The relationship between SF-6D utility scores and lifestyle factors across three life-stages: Evidence from the Australian Longitudinal Study on Women's Health

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Abstract

Purpose: To investigate how SF-6D utility scores change with age between generations of women, and to quantify the relationship of SF-6D with lifestyle factors across life-stages.

Methods: Up to seven waves of self-reported, longitudinal data were drawn for the 1973-78 (young, N=13772), 1946-51 (mid-age, N=12792), 1921-26 (older, N=9972) cohorts from the Australian Longitudinal Study on Women's Health. Mixed effects models were employed for analysis.

Results: Young and mid-age women had similar average SF-6D scores at baseline (0.63-0.64), which remained consistent over 16 year period. However, older women had lower scores at baseline at 0.57 which steadily declined over 15 years. Across cohorts, low education attainment, greater difficulty in managing on income, obesity, physical inactivity, heavy smoking, non-drinking and increasing stress levels were associated with lower SF-6D scores. The magnitude of effect varied between cohorts. SF-6D scores were lower amongst young women with high risk drinking behaviours than low-risk drinkers. Mid-age women who were underweight, never married, or underwent surgical menopause also reported lower SF-6D scores. Older women who lived in remote areas, who were ex-smokers, or were underweight reported lower SF-6D scores.

Conclusion: The SF-6D utility score is sensitive to differences in lifestyle factors across adult life-stages. Gradual loss of physical functioning may explain the steady decline in health for older women. Key factors associated with SF-6D include physical activity, body mass index, menopause status, smoking, alcohol use and stress. Factors associated with poorer SF-6D scores vary in type and magnitude at different life stages.

Introduction

Health related quality of life (HRQoL) is a subjective, multi-dimensional construct which measures the impact of health on quality of life [1]. HRQoL encapsulates multiple dimensions including physical function, psychological health and social well-being, consistent with the WHO definition of health [2]. Generic HRQoL measures such as the SF-36 [3] are typically used in research settings to quantify the HRQoL of a population, and impact of risk factors on the health and wellbeing of the population [1]. HRQoL measures are also useful in a health policy setting to inform health care spending and in economic evaluations of health interventions. Generic preference-weighted measures of HRQoL (PW_HRQoL) such as the SF-6D [4] and EQ-5D [5] generate utility scores which can be used as a measure of population health, and to calculate quality adjusted life years (QALYs) for economic evaluations [6].

The SF-6D is derived from the SF-36[4]. Lower SF-6D utility scores represent poorer health which is associated with increased health service utilization and expenditure [7]. Hence, identifying subgroups with lower SF-6D scores is needed to improve health resource allocation and better target health promotion activities and interventions. Evidence on the association between SF-6D and demographic and lifestyle factors has been mainly limited to cross-sectional study designs [8-10,6,11,12], or samples drawn from populations with specific health conditions. Australian population norms for the SF-6D derived from the SF-36v1, suggest that lower SF-6D scores are associated with being female, lower education attainment, and higher levels of socioeconomic disadvantage [12]. SF-6D scores generally decline with age, and have an inverse 'J' shaped association with body mass index (BMI), that is, compared to those with acceptable BMI levels, mean SF-6D scores are generally lower for those overweight and underweight and lowest for those obese. These findings are consistent with other Australian and international studies using community samples [8-10,6], although one study found no difference in SF-6D scores by income [13], while another found that those aged 60 years or older had higher SF-6D scores compared to those aged 40-59 years [11]. Other cross-sectional studies have found that that those widowed [8,9], smokers [11], and those with health problems that affect work [9] have lower SF-6D scores. The relationship between alcohol consumption and SF-6D scores remains unclear [11,14,15].

Research using longitudinal data is needed to examine how SF-6D scores change over the life-course. Current evidence for the SF-6D from longitudinal studies from community settings are mixed and is limited to exploring the relationship between SF-6D and age [16] and BMI[17]. There is a need for gender specific SF-6D trends given that cross-sectional research has shown men have higher SF-6D scores on average than women [8-10,6,12]. It is unknown whether women at different life stages

have similar SF-6D scores, or how these scores change over time, between generations of women. Information on common lifestyle factors associated with poor health across different life-stages (measured using the SF-6D) are needed to better target health promotion activities and interventions strategies. This research aims to address these gaps using data from three generations of women from the Australian Longitudinal Study on Women's Health.

Methods

Study population

The Australian Longitudinal Study on Women's Health (ALSWH) is a prospective population based study measuring the health and wellbeing of over 40,000 Australian women, since 1996 [18]. The sampling frame was all women in selected age ranges (18-23, 45-50, 70-75), from Australian Medicare database, the universal health insurance scheme that includes all Australian citizens and permanent residents. Women were randomly selected from Australian Medicare into three cohorts, based on their age in 1996: 1973-78 or 'young' cohort (aged 18-23 at baseline, n=14247, response rate=41-42%), 1946 -51 or 'mid-age' cohort (aged 45-50 at baseline, n=13715, response rate=53-56%) and 1921-26 or 'older' cohort (aged 70-75 at baseline, n=12432, response rate=37-40%). Women from rural and remote regions were oversampled to capture the heterogeneity of health and wellbeing of women living outside urban areas. Data were collected every two to three years from participants or proxies, using online or mailed questionnaires. Women in aged-care facilities were still able to receive surveys. Informed consent was obtained prior to participation. Full details of the study methodology, sample recruitment and retention are available in the data supplement and elsewhere [18] .

Participants

For this analysis, data was drawn from six surveys for the 1973-78, and 1921-26 cohorts (from 1996 to 2012 and 1996 to 2011 respectively), and seven surveys for the 1946-51 cohort (from 1996 to 2013). At each survey, those who completed the eleven SF-36v1 items used to calculate the SF-6D utility score were included in the analysis (Table 1).

Demographic and lifestyle factors

Demographic and lifestyle factors were selected based on identified existing relationships with SF-6D utility scores in the literature. Other factors thought to influence the SF-6D (country of birth, physical activity, menopause status and stress) were included to identify possible new relationships.

Demographic factors used in this research include area of residence (major cities of Australia; regional Australia; remote Australia) [19], country of birth (Australian born; Asia; Europe; Other English speaking background (ESB); Other) [20], participants' highest education attainment (no formal qualification; Year 10/ Year 12; trade/ diploma; university degree or higher), marital status (partnered; separated/ divorced; widowed; never married), paid employment status (employed, paid; employed, not paid; unemployed) and ability to manage on income (impossible/difficult always; difficult sometimes; not too bad; easy).

Lifestyle factors include body mass index, derived from self-reported height and weight: underweight (BMI < 18.5 kg/m^2), acceptable weight (BMI 18.5 - <25), overweight (BMI 25 - < 30), and obese (BMI 30 or more) [21]; level of physical activity (none/sedentary; low; moderate; high) [22], alcohol drinking patterns (non-drinker, rarely drinks, low risk drinker, risky drinker; high risk drinker) [23]; smoking status (never smoked, ex-smoker, smokes < 10 cigarettes per day, 10-19 cigarettes per day, ≥ 20 cigarettes per day) [24]; caring for someone at home (yes; no); menopause status (for 1946-51 cohort only: surgical menopause; hormone use; pre-menopausal; peri-menopausal; post-menopausal) [25]. Mean stress was measured as a continuous variable, ranged from 0, representing 'Not stressed' to 4, representing 'Extremely stressed' [26].

Deriving SF-6D health utility scores from SF-36v1

Eleven items from six dimensions of the SF-36v1 [3] were used to calculate the SF-6D utility score [4] using Australian SF-6D (SF-36) scoring algorithm [27]. The SF-6D algorithm assigns a utility score to each health state described by the SF-36 on a preference-based scale where 0 represents a health state equivalent to being dead and 1 represents full health. Australian SF-6D scores range from -0.363 to 1, where negative health utilities score represent health states deemed worse than death [27]. A difference of at least 0.03 in SF-6D scores is deemed important (Minimally important difference or MID) [28]. Mean differences in SF-6D scores were categorised: 'small', less than 0.03; 'modest', 0.03 to <0.05; 'moderate', 0.05 to <0.10; and 'large', 0.10 and above [29].

Statistical Analysis

All analyses were conducted separately for each cohort, using SAS 9.4. Descriptive statistic for the SF-6D score (mean, SD) at each survey were tabulated. Ceiling and floor effects for the SF-6D score were quantified using the proportion of participants at each survey who reported "full health" (SF-6D score of 1) and "pits" (SF-6D = -0.363) respectively. The proportion of participants reporting disability in each SF-6D dimension were calculated.

Linear mixed-effects models with random intercepts and were used in all regression analyses to account for the correlated nature of repeated observations within individuals [30]. These models also handle item non-response using maximum likelihood methods (assuming missing at random) by implicitly imputing a value for missing responses based on the values of other responses and modelled correlation structure [31,32]. Unstructured variance-covariance matrix allowed each variance and covariance to be estimated uniquely from the data resulting in the best possible model fit. In all models, age at baseline was mean centred to meaningfully interpret the model intercept. Non-linear relationship between SF-6D and the time variable 'time from baseline' measured in three-yearly intervals, was assessed by including higher order polynomials in the models. While the

model Akaike information criterion (AIC) and Bayesian information criterion (BIC) suggested polynomials improved model fit slightly, there was little net benefit in fitting these models as it complicated model interpretation. 'Time from baseline' was fitted as a linear variable in all regression analyses.

SF-6D trends for Figure 1 were produced by fitting SF-6D scores against age at baseline and 'time from baseline' (Model 1). The association between SF-6D and each demographic and lifestyle variable, adjusted for age at baseline and 'time from baseline' was quantified (Model 2, data not shown). As stress was strongly associated with SF-6D as well as other lifestyle characteristics, the models were adjusted for all demographic and lifestyle variables of interest, excluding stress (Model 3, data not shown), and including stress (Model 4). AICs and BICs were used to compare the goodness of fit of model 3 and model 4 (Supplementary Table 2). Type 3 F-tests were used to statistically assess the significance of each demographic and lifestyle variable, assuming that all other variables in the model equation are present (see Supplementary Table 3).

Regression model equations

$$\mathrm{SF-6D} \sim \mathrm{Intercept} + \text{ age at baseline } + \text{ time from baseline } (\mathbf{Model\ 1})$$

$$\mathrm{SF-6D} \sim \mathbf{Model\ 1} + Demographic\ or\ Lifestyle\ \ variable^{a,b,c}\ (\mathbf{Model\ 2})$$

$$\mathrm{SF-6D} \sim \mathbf{Model\ 1} + Area\ of\ residence + Country\ of\ birth + Marital\ status + Education + Employment\ status^{b} + Ability\ to\ manage\ on\ income + BMI + Physical\ activity + Smoking\ status + Alcohol\ use + Menopause\ status^{c}\ (\mathbf{Model\ 3})$$

$$\mathrm{SF-6D} \sim \mathbf{Model\ 3} + Stress\ (\mathbf{Model\ 4})$$

Note:

a. One demographic or lifestyle variable was added to the regression model
b. Employment status was included in regression analysis for the 1973-78 and 1946-51 cohorts only
c. Menopause status was included in regression analysis for the 1946-51 cohorts only

Treatment of missing data and sensitivity analysis

There were two datasets used in this research: The original data (main results) and the imputed data (sensitivity analysis).

Data on some demographic and lifestyle variables were not routinely collected at each wave (see Data Supplement Table 1). The main regression analysis (Model 1 to 4) was carried out on the original data, where survey items not asked were set to missing. The results for these analysis are presented in Table 2 and Figure 1.

Sensitivity analysis

The main analysis used fewer surveys as complete missing data in one variable for a particular survey will result in all other information for that survey being dropped in the model estimation process. Hence, to maximize the number of surveys included in the model, data routinely not collected were imputed by carrying forward or backward participant's data from prior or subsequent surveys (see Data Supplement Table 1). Models 1 to 4 were repeated on the imputed data to determine whether regression results from the imputed data would be similar to the original data. Results from the sensitivity analysis were similar to the original data, hence only regression results from the original data were presented in the manuscript.

Results

SF-6D scores ranged from -0.363 to 1 in all three cohorts (Table 1). Across all cohorts, less than 1% of women at each survey scored "perfect health" (SF-6D score of 1), and less than 0.01% of women scored "pits" (SF-6D = -0.363) suggesting no substantial ceiling or floor effect in SF-6D scoring. Women reported increasing problems with physical functioning as they aged but for mental health, problems declined with age. Women reported more problems with their vitality than any other health dimensions of the SF-6D.

Young and mid-age women reported similar and consistent mean SF-6D trends as they aged (between 0.63 and 0.64), over a 16 to 17 year period (Figure 1). The mean SF-6D scores were markedly lower at baseline (at 0.566) for older women compared with young and mid-age women. For older women, SF-6D scores declined by 0.03 (meeting the MID threshold of 0.03) every three years, over a 15 year period. Participant demographic, socioeconomic, health and lifestyle characteristics at baseline are presented in Supplementary Table 1.

Common factors across cohorts that met the Minimum Important Difference threshold of 0.03

Across all cohorts, women who found it 'difficult always/impossible' to manage on income (vs easy), were obese (vs 'acceptable' weight), had sedentary or low levels of physical activity (vs high), smoked at least 20 cigarettes a day (vs never smoked), were non-drinkers (vs low risk drinkers) or experienced stress reported lower mean SF-6D scores (Table 2, Model 4). The magnitude of these differences varied between cohorts. Underweight (vs 'acceptable' weight) or moderately physically active (vs high) mid-age or older women reported lower SF-6D scores than women of similar age. Low education attainment (vs university degree or higher) was associated with lower mean SF-6D scores, notably amongst young and mid-age women. Model 3 and 4 Goodness of Fit and Model 4 Type 3 tests results are presented at Supplementary Table 2 and 3.

Factors specific to each cohort

Young women with high risk drinking behaviours reported lower SF-6D scores than low risk drinkers (Table 2, Model 4). Mid-age women who never married (vs in a relationship), underwent surgical menopause (vs post-menopause), were unemployed or in unpaid employment (vs paid employment) also had lower SF-6D scores. In the older cohort, living in remote areas (vs major cities), finding it 'difficult sometimes' to manage income (vs easy), smoking 10-19 cigarettes per day or being an ex-smoker (vs never smoked) were all factors associated with lower SF-6D scores.

Sensitivity analysis

Results from the sensitivity analysis using the imputed data showed that regression point estimates were similar to the original data across all three cohorts (data not shown).

Discussion

This is the first study to quantify the relationship of SF-6D with age and identify key lifestyle factors associated with poorer SF-6D scores for women at different life-stages. Difficulty in ability to manage on income, stress, physical inactivity, non-drinker status, smoking and obesity were common modifiable lifestyle factors associated with lower mean SF-6D scores across the lifespan. However, the magnitude of these differences between cohorts can vary considerably. Being underweight, a high risk drinker and undergoing surgical menopause were factors associated with lower SF-6D scores specific to each cohort.

Young and mid-age women had similar average SF-6D scores, which remained consistent as they aged. These findings contrast Stewart et al. who reported a declining trend in SF-6D and EQ-5D utility scores for adults aged 18-69 [16]. Compared to young and mid-age women, older women had considerably lower scores at baseline which steadily declined with age which may be attributed to an age effect in physical functioning [33]. These trends are somewhat consistent with longitudinal results on SF-6D (SF-12) and EQ-5D from the US, where from middle age onwards, utility values in adults declined rapidly with age [16].There is general agreement that women have lower SF-6D utility scores on average compared to men [8-10,6,12]. Hence, while our SF-6D trends for women are generally similar to those from the US, the differences observed could be because Stewart et al. do not separate out utility trends by gender.

We found an inverse 'J' shape association between self-reported BMI and SF-6D utility scores, consistent across the life-stages, supported by other cross-sectional research on the SF-6D [12,15,10,11] and EQ-5D [34]. Conversely, Baxter et al. found no association between BMI and SF-6D in female Australian public service workers [14]. This may be due to differences in study design and population sampled (cross-sectional vs longitudinal, Australian public service workers vs Australian general population).

Lower SF-6D scores seen for underweight older women may be due to ageing, where eating less and weight loss are common [35] as is poorer quality of life due to increasing physical impairment, inactivity and frailty [36]. Lower physical activity was associated with poorer SF-6D utility scores in this research, supported by others [37,38,14]. Across the three life-stages, physically inactive women had markedly lower SF-6D scores than highly active women which had the greatest effect on the health of older women. Those in ill health may not be well enough to be physically active. Given the health risks associated with physical inactivity and being underweight later in life, where possible, older women should keep physically active which in turn may improve appetite [39].

We found a consistent dose-response relationship between smoking status, determined by number of cigarettes smoked, and lower SF-6D utility score across the three cohorts, which were supported by previous research on the SF-6D [11], EQ-5D [40] and HRQoL [41]. Although these findings contrast other studies [14,15], the differences observed may be due to differences in the number of levels used to classify smoking patterns. The smoking profiles associated with poorer women's health differ by life stage, hence health promotion strategies to target tobacco control should be tailored to each life stage.

There is general agreement on the protective effects of moderate alcohol consumption to cardiovascular health [42]. Conversely, a recent meta-analysis suggested no net benefit of moderate alcohol consumption compared to lifetime abstinence or occasional drinking [43]. While low to moderate alcohol consumption has been associated with better EQ-5D scores in the general population [44] and HRQoL in older women [45], findings for the SF-6D remain unclear [14,15]. In our study, low risk drinkers had the best health and non-drinkers reported the poorest health in all three cohorts, supporting finding from other EQ-5D research [44]. However, it is unclear whether non-drinkers in our research were lifetime abstainers or have not consumed alcohol for health reasons. Future work should consider differentiating between life time abstainers from non-drinkers due to health concerns, to examine the possible differential effect on SF-6D scores.

To date, there has been no research that has examined the association between SF-6D and menopause status or stress. Our findings suggest that compared to post-menopausal women, mid-age women who underwent surgical menopause had lower SF-6D scores. Unlike natural menopause which is a gradual transition, surgical menopause can lead to dramatic reduction in sex hormones, prolonged menopause symptoms, poorer adaptation to symptoms and result in loss of quality of life [46].

The negative effect of chronic stress on health and quality of life is well established [47]. In this study, increased stress was associated with poorer quality of life across the adult life-stages. The magnitude of effect was largest for older women compared with young and mid-age women. Young, mid-age and older women face different challenges which can result in stress. While we are unable to determine whether the stress experienced by these women was 'chronic', the demonstrated large effect of stress on health of women across the lifespan suggests that health promotion strategies to manage or reduce stress is recommended [47].

These findings should not be interpreted as QALYs as mortality information was excluded in these analyses. Instead, our longitudinal findings on patterns of SF-6D score with age could be used as a reference case in economic evaluations. These age and gender specific findings could be used in

health assessment studies where utility score is unavailable. This is likely to be a more appropriate prediction of the health and health trajectory of Australian women, supported by the low ceiling effect of the SF-6D in this research. This may be preferred to assigning 'full health' status to women post intervention or to those without the condition of interest, given that the majority of women may not reach 'full health' status due to ageing and other factors [12].

Strengths and limitations of study

A key strength of this study is that we have used large longitudinal data from three cohorts of women, each at different life stages, followed-up for almost 20 years. Hence, we are able to examine utility patterns with age and how modifiable lifestyle factors may be associated with health differently, at different life stages. The final model (Model 4) showed better goodness of fit than Model 3, across all three cohorts. While we have used self-reported height and weight to calculate BMI, previous ALSWH research have demonstrated acceptable agreement (Kappa = 0.81) between BMI categories derived from self-report and measured data [48]. We have included responses from proxies which are more common in the 1921-26 cohort (roughly 16% of responders at survey 6), compared to the other two cohorts (≤ 1% of young and mid-age responders at survey 6). Reasons for proxy responses include illiteracy, language barriers, time constraints, existing health conditions and disabilities.

Sample size changes over 15-17 year period for each cohort are primarily driven by participant attrition [18]. In the 1921-26 cohort, those lost to follow-up may not be able to respond due to increasing frailty, cognitive decline, or death (60% died as of 2015) [18]. This may result in an over-estimation of reported mean SF-6D scores, and under-estimation of the magnitude of decline seen for older women. Hence, our findings for older women may only be generalizable to healthy older women. In the 1973-78 cohort, non-response may be due to the highly mobile nature of young women. However, prior research suggests no serious bias in results from longitudinal analyses between risk factors and health outcomes in this cohort [49]. Retention rates for the 1946-51 cohort was 83% at survey 6, and non-response mainly due to being unable to contact participants.

ALSWH participants across all cohorts are generally representative of the Australian population (assessed using the five-yearly Australian Census), but at baseline, were more likely to be higher educated, Australian, or immigrants from English speaking countries compared to the general population[18]. At survey 6, there was over-representation of university educated women and under-representation of immigrants from non-English speaking countries, particularly in the 1973-78 cohort, when compared to the general population. Most of the participants were of Caucasian descent, hence these findings may only be generalizable to Caucasian populations.

We have used the SF-6D scoring algorithm to derive utilities from women's responses to the SF-36v1, which is a standard, validated measure of quality of life [3]. The Australian valuation method of SF-6D used has low ceiling or floor effects compared to other valuation methods [27]. While attrition may affect the measurement of the SF-6D, skewing score distributions toward healthy ranges, the differences in the valuation of Australian and 2002 UK SF-6D algorithms [27] may largely contribute to differences observed in the SF-6D utility score range, floor and ceiling effects, when compared with other research. Methodology used in the Australian valuation of the SF-6D is limited in that there was an overrepresentation of middle age adults, and under-representation of those aged ≥ 60 years relative to the Australian population [27]. Hence, the SF-6D preference weights derived may not fully reflect the opinions of these age groups. However, our data does show a sharper decline in SF-6D trends with age, for ages 70+ which is in agreement with SF-6D(SF-12) longitudinal findings [16].

Overall, the average SF-6D utility scores for women in this study were lower in general by age, education and BMI, compared to the Australian SF-6D population norm results for women [12]. However since UK preference weights were used to estimate the Australian SF-6D population norms [12], it is uncertain how comparable these utility scores will be with our data, which used Australian preference weights. Regardless, our results are similar to those seen elsewhere, and are strengthened by using Australian preference weights. As the MID in the Australian context has not been established, we have used MID threshold of 0.03, derived from studies which use UK SF-6D algorithms. Further work is required to determine the MID threshold for Australian general population and patient samples, using the Australian algorithm. Australian population norms for the SF-6D, updated using Australian preference weights are needed to facilitate direct comparisons with other Australian studies.

Conclusion

We present evidence supporting a relationship between SF-6D utility score and smoking, physical activity, body mass index, alcohol consumption, menopause status, and stress for women at different life stages. Insights gained on these key factors could be used to tailor health services and interventions to the differing needs of specific age groups.

Ethical approval: This research was approved by the University of Newcastle (H-076-0795 and H-2012-0256) and The University of Queensland human ethics committees (2004000224 and 2012000950). All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Tables and Figures

Table 1 SF-6D descriptive statistics and percentage of respondents reporting any problem in each dimension by cohort and survey

Cohort	1973-78 cohort						1946-51 cohort							1921-26 cohort					
Survey	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**	**6**
Year surveyed	**1996**	**2000**	**2003**	**2006**	**2009**	**2012**	**1996**	**1998**	**2001**	**2004**	**2007**	**2010**	**2013**	**1996**	**1999**	**2002**	**2005**	**2008**	**2011**
Years from baseline	**0**	**4**	**7**	**10**	**13**	**16**	**0**	**2**	**5**	**8**	**11**	**14**	**17**	**0**	**3**	**6**	**9**	**12**	**15**
Total, N	13772	9197	8819	9006	8090	7906	12792	11624	10591	10158	10148	9579	8797	9972	8996	6347	5565	4297	3084
Mean Age	20.7	24.6	27.6	30.6	33.7	36.7	47.6	49.5	52.5	55.5	58.5	61.5	64.8	72.5	75.3	78.2	81.2	84.2	87.1
SF-6D Score																			
Mean	0.633	0.640	0.650	0.658	0.658	0.653	0.641	0.639	0.624	0.625	0.630	0.623	0.625	0.566	0.576	0.538	0.497	0.466	0.431
SD	0.214	0.215	0.217	0.214	0.215	0.218	0.235	0.244	0.243	0.243	0.243	0.243	0.235	0.269	0.269	0.269	0.274	0.273	0.268
Median	0.666	0.685	0.688	0.693	0.694	0.693	0.692	0.692	0.687	0.687	0.692	0.687	0.687	0.609	0.617	0.563	0.519	0.486	0.447
Minimum	-0.352	-0.209	-0.352	-0.262	-0.252	-0.336	-0.363	-0.352	-0.342	-0.347	-0.363	-0.363	-0.258	-0.363	-0.363	-0.363	-0.363	-0.363	-0.363
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Ceiling effect, %	0.5	0.3	0.3	0.4	0.3	0.4	0.7	0.9	0.5	0.6	0.8	0.7	0.8	0.5	0.8	0.4	0.3	0.2	0.2
Floor effect, %	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	0.0	0.0	0.0	<0.1	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Proportion with any problems in each SF-6D dimension																			
Physical functioning, %	56.1	49.8	49.5	49.6	52.5	51.5	69.4	74.9	81.4	84.1	83.9	86.5	87.8	96.1	93.8	95.6	96.8	97.4	97.8
Role limitation, %	43.2	39.0	37.0	36.6	36.5	34.2	36.0	36.6	36.6	37.0	35.5	36.5	36.1	51.9	52.0	59.7	66.6	71.9	75.7
Social functioning, %	56.5	54.3	50.8	49.4	44.4	46.9	41.9	41.6	41.7	41.1	39.6	39.4	39.2	39.8	37.1	44.4	50.1	53.1	56.3
Pain, %	75.7	75.5	75.1	77.5	78.3	83.3	77.5	76.3	81.0	82.6	83.1	85.2	86.2	78.8	76.3	82.1	84.4	85.2	86.9
Mental Health, %	92.4	91.0	87.8	84.8	83.8	83.0	82.4	79.2	78.5	76.4	74.3	72.5	70.6	71.0	66.1	66.0	67.3	69.0	69.8
Vitality, %	96.4	98.3	98.6	98.6	98.6	98.3	96.5	96.9	97.5	97.2	96.7	97.0	96.5	94.9	96.1	97.2	97.1	97.8	98.1

Table 2 Adjusted association between SF-6D and demographic, socioeconomic, and lifestyle characteristics in the 1973-78, 1946-51 and 1921-26 cohort: Linear mixed effect model results

	1973-78 cohort (N = 10416)					1946-51 cohort (N = 11009)					1921-26 cohort (N = 7105)				
	Est	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**
Intercept	0.889	0.005	0.879 to 0.899	<0.001		0.908	0.007	0.894 to 0.923	<0.001		0.834	0.008	0.818 to 0.851	<0.001	
Mean age at baseline	-0.001	0.001	-0.003 to 0.001	0.313		-0.003	0.001	-0.005 to -0.001	0.011		-0.011	0.002	-0.014 to -0.008	<0.001	
Time from baseline	-0.007	0.001	-0.009 to -0.005	<0.001		-0.004	0.001	-0.006 to -0.001	0.002		-0.032	0.001	-0.035 to -0.030	<0.001	
Area of residence															
Major cities			**Reference**					**Reference**					**Reference**		
Regional	0.006	0.003	0.001 to 0.011	0.022		-0.003	0.003	-0.01 to 0.004	0.402		0.007	0.005	-0.003 to 0.017	0.148	
Remote	0.016	0.007	0.003 to 0.030	0.019		0.016	0.008	0.001 to 0.03	0.039		0.043	0.018	0.007 to 0.078	0.020	†
Country of birth															
Australian born			**Reference**					**Reference**					**Reference**		
Asia	-0.010	0.011	-0.031 to 0.011	0.345		-0.026	0.011	-0.048 to -0.004	0.019		0.002	0.025	-0.047 to 0.050	0.948	
Europe	0.031	0.014	0.003 to 0.059	0.028	†	-0.023	0.007	-0.036 to -0.010	0.001		-0.001	0.010	-0.021 to 0.019	0.936	
Other	0.003	0.016	-0.028 to 0.035	0.831		-0.029	0.018	-0.065 to 0.007	0.115		0.020	0.033	-0.045 to 0.085	0.555	
Other ESB	0.015	0.007	0.001 to 0.029	0.043		0.001	0.005	-0.008 to 0.011	0.755		0.016	0.007	0.002 to 0.031	0.029	
Marital status															
Never Married	-0.012	0.003	-0.018 to -0.006	<0.001		-0.044	0.010	-0.065 to -0.024	<0.001	†	-0.019	0.015	-0.047 to 0.010	0.210	
Separated/Divorced	-0.012	0.005	-0.021 to -0.002	0.016		-0.026	0.004	-0.035 to -0.018	<0.001		0.001	0.011	-0.021 to 0.023	0.905	
Widowed	-0.020	0.027	-0.073 to 0.033	0.457		-0.022	0.006	-0.034 to -0.010	<0.001		0.003	0.005	-0.007 to 0.013	0.530	
In a relationship			**Reference**					**Reference**					**Reference**		
Education															
No formal qualification	-0.077	0.016	-0.109 to -0.044	<0.001	‡	-0.044	0.006	-0.056 to -0.033	<0.001	†	-0.017	0.006	-0.029 to -0.006	0.003	
Year10/Year 12	-0.021	0.004	-0.028 to -0.014	<0.001		-0.021	0.005	-0.030 to -0.012	<0.001				**Reference**		
Trade/Diploma	-0.015	0.003	-0.021 to -0.009	<0.001		-0.011	0.005	-0.022 to -0.001	0.037		0.016	0.008	0.001 to 0.031	0.038	

	1973-78 cohort (N = 10416)					1946-51 cohort (N = 11009)					1921-26 cohort (N = 7105)				
	Est	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**
University Degree or Higher			**Reference**					**Reference**			0.031	0.012	0.008 to 0.054	0.008	†
Employment status															
Unemployed	-0.016	0.003	-0.022 to -0.011	<0.001		-0.066	0.003	-0.072 to -0.061	<0.001	‡					
Employed, not paid	0.001	0.004	-0.008 to 0.010	0.860		-0.036	0.004	-0.044 to -0.028	<0.001	†					
Employed, paid			**Reference**					**Reference**							
Ability to manage on income															
Difficult always or Impossible	-0.021	0.004	-0.030 to -0.013	<0.001		-0.047	0.005	-0.057 to -0.038	<0.001	†	-0.064	0.010	-0.083 to -0.045	<0.001	‡
Difficult sometimes	-0.002	0.003	-0.008 to 0.005	0.581		-0.026	0.004	-0.034 to -0.019	<0.001		-0.047	0.006	-0.060 to -0.034	<0.001	†
Not too bad	0.004	0.003	-0.001 to 0.010	0.119		-0.012	0.003	-0.018 to -0.005	<0.001		-0.026	0.005	-0.036 to -0.017	<0.001	
Easy			**Reference**					**Reference**					**Reference**		
Body Mass Index															
Obese, BMI ≥ 30	-0.038	0.003	-0.045 to -0.032	<0.001	†	-0.057	0.004	-0.064 to -0.050	<0.001	‡	-0.059	0.007	-0.073 to -0.046	<0.001	‡
Underweight, BMI < 18.5	-0.014	0.006	-0.027 to -0.002	0.023		-0.038	0.011	-0.060 to -0.015	0.001	†	-0.075	0.010	-0.095 to -0.054	<0.001	‡
Overweight, 25 ≤ BMI < 30	-0.010	0.003	-0.016 to -0.005	<0.001		-0.020	0.003	-0.026 to -0.014	<0.001		-0.018	0.005	-0.027 to -0.009	<0.001	
Acceptable weight, 18.5 ≤ BMI < 25			**Reference**					**Reference**					**Reference**		
Physical activity level															
Nil/sedentary	-0.114	0.004	-0.121 to -0.107	<0.001	§	-0.117	0.003	-0.124 to -0.111	<0.001	§	-0.185	0.006	-0.196 to -0.174	<0.001	§
Low	-0.055	0.003	-0.060 to -0.050	<0.001	‡	-0.052	0.003	-0.058 to -0.046	<0.001	‡	-0.070	0.006	-0.081 to -0.059	<0.001	‡
Moderate	-0.024	0.003	-0.029 to -0.018	<0.001		-0.032	0.003	-0.037 to -0.026	<0.001	†	-0.030	0.006	-0.042 to -0.018	<0.001	†
High			**Reference**					**Reference**					**Reference**		
Smoking status (cigarettes per day)															
Smoke ≥ 20	-0.047	0.007	-0.061 to -0.034	<0.001	†	-0.042	0.007	-0.056 to -0.029	<0.001	†	-0.052	0.017	-0.085 to -0.019	0.002	‡
Smoke 10-19	-0.012	0.005	-0.022 to -0.002	0.023		-0.012	0.007	-0.025 to 0.002	0.096		-0.047	0.017	-0.081 to -0.013	0.006	†
Smoke <10	-0.004	0.004	-0.012 to 0.005	0.359		-0.016	0.008	-0.032 to -0.001	0.034		-0.014	0.020	-0.053 to 0.024	0.463	

	1973-78 cohort (N = 10416)					1946-51 cohort (N = 11009)					1921-26 cohort (N = 7105)				
	Est	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**	**Est**	**SE**	**95% CI**	**P**	**MID[a]**
Ex-smoker	-0.004	0.003	-0.010 to 0.002	0.201		-0.011	0.003	-0.017 to -0.004	0.002		-0.035	0.006	-0.046 to -0.024	<0.001	†
Never smoked	**Reference**					**Reference**					**Reference**				
Alcohol use															
Non-drinker	-0.034	0.004	-0.042 to -0.027	<0.001	†	-0.039	0.004	-0.047 to -0.030	<0.001	†	-0.039	0.005	-0.050 to -0.028	<0.001	†
Rarely drinks	-0.019	0.003	-0.024 to -0.014	<0.001		-0.024	0.003	-0.031 to -0.018	<0.001		-0.018	0.005	-0.029 to -0.008	0.001	
Risky drinker	-0.004	0.006	-0.015 to 0.008	0.534		-0.003	0.005	-0.013 to 0.008	0.589		0.016	0.012	-0.008 to 0.040	0.201	
High risk drinker	-0.032	0.013	-0.057 to -0.007	0.014	†	-0.014	0.014	-0.041 to 0.013	0.320		-0.052	0.044	-0.138 to 0.034	0.235	
Low risk drinker	**Reference**					**Reference**					**Reference**				
Menopause status															
Surgical menopause						-0.042	0.003	-0.049 to -0.035	<0.001	†					
Hormone use						-0.008	0.005	-0.018 to 0.002	0.097						
Pre-menopausal						0.015	0.013	-0.009 to 0.040	0.227						
Peri-menopausal						-0.004	0.005	-0.014 to 0.007	0.506						
Post-menopausal						**Reference**									
Home carer role															
Yes	-0.011	0.005	-0.020 to -0.002	0.017		-0.003	0.004	-0.011 to 0.006	0.509		-0.010	0.007	-0.024 to 0.004	0.160	
No	**Reference**					**Reference**					**Reference**				
Stress	-0.151	0.002	-0.156 to -0.147	<0.001	§	-0.185	0.003	-0.191 to -0.179	<0.001	§	-0.197	0.006	-0.209 to -0.184	<0.001	§

Note:

Est: Model parameter estimate; SE: Standard Error; 95% CI : 95% confidence interval; ESB: English speaking background

The association between SF-6D and each demographic and lifestyle variable was adjusted for mean centred age at baseline, 'time from baseline' (years from baseline in 3-yearly intervals), as well as other demographic and lifestyle variables in the table, including stress. Menopause status was included in the regression model for 1946-51 cohort only, while paid employment status was included in the 1973-78 and 1946-51 cohort only.

For the 1973-78 cohort, baseline age was mean centred at 20.7 years. In the linear mixed effects models, country of birth was fixed at baseline. All other demographic and lifestyle variables were fitted as time-varying variables.

For the 1946-51 cohort, baseline age was mean centred at 47.6 years. Area of residence, country of birth, and education were fixed at baseline in the linear mixed effects model. All other demographics and lifestyle characteristics were fitted as time-varying variables.

For 1921-26 cohort, baseline age was mean centred at 72.6 years. Area of residence, country of birth, education, smoking status and stress level were fixed at baseline in the linear mixed effects model. All other demographics and lifestyle characteristics were fitted as time-varying variables.

a. Point estimates of demographic and lifestyle characteristics that met or exceeded the minimal important difference (MID) threshold of 0.03.

† Modest difference in point estimate (0.03 to < 0.05)

‡ Moderate difference in point estimate (0.05 to < 0.10)

§ Large difference in point estimate (≥ 0.1)

Figure 1 Average SF-6D scores trends for the 1973-78, 1946-51, 1921-25 cohort