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Preference-Based Assessments

Health Utility Decrements Associated With Social Isolation and Loneliness: Evidence From Australian Longitudinal Data

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ABSTRACT

Objectives: This study estimates health utility decrements associated with social isolation and loneliness (SIL) using nationally representative longitudinal data from Australia.

Methods: Four waves of the Household, Income and Labour Dynamics in Australia survey were analyzed. Health utility was measured using the Short Form 6-Dimension with the Australian weighting algorithm. Social isolation was defined as living alone with infrequent social contact, and loneliness as a score ≥5 on a 1 to 7 scale. Respondents were classified as neither, socially isolated only, lonely only, or both. Individual fixed-effects panel regressions were applied to estimate within-person associations, with adjustment for time-varying health and sociodemographic factors.

Results: A total of 53 108 observations from 21 965 individuals (mean age 44.9; 53% male) were included, with 20% experiencing SIL (3% socially isolated only, 15% lonely only, 2% both). Compared with no SIL, adjusted models showed utility decrements of 0.020 for social isolation, 0.061 for loneliness, and 0.102 for both (all $P < .001$). The combined decrements significantly exceeded the sum of individual estimates ($P < .05$), suggesting interaction effects. Loneliness had the greatest impact on young adults (15-24 years), whereas social isolation affected middle-aged females (25-44 years) the most. Results were robust across sensitivity analyses, except that applying the UK weighting algorithm yielded smaller estimates and no significant interaction effects.

Conclusions: SIL is independently associated with reduced health utility, with some variation by age and sex. Potential interaction effects of SIL on health utility should be considered in economic evaluation, while recognizing their sensitivity to the choice of weighting algorithm.

Keywords: economic evaluation, health utility, loneliness, social isolation.

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Highlights

- This study estimated within-person health utility decrements associated with social isolation and loneliness using longitudinal Australian data and methods that account for unobserved individual-level confounders, addressing limitations of prior cross-sectional studies.
- Loneliness was linked to larger utility decrements than social isolation, with evidence of potential interaction effects when both occurred together.
- Utility decrements varied by age and sex: loneliness had the greatest impact on young adults, whereas social isolation mostly affected middle-aged females, highlighting the need to consider these differences in future economic evaluations and policy making.

Introduction

Social isolation and loneliness (SIL) are increasingly recognized as critical public health concerns, with growing evidence linking both to higher morbidity and mortality.[1-3] Existing systematic reviews and meta-analyses suggest that social isolation and loneliness are associated with a 20% to 30% increased risk of mortality over 5 to 10 years, comparable to well-established risk factors, such as smoking, obesity, and physical inactivity.[3,4] Loneliness and social isolation are also found to be associated with substantial economic and social consequences, such as lower productivity and potentially higher use of social and healthcare services.[5,6] In response, policy makers are increasingly interested in understanding the issues and identifying effective interventions to alleviate them.

Multiple studies have assessed the effectiveness of both in-person and digital interventions to reduce SIL,[7,8] but evidence on their economic value remains scarce.[9,10] One common approach to generate such evidence is through cost-utility analysis, in which additional costs of new interventions are compared with their expected health benefits, typically measured in quality-adjusted life-years (QALYs). A QALY combines length of life with health-related quality of life, expressed as a health utility value reflecting preferences for varying health states, anchored at 0 (death) and 1 (full health), with negative values indicating states worse than death.

Generic preference-based health utility measures, such as the EuroQol 5-dimension (EQ-5D) and Short Form 6-Dimension (SF-6D), produce these utility scores based on population preferences, as determined by utility weighting algorithms that assign values to varying health states.[11] These measures therefore enable comparisons across diseases and conditions because they can be used across different health areas (hence the term generic) and play a critical role in economic evaluations. However, longitudinal evidence estimating how changes in SIL relate to within-person changes in health utility remains limited.

A recent systematic review highlights that most health utility impacts of SIL estimates are based on cross-sectional data,[12] making them susceptible to bias from unobserved individual heterogeneity. For instance, individuals experiencing SIL often differ systematically from those who do not in terms of variables including but not limited to, genetic predisposition or baseline health—factors that are difficult to measure but may influence health utility.[13] Additionally, prior research has tended to narrowly examine specific age groups or individuals with certain health conditions, limiting the generalizability of findings. For example, the study by Freak-Poli et al[14] (2022) focuses on older women, Majmudar et al[15] (2024) on informal carers, Fan et al[16] (2023) on coronary heart disease patients, and Badcock et al[17] (2020) on people with psychotic disorders.

Another potential gap in the current literature is that SIL are often analyzed separately, with limited attention to the potential effect of their cooccurrence on health utility. Conceptually, loneliness is defined as a subjective emotional response to a perceived gap between desired and actual social relationships, whereas social isolation refers to an objective state of limited social contact or networks.[18] Although related, these experiences do not always overlap; some individuals may feel lonely despite having frequent social contact, whereas others may be socially isolated without feeling lonely. Therefore, it is important to examine how both loneliness and social isolation contribute to and interact in influencing health utility, particularly in the context of interventions aimed at addressing both.

This study contributes to the literature by providing evidence on how SIL, as well as the combination of both, are associated with health utility decrements in the general population. We differ from past studies by leveraging multiple waves of nationally representative longitudinal data from Australia, providing a unique opportunity to assess these relationships over time, independent of any stable individual-level unobserved confounders. These findings are intended to inform future economic evaluations of policies or interventions targeting SIL and improve efforts to quantify the broader health burden of SIL to support population health monitoring and policy prioritization.

Methods

Data

Data were obtained from the Household, Income and Labour Dynamics of Australia (HILDA) Release 22, a nationally representative panel survey initiated in 2001. In the first wave, HILDA collected information from about 13 969 individuals across 7682 households through self-completed questionnaires, and in-person or phone interviews with respondents aged 15 and above. To maintain representativeness, a top-up sample was introduced in 2011, adding 2153 households to better capture the evolving Australian population. HILDA surveys have relatively high retention rates, with a wave-on-wave response rate of about 90% or higher.[19]

This study used waves 9, 13, 17, and 21 of the survey (release 22), which were collected in 2009, 2013, 2017, and 2021, respectively, because of the availability of more comprehensive measurement of chronic diseases (self-reported) diagnoses needed as control variables. The main sample consisted of respondents aged 15 or older who provided complete information on our variables of interest. The final sample consisted of 53 108 person-years observations from 21 965 unique individuals (see Appendix Fig. 1 in Supplemental Materials for the sample selection sequence).

Outcome

Our primary outcome was health utility. In the HILDA survey, health status was assessed using the 36-item Short Form Health Survey (SF-36). Responses to a subset of SF-36 items were then mapped onto the SF-6D classification system, which describes health across 6 dimensions: physical functioning, role limitations, social functioning, pain, mental health, and vitality, each with 4 to 6 levels of severity.[11] Using an Australian preference-based weighting algorithm developed by Norman et al[20] (2014), these SF-6D health states were converted into utility scores on a scale anchored at 0 (equivalent to death) and 1 (full health), with negative values representing states considered worse than death.

Exposure

The key exposure variables were SIL. In our main analysis, we followed the approach of Kung et al[21] (2021), which defined individuals as socially isolated if they lived alone and responded to the self-completion question, “In general, how often do you get together socially with friends or relatives not living with you?” with “less than once per week.” Individuals were classified as lonely if they scored 5 or higher (on an agreement scale of 1, strongly disagree, to 7, strongly agree) in response to the statement, “I often feel very lonely.” This item was part of a ten-item instrument of Self Completion Questionnaire (SCQ) module of the survey used to assess respondents’ social support (see Appendix Table 1 in Supplemental Materials).

We then combined these 2 indicators into 4 mutually exclusive categories: (1) neither socially isolated nor lonely (no SIL), (2) socially isolated but not lonely (SI only), (3) lonely but not socially isolated (lonely only), and (4) both lonely and socially isolated (both SIL). This categorization allowed us to examine whether cooccurring social isolation and loneliness had greater association with health utility than the sum of each condition alone, using the “no SIL” as the reference group.

Covariates

To examine the independent associations between loneliness, social isolation, and health utility, we included a set of time-varying covariates known to be correlated with both. Sociodemographic controls included age (modeled as yearly dummy variables to capture nonlinear effects), education, employment status (both dummy categorical), and log-transformed per capita household income. Area-level factors included SA3-level quintiles of the 2021 Index of Relative Socioeconomic Advantage and Disadvantage, remoteness classifications from the 2021 Australian Statistical Geography Standard, and state/territory of residence. Index of Relative Socioeconomic Advantage and Disadvantage is a Socioeconomic Index for Area summarizing the socioeconomic conditions of people and households in an area. Marital status and household composition were excluded because they are components of the social isolation measure (see Section 2.3). We also controlled for major life events in the past 12 months (eg, injury, bereavement, or job change), which may influence both SIL and health status.

We also included disability and chronic illness to account for potential confounding in the relationship between SIL and health utility. Disability was measured using a binary indicator based on responses to the question “Do you have any long-term health condition, impairment, or disability that restricts you in your everyday activities and has lasted, or is likely to last, for 6 months or more?” We also included binary indicators for self-reported chronic or serious illness diagnoses, based on the question: “Have you been told by a doctor or nurse that you have any of these conditions? Please only include current conditions that have lasted or are likely to last for 6 months or more.” Diagnoses included arthritis, cancer, chronic lung conditions (chronic bronchitis or emphysema), mental health conditions (depression, anxiety, or other mental illnesses), and cardiometabolic diseases such as hypertension, heart disease, circulatory conditions, and diabetes. These time-varying covariates were included to provide a more comprehensive adjustment for health status.

Statistical Analysis

We first summarized the data by presenting the mean and standard deviation for continuous variables and the prevalence (in percentage) and number of observations for binary and categorical variables. This summary included key sociodemographic variables, health conditions, and health utility (along with its underlying SF-36 dimensions) by combined SIL status for the overall sample. We then reported the estimated prevalence of SIL and the mean health utility by SIL category across sex and age groups: 15-24, 25-44, 45-64, and 65+ years, similar to Kung et al[21] (2021). These age categories were selected to reflect key life stages that may influence the relationship between social isolation, loneliness, and health in general. Transition probabilities showing within-person changes in SIL status across 4 waves were also estimated.

Our main empirical approach was individual linear fixed-effects (FE) panel data regression analysis, which was well-suited for examining the within-person relationship between exposure and outcomes over time.[22] This method focuses on the same person, assessing how changes in exposure were associated with changes in outcomes. By making these comparisons, the FE model adjusts for all individual-level factors that do not change over time (such as genetic predisposition, early-life experiences, or long-standing personality traits), even if these factors were not measured in the survey.[13] Standard errors were clustered at the individual level to adjust for serial correlation within individuals.[23]

Three models were estimated. The first model included only year indicators as a control variable (unadjusted model), the second model adjusted for socioeconomic status and major life events, and the third model additionally controlled for health conditions (adjusted model). Overall, the estimated coefficients from the FE model could be interpreted as the contemporaneous health utility decrement associated with the SIL indicator (compared with the reference category), conditional on the included control variables. We tested whether the combined effect of loneliness and social isolation exceeded additivity using a linear combination test. All analyses were performed with Stata 18.0.

Sensitivity Analysis

To assess the robustness of our findings, we conducted several sensitivity analyses. First, we addressed potential structural or mode-related differences by excluding wave 21 (conducted entirely via telephone during the COVID-19 pandemic). Second, we reestimated the models using all available waves to reduce the long (4-year) interval between surveys in the main analysis, noting the limitation that detailed self-reported diagnoses were unavailable for some waves. Third, we tested alternative definitions of exposure: (1) SIL intensity, combining the full loneliness scale (1-7) with levels of social isolation based on frequency of social contact; (2) SIL persistence, defined using responses from the current and 2 previous waves; and (3) a multi-item SIL classification following Manera et al[24] (2022) (see Appendix Table 1 in Supplemental Materials notes for details). Fourth, we applied longitudinal sample weights to account for sample design and attrition. Fifth, we used multiple imputation by chained equations[25] for missing health utility and SIL data (12%-13.7%), applying predictive mean matching with 5 nearest neighbors and multinomial logit for SIL using covariates as auxiliary variables, with 20 imputations combined using Rubin’s rules. Finally, we applied the UK SF-6D utility algorithm[11] to assess sensitivity to the choice of valuation method and to facilitate international comparison.

Results

Prevalence of Social Isolation and Loneliness

Figure 1 shows the prevalence of social isolation, loneliness, and their combination across age groups, stratified by sex. Loneliness only declined with age, from 18% in those aged 15 to 24 to 12% in those 65+, whereas social isolation only and combined SIL increased. Social isolation only was highest among older adults (5.8% in the 65+ group). Similar trends were seen in both sexes, with loneliness only peaking at 20% in young females (15-24) and social isolation only peaking at 6.9% among older men (65+). The combined SIL status remained low but rose in older adulthood (details shown in Appendix Table 2 in Supplemental Materials). In addition to this pooled prevalence, transition probabilities of SIL across waves indicate substantial within-person variation over time (see Appendix Table 3 in Supplemental Materials).

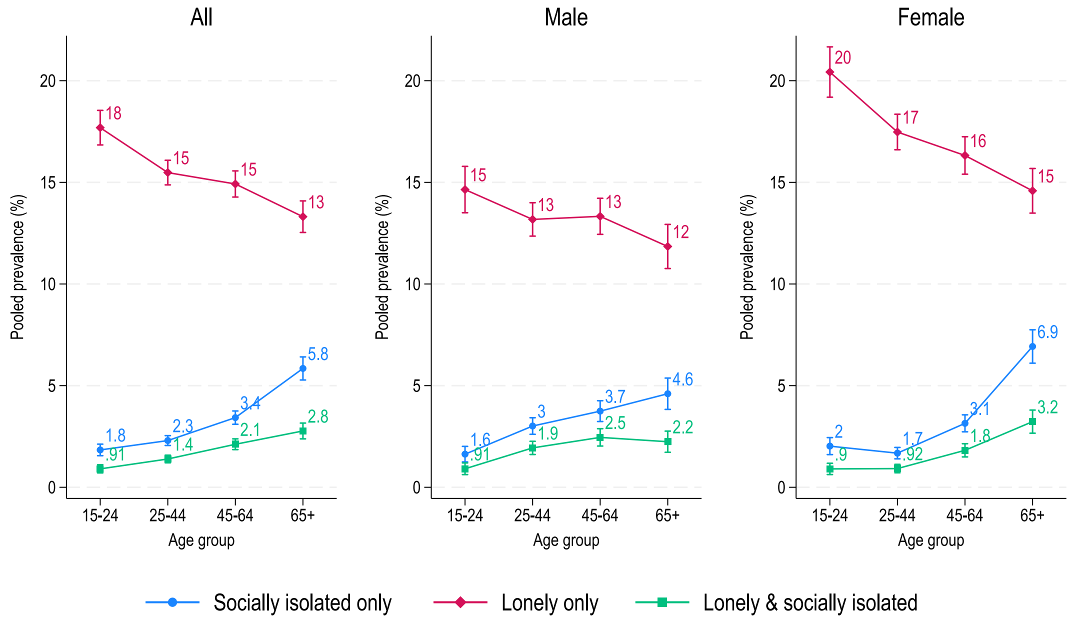
Sociodemographic and Health Characteristics

Table 1 presents the distribution of key sociodemographic variables across SIL categories. Compared with those who were neither socially isolated nor lonely, individuals who were both socially isolated and lonely were, on average, older (SIL: 51.8 years vs no SIL: 44.6 years), more likely to be separated or divorced (36% vs 6%), less likely to have bachelor, diploma, or postgraduate degree (29% vs 39%), and more likely to be not in the labor force (45% vs 30%). Equivalized disposable income was relatively similar across groups. However, those who were both socially isolated and lonely were more likely to reside in more disadvantaged areas (22% vs 16% in the lowest quintile of the Socioeconomic Index for Area) and slightly less likely to live in major cities (67% vs 68%).

Table 2 presents the average SF-6D health utility index, SF-36 scores per dimension, and the prevalence of health conditions across SIL groups. Those experiencing both SIL had the lowest health utility (mean: 0.39, SD: 0.29), significantly lower than those who were neither (mean: 0.68, SD: 0.22). They also had poorer physical and mental health, with lower SF-36 general health (51.96 vs 70.38) and mental health (53.81 vs 76.57) scores. Chronic disease burden was higher in this group (70% vs 43%), with notable prevalence of depression or anxiety (38%), high blood pressure (26%), and arthritis or osteoporosis (29%).

Figure 2 further illustrates disparities in SF-6D health utility across SIL categories by sex and age group (see also Appendix Table 4 in Supplemental Materials for more detailed report). Across all age groups and both sexes, individuals experiencing both SIL consistently reported the lowest mean SF-6D utility scores, with particularly pronounced declines among older adults and females. Although sex differences were modest, the impact of SIL on health utility appeared slightly greater among females.

Figure 1. Prevalence of combined social isolation and loneliness measure by age group. This figure shows pooled prevalence (in %) of combined measure of social isolation and loneliness across age group for all individuals, males, and females. Sample is obtained from HILDA waves 9, 13, 17, and 21. Error bars show 95% CIs based on standard errors clustered at the individual level.



HILDA indicates Household, Income and Labour Dynamics of Australia.

Estimated Health Utility Decrements Associated With SIL

Table 3 presents the estimated health utility decrement associated with social isolation and loneliness, based on linear FE panel regression with 3 model specifications. All decrements are compared with being not lonely or socially isolated. Across all models, social isolation or loneliness were consistently associated with significantly lower health utility relative to being neither lonely nor socially isolated.

In the unadjusted model (column 1), social isolation alone was associated with 0.024 points of utility decrement, whereas loneliness resulted in a larger decrement of 0.069 points. The greatest decline was observed among those experiencing both conditions, with a reduction of 0.117 points. These decrements were slightly attenuated after adjusting for additional control variables but remained statistically significant ($P < .001$). In the adjusted model (column 3), the estimated decrements were 0.020 for social isolation alone, 0.061 for loneliness alone, and 0.102 for both. Finally, in the "combined vs additive difference" row, we show that the utility decrements associated with experiencing both conditions significantly exceeded the sum of individual decrements by 0.022 points ($P = .027$).

This pattern was generally consistent when the analysis was stratified by age, although the magnitude of utility decrements varied. In the adjusted model (column 3), the largest estimated health utility decrement for loneliness alone was observed among young adults (aged 15-24), at 0.079 points ($P < .01$), with diminishing magnitude seen in older age groups. Our estimates for social isolation alone were statistically significant only among individuals aged 25 to 44, at 0.024 points. The difference between combined and additive effects was most pronounced among individuals aged 45 or older, with estimated extra utility decrements of approximately 0.041 points ($P < .05$).

For illustrative purposes, we applied the adjusted utility decrements to the observed mean utility of 0.683 for the reference group (neither lonely nor socially isolated) in the overall analytical sample. This simple approach yielded approximate utility values of 0.663 for those who were socially isolated only, 0.622 for those who were lonely only, and 0.581 for those experiencing both SIL.

Sex Differences

Table 4 presents our estimates separately for males and females, following the same model specifications as in Table 3. In the adjusted model, for males (column 3), social isolation only, loneliness only, and both SIL were associated with a health utility decrements of 0.019, 0.061, and 0.111, respectively (all P values $<$ .001). For females (column 6), the corresponding health utility decrements were 0.022 ($P < .01$) for social isolation alone, 0.061 ($P < .001$) for loneliness alone, and 0.094 ($P < .001$) for experiencing both SIL.

The age-stratified analysis further indicated notable sex differences. In the adjusted models (column 3 for males and column 6 for females), the largest decrements for loneliness alone were observed among males aged 25-44 (0.083, $P < .001$) and among females aged 15 to 24 (0.093, $P < .001$). In contrast, social isolation alone was significantly associated with reduced health utility only among females aged 25 to 44 (0.056, $P < .01$). Finally, the difference between combined and additive effects were most pronounced among females aged 45 to 64 (0.047) and males aged 65 and over (0.059 points), although these are not statistically significant at 5% level.

Appendix Figure 2 in Supplemental Materials shows the adjusted health utility decrements for the 3 SIL categories by sex and age group, with the "no SIL" group as the reference,

Table 1. Descriptive statistics of sociodemographic variables by SIL category.

Variables	Not lonely or socially isolated	Socially isolated only	Lonely only	Socially isolated and lonely	All
Age, mean (SD)	44.7 (18.4)	53.3 (19.5)	43.5 (18.5)	52.2 (19.1)	44.9 (18.6)
Age group, *n* (%)					
15-24	7012 (17%)	162 (10%)	1,559 (19%)	80 (8%)	8,813 (17%)
25-44	14 734 (35%)	419 (25%)	2,822 (35%)	254 (27%)	18 229 (34%)
45-64	13 412 (32%)	578 (34%)	2,516 (31%)	357 (38%)	16 863 (32%)
65+	7185 (17%)	538 (32%)	1,225 (15%)	255 (27%)	9203 (17%)
Sex, *n* (%)					
Female	20 220 (48%)	816 (48%)	3286 (40%)	492 (52%)	24 814 (47%)
Male	22 123 (52%)	881 (52%)	4836 (60%)	454 (48%)	28 294 (53%)
Marital status, *n* (%)					
Married or de facto	29 695 (70%)	53 (3%)	4437 (55%)	19 (2%)	34 204 (64%)
Separated or divorced	2673 (6%)	579 (34%)	908 (11%)	344 (36%)	4504 (8%)
Widowed	1261 (3%)	281 (17%)	388 (5%)	151 (16%)	2081 (4%)
Single	8714 (21%)	784 (46%)	2389 (29%)	432 (46%)	12 319 (23%)
Education, *n* (%)					
Postgraduate	5315 (13%)	172 (10%)	726 (9%)	69 (7%)	6282 (12%)
Bachelor/diploma	11 004 (26%)	388 (23%)	1736 (21%)	204 (22%)	13 332 (25%)
Cert 3 or 4	9177 (22%)	388 (23%)	1882 (23%)	222 (23%)	11 669 (22%)
High school	6486 (15%)	244 (14%)	1313 (16%)	153 (16%)	8196 (15%)
Below high school	10 361 (24%)	505 (30%)	2465 (30%)	298 (32%)	13 629 (26%)
Employment status, *n* (%)					
Employed, full-time	18 998 (45%)	718 (42%)	2830 (35%)	339 (36%)	22 885 (43%)
Employed, part-time	9527 (22%)	230 (14%)	1804 (22%)	124 (13%)	11 685 (22%)
Unemployed	1309 (3%)	57 (3%)	473 (6%)	58 (6%)	1897 (4%)
Not in the labor force	12 509 (30%)	692 (41%)	3015 (37%)	425 (45%)	16 641 (31%)
Country of birth, *n* (%)					
Australia	33 753 (80%)	1348 (79%)	6570 (81%)	730 (77%)	42 401 (80%)
Other English speaking	3961 (9%)	154 (9%)	713 (9%)	94 (10%)	4922 (9%)
Other	4629 (11%)	195 (11%)	839 (10%)	122 (13%)	5785 (11%)
SEIFA (IRSAD), *n* (%)					
Quintile 1	7700 (18%)	454 (27%)	2071 (25%)	288 (30%)	10 513 (20%)
Quintile 2	8075 (19%)	335 (20%)	1673 (21%)	182 (19%)	10 265 (19%)
Quintile 3	8447 (20%)	324 (19%)	1648 (20%)	155 (16%)	10 574 (20%)
Quintile 4	8898 (21%)	302 (18%)	1418 (17%)	168 (18%)	10 786 (20%)
Quintile 5	9223 (22%)	282 (17%)	1312 (16%)	153 (16%)	10 970 (21%)
Remoteness, *n* (%)					
Major city	28 835 (68%)	1105 (65%)	5354 (66%)	637 (67%)	35 931 (68%)
Inner regional	8924 (21%)	424 (25%)	1837 (23%)	198 (21%)	11 383 (21%)
Outer regional	3937 (9%)	145 (9%)	825 (10%)	99 (10%)	5006 (9%)
Remote or very remote	647 (2%)	23 (1%)	106 (1%)	12 (1%)	788 (1%)
Log equivalized disposable income, mean (SD)	10.8 (0.6)	10.5 (0.9)	10.7 (0.6)	10.4 (0.8)	10.8 (0.7)
Observations	42 343	1697	8122	946	53 108

Note. Sample is based on pooled data from HILDA waves 9, 13, 17, and 21.
HILDA indicates Household, Income and Labour Dynamics of Australia; IRSAD, Index of Relative Socioeconomic Advantage and Disadvantage; SEIFA, Socioeconomic Index for Area; SIL, social isolation and loneliness.

based on estimates from column 3 of Table 3 and columns 3 and 6 of Table 4.

Sensitivity Analysis

Excluding wave 21 (COVID-19) produced almost identical estimates to the main results (see Appendix Table 5 in Supplemental Materials), whereas including all available survey waves resulted in estimates that were consistent in direction but with smaller magnitudes (see Appendix Table 6 in Supplemental Materials). Analyses incorporating variation in the intensity and persistence of SIL indicated progressively larger health utility decrements with higher degrees of loneliness and social isolation (see Appendix Fig. 3 in Supplemental Materials). The alternative SIL definition from Manera et al[24] yielded broadly similar results, although among females aged 25 to 44 the decrement for social isolation alone exceeded that for loneliness alone (see Appendix Table 7 in Supplemental Materials). Applying longitudinal weights did not materially change the overall pattern but reduced precision for the 15 to 24 age group (see Appendix Table 8 in Supplemental Materials), whereas multiple imputation resulted in about 13% to 19% larger estimates (see Appendix Table 9 in Supplemental Materials). Finally, using the UK SF-6D algorithm produced broadly similar patterns but substantially smaller

Table 2. Descriptive statistics of SF-6D health utility index, SF-36 scores, and health conditions, by SIL category.

Variables	Not lonely or socially isolated	Socially isolated only	Lonely only	Socially isolated and lonely	All
Health utility, mean (SD)					
SF-6D utility index	0.68 (0.22)	0.59 (0.27)	0.49 (0.27)	0.38 (0.29)	0.65 (0.25)
SF-36 dimensions (scores 0-100)					
Physical functioning	85.74 (21.61)	77.32 (27.32)	78.81 (25.39)	69.05 (29.55)	84.11 (22.85)
Role-physical	81.86 (33.94)	68.78 (41.63)	67.86 (40.94)	55.38 (44.70)	78.83 (36.11)
Bodily pain	74.84 (22.50)	69.58 (25.38)	64.85 (25.57)	58.43 (26.88)	72.85 (23.54)
General health	70.26 (19.61)	63.77 (22.18)	58.05 (21.94)	51.58 (23.26)	67.86 (20.74)
Vitality	61.65 (18.79)	56.54 (20.75)	45.75 (20.91)	40.99 (21.37)	58.68 (20.21)
Social functioning	85.82 (20.85)	76.60 (26.68)	66.92 (27.52)	55.96 (29.84)	82.10 (23.67)
Role emotional	86.13 (30.05)	75.52 (38.26)	61.33 (42.52)	50.79 (43.96)	81.37 (34.27)
Mental health	76.50 (15.11)	72.14 (17.89)	58.31 (20.00)	53.58 (20.94)	73.17 (17.63)
Health conditions, n (%)					
Any disability	10 919 (26%)	683 (40%)	3252 (40%)	501 (53%)	15 355 (29%)
Chronic/serious health conditions					
Any conditions	18 293 (43%)	980 (58%)	4688 (58%)	670 (71%)	24 631 (46%)
Arthritis or osteoporosis	6562 (15%)	416 (25%)	1522 (19%)	283 (30%)	8783 (17%)
Asthma	4471 (11%)	191 (11%)	1199 (15%)	153 (16%)	6014 (11%)
Any type of cancer	1262 (3%)	70 (4%)	254 (3%)	43 (5%)	1629 (3%)
COPD	629 (1%)	70 (4%)	233 (3%)	62 (7%)	994 (2%)
Type 1 diabetes	352 (1%)	20 (1%)	84 (1%)	9 (1%)	465 (1%)
Type 2 diabetes	1885 (4%)	118 (7%)	476 (6%)	70 (7%)	2549 (5%)
Depression or anxiety	4765 (11%)	316 (19%)	2434 (30%)	363 (38%)	7878 (15%)
Other mental illness	624 (1%)	59 (3%)	467 (6%)	84 (9%)	1234 (2%)
Heart disease	1661 (4%)	129 (8%)	387 (5%)	90 (10%)	2267 (4%)
High blood pressure	7022 (17%)	414 (24%)	1490 (18%)	253 (27%)	9179 (17%)
Other circulatory conditions	953 (2%)	86 (5%)	288 (4%)	58 (6%)	1385 (3%)
Observations	42 343	1697	8122	946	53 108

Note. This table presents the mean and standard deviation of health utility measures (SF-6D health utility index and score of each component of SF-36), as well as frequency and proportion of individuals with certain health conditions. Sample is based on pooled data from HILDA waves 9, 13, 17, and 21.
COPD indicates chronic obstructive pulmonary disease; HILDA indicates Household, Income and Labour Dynamics of Australia; SF-6D, Short Form 6-Dimension; SF-36, Short Form 36; SIL, social isolation and loneliness.

decrements (eg, 0.047 vs 0.102 for combined SIL) and no significant interaction effects (see Appendix Table 10 in Supplemental Materials).

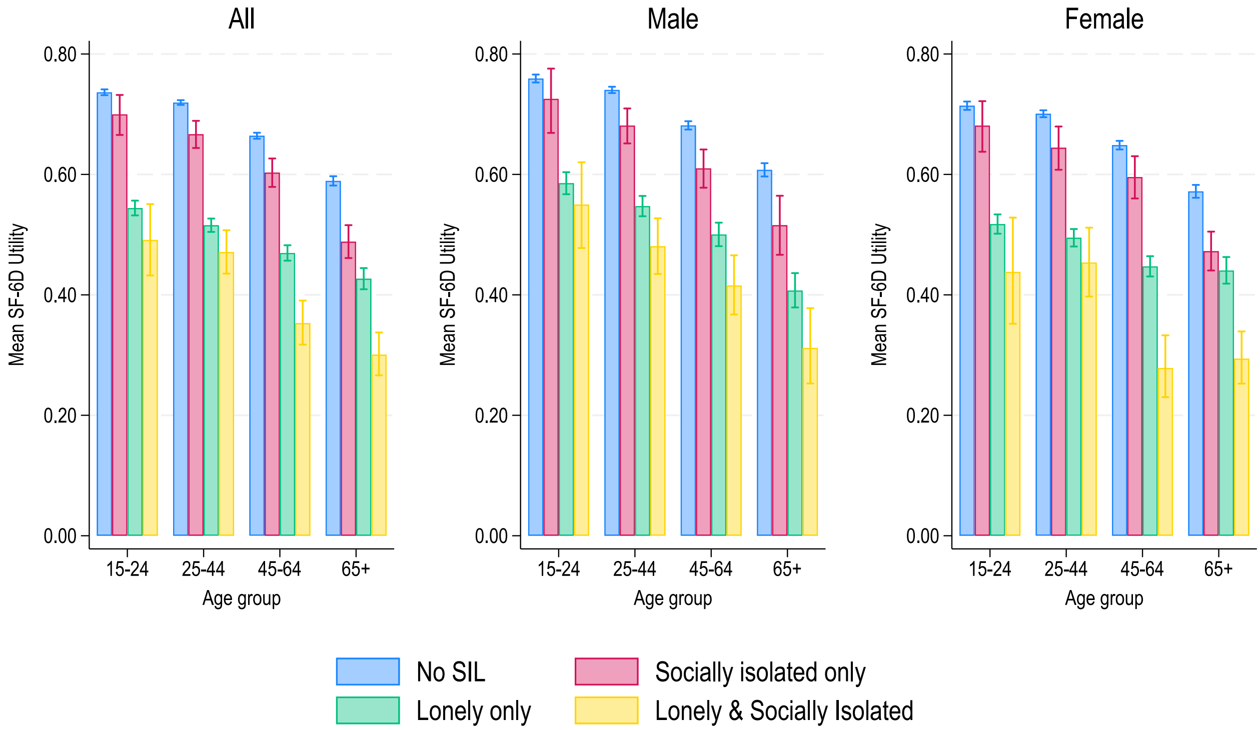
Discussion

Our findings suggest significant health utility decrements associated with SIL in a longitudinal sample of the Australian general population aged 15 years or older. Compared with being neither lonely nor socially isolated, we found that loneliness alone yielded a greater utility decrement than social isolation alone, and those experiencing both conditions may face a compounded reduction in health utility, suggesting possible interaction effects of SIL. One potential explanation is that loneliness may have a greater adverse impact among socially isolated individuals because they lack the buffering effects of social connections.[26] Results from previous studies that mainly focus on mortality outcomes however have been mixed.[27-29] The study by Beller and Wagner[27] (2018) found a significant combined effect, whereas Tanskanen and Anttila[28] (2016) and Lennartsson et al[29] (2022) found nonstatistically significant results. These inconsistencies in prior research may reflect limited statistical power from small sample sizes, or that short-term interaction effects of SIL on health utility observed in our analyses might not necessarily translate into longer-term outcomes such as mortality.

To contextualize our main estimates, we compared them with within-individual variation in health utility over time (SD = 0.106). The estimated utility decrements associated with social isolation only, loneliness only, and both loneliness and social isolation were approximately 0.19, 0.58, and 0.96 of the within SD, respectively, which qualitatively correspond to small, medium, and large effect sizes, respectively. Furthermore, our estimated utility decrement for combined loneliness and social isolation (0.047 for both sexes, with UK algorithm) was only slightly lower than that for depression (0.063 in women and 0.066 in men, also with UK algorithm) in recent Australian estimates, indicating its clinical significance.[30] Finally, our estimates were also consistent with a recent German study using the EQ-5D which found a greater utility decrement for loneliness (0.07) than for social isolation (0.04), although their analysis considered SIL separately and did not examine their combined effects.

The study also found that health utility decrements from SIL vary by sex and age, suggesting the need for considering age- and sex-specific parameter values of health benefits associated with interventions targeting SIL. Loneliness had the largest utility decrements among young adults and can potentially be explained by their greater needs for peer relationships and their less developed coping mechanisms.[31] In contrast, middle-aged adults (aged 25-44), particularly females, appeared to be the most affected by social isolation. One possible explanation is that this group often needs to balance multiple responsibilities, such as

Figure 2. Mean SF-6D health utility by combined social isolation and loneliness status by sex and age group. This figure shows pooled mean and standard error (clustered at individual level) of SF-6D health utility by social isolation and loneliness status across age group for all individuals, males, and females. Sample is obtained from HILDA waves 9, 13, 17, and 21. Error bars show 95% CIs based on standard errors clustered at the individual level.



HILDA indicates Household, Income and Labour Dynamics of Australia; SF-6D, Short Form 6-Dimension.

work, household duties, and caregiving, making them more vulnerable when socially isolated.[32] The smaller utility decrement associated with loneliness among older adults (aged 45 and over) compared with younger adults may reflect greater social acceptance of solitude and adaptive coping mechanisms developed with age, including more time to engage in activities that mitigate the impact of loneliness on their health utility.[33] On the other hand, the stronger interaction effects of SIL among older adults may be explained by their greater reliance on social support for daily functioning.[34]

Our sensitivity analyses generally demonstrate the robustness of the main findings across alternative model specifications, utility weighting approaches, multiple imputation, and definitions of SIL. The use of longitudinal sample weight, however, resulted in considerably less precise estimates for younger groups, likely due to attrition-related smaller sample sizes, whereas larger estimates from multiple imputation indicated that missing cases may have lower health utility and were more likely to be socially isolated or lonely. The smaller decrements and nonsignificant interaction effects observed with the UK weighting algorithm may reflect both societal and methodological differences in health state valuation. The UK algorithm, based on standard gamble, is known to compress scores at the lower end, whereas the Australian discrete choice experiment-based weighting algorithm captures a wider utility range and is more sensitive to mental and social health impairments.[20]

Policy Implication

In practice, our age- and sex-specific estimates of health utility decrements associated with SIL can be directly applied as input parameters in cost-utility analyses of policies and interventions aimed at alleviating SIL. For example, community-based programs (eg, befriending schemes and group social activities), digital interventions (eg, online support group), or broader policy changes (eg, community infrastructure investment) could use these estimates to translate expected changes in SIL prevalence into QALY gains. By incorporating these values into economic models, policy makers can also compare the value for money of different types of SIL interventions or with other public health initiatives and prioritize resource allocation with full consideration of community-specific needs.

Strengths and Limitations

This study has several strengths. First, the use of rich longitudinal data enables us to control for time-invariant confounders that address a limitation in many prior studies relying on cross-sectional designs. Second, the estimation of interaction effects between SIL provides new insights into their combined impact on health utility, which remains largely unexplored in previous research. Third, the sample is representative of the Australian general population, making the findings generalizable within the Australian research context and potentially applicable to other settings with similar characteristics.

Despite these strengths, certain limitations should be acknowledged. First, although nonlinear models are often recommended for health utility data because of their skewed and bounded nature,[35] they are typically intractable with the presence of individual fixed effects.[13] Given our focus on adjusting for unobserved individual confounders, the linear FE model is a more practical approach in this context.[13] Second, despite our rich covariates, the lack of information on disease severity may lead to residual confounding. Additionally, health utilities for SIL were

Table 3. Estimated SF-6D health utility decrements associated with combined social isolation and loneliness status.

Social isolation and loneliness status	(1)	(2)	(3)
All ages			
Socially isolated only	−0.024* (0.006)	−0.022* (0.006)	−0.020* (0.006)
Lonely only	−0.069* (0.003)	−0.065* (0.003)	−0.061* (0.003)
Lonely and socially isolated	−0.117* (0.009)	−0.111* (0.009)	−0.102* (0.009)
Test: combined vs additive difference	0.024† (0.010)	0.024† (0.010)	0.022† (0.010)
R^2 (within)	0.061	0.117	0.162
Observations	53,108	53,108	53,108
Age 15-24			
Socially isolated only	−0.019 (0.019)	−0.011 (0.019)	0.001 (0.018)
Lonely only	−0.094* (0.010)	−0.089* (0.010)	−0.079* (0.010)
Lonely and socially isolated	−0.101‡ (0.038)	−0.095‡ (0.035)	−0.092‡ (0.032)
Test: combined vs additive difference	−0.013 (0.043)	−0.005 (0.040)	0.014 (0.037)
R^2 (within)	0.047	0.108	0.150
Observations	8813	8813	8813
Age 25-44			
Socially isolated only	−0.024 (0.014)	−0.027† (0.013)	−0.024 (0.013)
Lonely only	−0.082* (0.006)	−0.077* (0.006)	−0.070* (0.006)
Lonely and socially isolated	−0.120* (0.020)	−0.109* (0.019)	−0.104* (0.019)
Test: combined vs additive difference	0.015 (0.024)	0.005 (0.023)	0.010 (0.023)
R^2 (within)	0.061	0.111	0.155
Observations	18 229	18 229	18 229
Age 45-64			
Socially isolated only	−0.010 (0.011)	−0.014 (0.010)	−0.013 (0.010)
Lonely only	−0.053* (0.006)	−0.049* (0.006)	−0.048* (0.006)
Lonely and socially isolated	−0.110* (0.017)	−0.108* (0.017)	−0.102* (0.016)
Test: combined vs additive difference	0.047† (0.018)	0.045† (0.018)	0.041† (0.017)
R^2 (within)	0.041	0.115	0.166
Observations	16 863	16 863	16 863
Age 65+			
Socially isolated only	−0.024 (0.013)	−0.013 (0.013)	−0.015 (0.013)
Lonely only	−0.031* (0.009)	−0.030* (0.008)	−0.031* (0.008)
Lonely and socially isolated	−0.093* (0.018)	−0.088* (0.017)	−0.088* (0.017)
Test: combined vs additive difference	0.039 (0.021)	0.045† (0.020)	0.041† (0.020)
R^2 (within)	0.115	0.167	0.203
Observations	9203	9203	9203
Control variables			
Sociodemographic		✔	✔
Major life events		✔	✔
Health conditions			✔

Note. Standard errors clustered at individual level in parentheses. All decrements are compared with not lonely or socially isolated. Combined vs additive differences were estimated using postestimation linear combination test. R^2 (within) reflect variation explained within individuals.
SF-6D indicates Short Form 6-Dimension.
*$P < .001$.
†$P < .05$.
‡$P < .01$.

not directly elicited but inferred from contemporaneous associations with derived SF-6D scores, conditional on covariates and model specification. As such, reverse causality is possible, whereby poorer health state (eg, low physical functioning) may induce loneliness or social isolation. Finally, because SIL is complex and multidimensional, our dichotomous measures represent

Table 4. Estimated SF-6D health utility decrements associated with combined social isolation and loneliness status by sex.

Social isolation and loneliness status	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
All ages						
Socially isolated only	−0.022* (0.008)	−0.019† (0.008)	−0.019† (0.008)	−0.026* (0.009)	−0.024* (0.008)	−0.022* (0.008)
Lonely only	−0.067‡ (0.005)	−0.065‡ (0.005)	−0.061‡ (0.005)	−0.070‡ (0.004)	−0.066‡ (0.004)	−0.061‡ (0.004)
Lonely and socially isolated	−0.128‡ (0.013)	−0.119‡ (0.013)	−0.111‡ (0.012)	−0.106‡ (0.013)	−0.102‡ (0.013)	−0.094‡ (0.012)
Combined vs additive difference	0.039* (0.015)	0.035† (0.014)	0.031† (0.014)	0.010 (0.015)	0.012 (0.014)	0.011 (0.014)
R^2 (within)	0.061	0.126	0.165	0.061	0.120	0.170
Observations	24 814	24 814	24 814	28 294	28 294	28 294
Age 15-24						
Socially isolated only	−0.011 (0.033)	0.014 (0.032)	0.026 (0.031)	−0.028 (0.023)	−0.032 (0.023)	−0.017 (0.022)
Lonely only	−0.062‡ (0.015)	−0.062‡ (0.015)	−0.057‡ (0.015)	−0.115‡ (0.013)	−0.110‡ (0.013)	−0.096‡ (0.013)
Lonely and socially isolated	−0.127* (0.042)	−0.107* (0.040)	−0.082† (0.036)	−0.070 (0.065)	−0.080 (0.060)	−0.092 (0.051)
Combined vs additive difference	0.054 (0.053)	0.059 (0.051)	0.051 (0.049)	−0.072 (0.069)	−0.062 (0.065)	−0.021 (0.056)
R^2 (within)	0.033	0.113	0.141	0.067	0.138	0.197
Observations	4172	4172	4172	4641	4641	4641
Age 25-44						
Socially isolated only	−0.007 (0.018)	−0.011 (0.018)	−0.010 (0.018)	−0.053† (0.021)	−0.060* (0.020)	−0.056* (0.019)
Lonely only	−0.095‡ (0.010)	−0.089‡ (0.010)	−0.083‡ (0.009)	−0.072‡ (0.008)	−0.070‡ (0.008)	−0.063‡ (0.008)
Lonely and socially isolated	−0.130‡ (0.026)	−0.119‡ (0.025)	−0.112‡ (0.025)	−0.107‡ (0.030)	−0.097‡ (0.028)	−0.098‡ (0.027)
Combined vs additive difference	0.027 (0.032)	0.019 (0.031)	0.020 (0.031)	−0.018 (0.035)	−0.033 (0.034)	−0.020 (0.033)
R^2 (within)	0.072	0.135	0.171	0.055	0.117	0.167
Observations	8462	8462	8462	9767	9767	9767
Age 45-64						
Socially isolated only	−0.027 (0.014)	−0.024 (0.014)	−0.026 (0.013)	0.006 (0.015)	−0.002 (0.015)	-Ref. (0.015)
Lonely only	−0.040‡ (0.010)	−0.038‡ (0.009)	−0.041‡ (0.009)	−0.063‡ (0.009)	−0.057‡ (0.008)	−0.053‡ (0.008)
Lonely and socially isolated	−0.113‡ (0.024)	−0.111‡ (0.023)	−0.111‡ (0.022)	−0.109‡ (0.024)	−0.110‡ (0.024)	−0.101‡ (0.023)
Combined vs additive difference	0.046 (0.025)	0.048 (0.025)	0.045 (0.024)	0.052† (0.026)	0.052† (0.026)	0.047 (0.025)
R^2 (within)	0.042	0.122	0.168	0.042	0.122	0.178
Observations	7900	7900	7900	8963	8963	8963
Age 65+						
Socially isolated only	−0.004 (0.019)	0.004 (0.019)	−0.004 (0.019)	−0.033 (0.017)	−0.022 (0.017)	−0.024 (0.017)
Lonely only	−0.034† (0.014)	−0.036* (0.013)	−0.036* (0.013)	−0.028† (0.011)	−0.024† (0.011)	−0.027† (0.011)
Lonely and socially isolated	−0.114‡ (0.032)	−0.107‡ (0.031)	−0.098* (0.031)	−0.081‡ (0.022)	−0.072‡ (0.021)	−0.075‡ (0.021)
Combined vs additive difference	0.076† (0.034)	0.076† (0.033)	0.059 (0.033)	0.020 (0.027)	0.025 (0.026)	0.025 (0.026)
R^2 (within)	0.114	0.185	0.232	0.117	0.175	0.206
Observations	4280	4280	4280	4923	4923	4923
Control variables						
Sociodemographic		✔	✔		✔	✔
Major life events		✔	✔		✔	✔
Health conditions			✔			✔

Note. Standard errors clustered at individual level in parentheses. Combined vs additive differences were estimated using postestimation linear combination test. R^2 (within) reflect variation explained within individuals.
SF-6D indicates Short Form 6-Dimension.
*$P < .01$.
†$P < .05$.
‡$P < .001$.

a simplification, and the reported decrements should be interpreted as average effects.

Future research should further examine the interaction between SIL and chronic health conditions, because these relationships may also have cumulative effects. Additionally, investigating the long-term health utility decrement associated with chronic SIL, rather than a contemporaneous relationship, would provide a more comprehensive understanding of the sustained association.

Conclusions

In conclusion, this study highlights the need to consider age- and sex-specific parameter values of health utility when modeling the health benefits of SIL interventions. The findings also suggest that economic evaluations should account for the possibility of interaction effects for which experiencing both SIL might manifest in a bigger health utility decrement than the sum of their individual effects, although this finding is sensitive to the choice of preference weight algorithm. Finally, these results further illustrate the public health importance of addressing SIL and provide key inputs for policy makers to prioritize and design interventions that maximize health gains.

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