approval of the analyses by the Principal Investigators and a standard data sharing agreement. Details regarding requests to access the data will be available through the web site ([www.ASPREE.org](http://www.ASPREE.org)). The data will then be made available through a web-based data portal safe haven at Monash University, Australia.

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** ASPREE (ASpirin in Reducing Events in the Elderly) trial and ALSOP (ASPREE Longitudinal Study of Older Persons) sub-study are being conducted in accordance with the Declaration of Helsinki 1964 as revised in 2008, the NHMRC Guidelines on Human Experimentation, the federal patient privacy (HIPAA) law and ICH-GCP guidelines and the International Conference of Harmonization Guidelines for Good Clinical Practice. ASPREE and ALSOP also follow the Code of Federal Regulations as it relates to areas of clinical research. The overall management and conduct of the ASPREE clinical trial and ALSOP sub-study are the responsibility of the ASPREE and ALSOP Steering Committee. The data of the present secondary data-analysis study were from a 5-year ASPREE clinical trial and ALSOP sub-study [Trial Registration: International Standard Randomized Controlled Trial Number Register (ISRCTN 83772183) and [clinicaltrials.gov](http://clinicaltrials.gov)].

gov (NCT 01038583)]. The current secondary data analysis has been approved by the Monash University Human Research Ethics Committee (Project ID: 21714) and ALSOP received ethics approval from this committee (Social ALSOP: CF11/1935–2011001094). The ASPREE trial was approved by multiple Institutional Review Boards in Australia and the U.S. ([www.aspree.org](http://www.aspree.org)).

**Informed consent** This study used data from a five-year ASPREE (ASpirin in Reducing Events in the Elderly) clinical trial and ALSOP sub-study (Trial Registration: International Standard Randomized Controlled Trial Number Register (ISRCTN 83772183) and [clinicaltrials.gov](https://clinicaltrials.gov) (NCT 01038583)). All individual participants of the ASPREE clinical trial and ALSOP sub-study signed informed consent on participation.

**Research involving human participants** ASPREE and ALSOP are being conducted in accordance with the Declaration of Helsinki 1964 as revised in 2008, the NHMRC Guidelines on Human Experimentation, the federal patient privacy (HIPAA) law and ICH-GCP guidelines and the International Conference of Harmonization Guidelines for Good Clinical Practice. ASPREE and ALSOP also follow the Code of Federal Regulations as it relates to areas of clinical research. The overall management and conduct of the ASPREE clinical trial and ALSOP sub-study are the responsibilities of the ASPREE and ALSOP Steering Committee ([www.aspree.org](http://www.aspree.org)).

**Consent to participate** This study used data from a five-year ASPREE (ASpirin in Reducing Events in the Elderly) clinical trial and ALSOP sub-study [Trial Registration: International Standard Randomized Controlled Trial Number Register (ISRCTN 83772183) and [clinicaltrials.gov](https://clinicaltrials.gov) (NCT 01038583)]. All individual participants of the ASPREE clinical trial and ALSOP sub-study signed informed consent on participation.

**Consent for publication** All authors gave their approval for submission.

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