



The association between loneliness with health service use and quality of life among informal carers in Australia

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ABSTRACT

Objective: The demanding nature of caregiving and limited social support can lead to informal carers experiencing loneliness, which can impact their well-being and overall health service use (HSU). The study aims to examine the association between loneliness with HSU and Health state utility values among informal carers in Australia. **Methods:** Data were derived from three waves (2009, 2013, and 2017) of the nationally representative longitudinal Household Income and Labour Dynamics of Australia (HILDA) survey, focusing on adult informal carers. Outcome measures included visits to the General Practitioner, the number of hospital admissions, and the SF-6D score. Generalized Estimating Equations (GEE) analysis was conducted to explore the associations between loneliness and HSU, as well as loneliness and utility values (based on SF-6D) while adjusting for age, sex, education, marital status, income, and physical/mental health conditions. **Results:** After controlling for covariates, lonely carers reported lower utility values (IRR = 0.91, 95%CI [0.89, 0.93], $p < 0.001$) compared to non-lonely carers. Lonely carers reported a higher number of GP visits (IRR = 1.18, 95% CI [1.04, 1.36], $p < 0.05$) as well as a higher likelihood of visiting specialists (AOR = 1.31, $p = 0.046$) and hospital doctors (AOR = 1.42, $p = 0.013$) compared to the non-lonely carers. **Conclusions:** The findings of this study highlight the relationship between loneliness on both healthcare utilization and carers' overall well-being. Addressing loneliness through targeted interventions and social support systems can help improve health outcomes and potentially reduce the overall healthcare costs among informal carers in Australia.

1. Background

Humans are inherently wired to require social networks and healthy social connections (Cacioppo et al., 2011; Martino et al., 2017). The absence of these social networks, which may lead to social isolation or loneliness, can trigger biological stress and have a significant impact on health (Singer, 2018). While social isolation is an objective state quantified by the reduced size of social networks and lack of social contact, loneliness is a subjective experience, which occurs when a person feels a discrepancy between desired and actual social relationships in terms of quality or quantity (Lim, 2020; Valtorta et al., 2016). Loneliness is increasingly recognized as a global public health issue due to its detrimental physical and mental effects (Holt-Lunstad and Report, 2017).

Research has linked loneliness to an increased risk of developing cardiovascular diseases (Knox and Uvnas-Moberg, 1998), cognitive deterioration (James et al., 2011), increased blood pressure (Hawkey et al., 2010), susceptibility to infectious illnesses (Cohen S et al., 1997), and an increased risk of early mortality (Stephoe et al., 2013). Additionally, loneliness has been associated with an increased risk of dementia (Kuiper et al., 2015), depression, and suicide (Cacioppo et al., 2006).

Important life transitions, inducing changes in one's social relations and interactions can trigger the onset of loneliness (Vasileiou et al., 2017). Taking on the role of an informal (unpaid) caregiver often constitutes a major life transition that is likely to disrupt one's status of social relations. Informal caregivers are individuals who provide care to those in need within existing relationships, such as family members,

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friends, or neighbours, extending their support beyond formal care settings (Health and Welfare, 2021). While caregiving can be fulfilling and positive, recent studies have found a connection between providing informal care and experiencing higher levels of loneliness (Hajek et al., 2021; Smith et al., 2018; Tebb and Jivanjee, 2000; Vasileiou et al., 2017). This is plausible given the fact that informal caregivers are often forced to reduce the time available for social interactions due to prioritizing caregiving (Schüz et al., 2015). The experience of loneliness among informal caregivers can further exacerbate stress (Pedreira et al., 2018) and hinder their ability to prioritize their own health (Duplantier and Williamson, 2023). Studies have also shown that caregiving can negatively impact caregivers' physical and mental health (Mohanty et al., 2020). When loneliness is added to the caregiving burden, it further exacerbates the challenges faced by caregivers, ultimately impacting their overall wellbeing (Bonin-Guillaume et al., 2022).

Health-related quality of life (HRQoL) is a multidimensional construct encompassing various health domains, including physical functioning, social and role-functioning, mental health, and other health perceptions (Yin et al., 2016). In health economics, preference-based measures, such as EQ-5D, Assessment of Quality of Life - 8 Dimension (AQoL-8D) or Short Form - 6 Dimension (SF-6D) are used to assess the HRQoL by gathering health state valuations from individuals, assigning a numerical value to describe the HRQoL associated with their specific health condition. This health state utility value is anchored on a scale from 0 to 1, where 0 represents the poorest possible health state (comparable to death or the worst imaginable health), and 1 represents perfect health (the best possible state) (Drummond et al., 2015). These values are then used in the calculation of quality-adjusted life years (QALYs), a key metric in cost-utility analysis. QALYs combine both the duration and the quality of life, making it a valuable tool for policymakers and healthcare professionals when making decisions about resource allocation in healthcare. Previous studies have independently explored the effects of loneliness on HRQoL (Majmudar et al., 2022) and the impact of being an informal carer on HRQoL (Litzelman et al., 2015). However, limited research has examined the combined effect of being an informal carer experiencing loneliness. Therefore, further exploration is required to examine the association between loneliness and informal carers utility values to gain a comprehensive understanding of the potential impacts and implications for targeted interventions.

Given the strong relationship between loneliness and health outcomes, and the associations between adverse health and health service use (HSU), a further area of research relates to the economic burden of loneliness and its association with HSU amongst informal carers. Understanding this relationship is critical to effectively address the unique healthcare needs of this vulnerable group and develop targeted interventions that can optimize their overall well-being. However, it is important to note that the pathways through which loneliness influences HSU among carers may vary.

Research findings regarding the HSU patterns of individuals experiencing loneliness has been inconsistent (Hastings et al., 2008; Molloy et al., 2010). Some research suggest an increased use of healthcare services, particularly in primary care services such as GP visits (Gerst-Emerson and Jayawardhana, 2015; Taube et al., 2015; Zhang et al., 2018), while other have not observed substantial change (Valtorta et al., 2018). Conversely, evidence, particularly among older adults, indicates a decrease in healthcare utilization, including preventive health services such as mammograms, dental visits, and immunizations (Vozikaki et al., 2018). Loneliness has also been associated with lower Medicare spending when adjusted for health status (Shaw et al., 2017). However, these instances of decreased usage could reflect barriers to access due to fewer support resources available to enable individuals to access outpatient and preventive services.

Compounding this issue is the existing caregiver burden in Australia where approximately 1 in 10 people in the community provide unpaid care to disabled or elderly individuals (Australian Bureau of Statistics, 2018). However, findings on HSU among informal caregivers have also

presented substantial inconsistency (Rahman et al., 2019). Some large population-based survey findings have found that caregivers tend to use outpatient healthcare services more frequently (Bremer et al., 2015; Chan et al., 2013) and seek mental healthcare more often than non-caregivers (Cochrane et al., 1997). Others have suggested no differences in healthcare utilization (Shaffer and Nightingale, 2020). Thus, it becomes essential to assess the added economic burden of loneliness among informal carers on their health service utilization (HSU) in Australia. With this, the aims of this study are 1) to explore the association between loneliness and HSU among informal carers and also 2) the association between loneliness and health state utility values of informal carers as measured by utility values.

2. Methods

Data were sourced from the Household Income and Labour Dynamics of Australia (HILDA) survey, a nationally representative panel survey launched in 2001. The survey collects data from 13,000 individuals within over 7000 households using a multistage sampling procedure (Roger Wilkins et al., 2019). The survey collects information on respondents' socio-demographic, economic, lifestyle, labour market activity, and health-related issues. Information is collected from household members aged 15 years and above, using a combination of self-completed questionnaires as well as in-person and telephone interviews administered by face-to-face trained interviewers. The HILDA survey was used in this research as it contains self-reported information on social constructs including loneliness, carer status, carers' HSU and uses the Short Form- 36-dimension (SF-36) instrument to assess HRQoL.

HSU data were not available in every wave of the survey. The HILDA survey began to gather information on HSU starting from wave 9 and collected these data every 4 years. Consequently, the current study utilized data from waves 9 (2009), wave 13 (2013) and wave 17 (2017) of the HILDA survey. The inclusion criteria for this study were a) individuals aged 18 and over; b) who provide informal care as defined by performing informal caregiving duty to any age group (disabled spouse, elderly parents or parents-in-law or those caring for an adult child, young child and relative) c) answering the 10 items of the social support questions in the Self-Completion Questionnaire. Our focus lies on caregiving duties that extend beyond the routine care provided to children and involve a level of assistance tailored to the unique needs of individuals requiring ongoing support due to disability, advanced age, or other circumstances. Participants who did not satisfy any of these criteria were excluded. A consort diagram is presented in the supplementary material (see Supplementary Material 1).

2.1. Exposure variable (loneliness)

The HILDA self-completion questionnaire gathers data on individuals' perceptions of the personal support and friendship available to them using the 10 items of social support questions (see Supplementary Material 2). A recent study constructed a scale based on the 10 items that measure loneliness as a separate construct to social isolation using exploratory structural equation modelling and multidimensional item response theory analysis (Manera et al., 2022). The authors identified 3 items with the strongest loadings on one factor which reflected the concept of loneliness (items 1, 2 and 7). Items 1, 2 and 7 were reverse coded to be in the same direction, with lower scores indicating higher loneliness, and a median score of 4 was used as a cut-off. Thus, individuals with a median score of less than 4 were categorized as lonely and those who scored 4 or more were categorized as not-lonely. Sensitivity analyses were conducted to compare the robustness of our results by using the one-item measure for loneliness (*I often feel very lonely*) an approach used by a recent study (Kung et al., 2021) (see Supplementary Material 3).

2.2. Outcome variables

Health Service Use (HSU): Participants in the HILDA survey were presented with a list of health professionals and asked to indicate whether they have visited any of them in the last 12 months (see Supplementary Material 4). Health professional visits were coded as a binary variable where respondents who reported visiting at least one health professional were coded as “yes”. Similarly, hospital admissions were coded as a binary variable if respondents reported an overnight stay and/or were admitted to hospital as a day patient in the last 12 months. General physician visits and hospital admissions were explored as a binary and continuous variable, whereby the number of visits and days in hospitals were used as outcome variables. Additional analyses were conducted exploring each health professional separately.

Health state utility value: The HILDA survey collects data on the HRQoL using, the Short Form-36 (SF-36), an internationally recognized tool for assessing functional health status and well-being. It comprises of 36 items which provide multi-item scales measuring each of eight distinct health dimensions (physical functioning, role-physical, bodily pain, general health, vitality, role-emotional, social functioning and mental health). For this study, SF-36 scores were converted into SF-6D utility scores (Brazier et al., 2002) using the Australian weights (Norman et al., 2013a). Compared to the SF-36, the SF-6D produces a single utility score that represents a person's HRQoL and reflects preferences of the general population in Australia for living in the different health states as defined by the measure.

2.3. Covariates

Additional variables were added to the model based on the Andersen and Newman Framework which explores factors influencing healthcare use, including individual characteristics (predisposing factors), available resources (enabling factors), and an individual's perceived or evaluated need for care (need factors) (Tesfaye et al., 2018). Efforts were made to avoid overfitting the model by selecting a parsimonious set of covariates that capture the essential predictors influencing healthcare utilization while maintaining model simplicity and generalizability. Based on the availability of data, the ‘pre-disposing variables’ included age of entry into the survey, sex, marital status, and formal education while income was included as an ‘enabling factor’. The income (in \$AUD) variable included in the HILDA survey refers to the Gross total income which includes wages, salary, pensions, government payments, etc if any. The selection of income as a covariate was informed by its availability in the dataset, its importance in addressing financial barriers to healthcare access among informal carers, and its alignment with the enabling factors identified in the theoretical framework. The HILDA survey also collects information on doctor-diagnosed physical health conditions, which include arthritis/osteoporosis, asthma, cancer, chronic bronchitis/emphysema, diabetes, heart disease, high blood pressure/hypertension, any other serious circulatory condition and mental health conditions including depression, anxiety, and other mental illness. These health conditions were included in the model as a part of the ‘need factors’ and analyses were adjusted for having at least one physical health condition and/or having at least one mental health condition. The same predictors were explored to assess the association between loneliness on the utility values among informal carers.

2.4. Statistical analyses

Descriptive statistics were used to assess the loneliness status of informal carers. Univariable analyses were performed to compare the baseline characteristics of participants and their HSU by the presence of loneliness using chi-squared test for categorical variables and Wilcoxon rank-sum test for count variables. We employed Generalized Estimating Equation (GEE), a kind of regression analysis that examines the correlations between repeated measures in a person, including subjects

regardless of missing values. Given the repeated measurements of individuals across waves 9, 13, and 17, GEE was deemed appropriate for examining correlations among these measures within each participant, irrespective of missing data points. To address the inherent autocorrelation within participants, we utilized an unstructured covariance matrix within the GEE framework. Additionally, to ensure robustness in our estimates, we incorporated Huber's robust approach for computing standard errors. This methodological approach allowed us to investigate the associations between HSU and loneliness, as well as utility values and loneliness, while adequately accounting for within-person correlation. GEE was chosen to account for the correlated nature of the data, even though the primary interest was not to look at it over time. Further, by employing GEE models, we ensured robust estimation of associations, further enhancing the validity of our findings in establishing causal links within the context of longitudinal data analysis.

In our analysis, all carers were pooled together across waves, ensuring consistency in the sample composition. Both outcomes and covariates were concurrently analyzed at each time point (t), allowing for the assessment of contemporaneous associations within each wave. In the GEE model, health service use and health state utility values were the outcome variables, and presence/absence of loneliness was used as exposure variable. Further covariates were added in a stepwise manner. Depending on the type of outcome variable, different families of GEE were used. For binary outcome variables (health professional visits, GP visits and hospital visits), the binomial family with a logit link function was used to estimate the odds ratio (OR)/adjusted odds ratio (AOR). For count variables (GP visits, hospital admissions, HSU score and utility values), the Poisson family with a log link function was used to estimate the incidence rate ratio (IRR). Regression diagnostic procedures (e.g., residual plots and diagnostic tests) indicated that a log link function is appropriate. Model 1 consisted of an unadjusted model, model 2 was adjusted for age and sex, model 3 adjusted model 2 further for income, marital status and education and model 4 adjusted model 3 additionally for health conditions (presence of physical and/or mental health conditions). Covariates were included in a stepwise manner to control for potential confounding variables and to identify the most important predictors of the outcome variable. We used the quasi-likelihood information criterion (QIC) to compare competing models. A smaller QIC score suggests a better fitting model (Pan, 2001). Statistical significance was set at 0.05 for all analyses. All statistical analyses were performed using the statistical software Stata, version 17.0. A detailed list of variables is provided. (See Supplementary Material 5).

3. Results

Table 1 provides the characteristics of participants at each selected wave of the HILDA study. The overall sample consisted of 737 informal carers in wave 9; 1028 in wave 13; and 1073 in wave 17. The sample characteristics appear similar across all waves. The mean age of informal carer at baseline (wave 9) was 53 years, with around 38% aged 50–65 years. The majority (64%) were female, 73% were married or de facto, 90% lived with a child or other family members and around 57% of total respondents were from major cities. Most respondents were born in Australia (78%) and around 50% of the respondents had an income greater than \$75,000 (AUD). Around 10% of the participants had at least one physical condition and around 32% had reported at least one mental health condition.

Table 2 shows the baseline characteristics of the participants by their loneliness status as measured by the 3-item and reports that 20% experienced loneliness. Among those who experienced loneliness, 66% were women and most of the lonely respondents were aged 50–65 years (34.6%) and residing in the major cities (58%). Lonely carers compared to non-lonely carers differed with respect to important characteristics including educational level, whereby lonely carers had lower higher education levels (33.3% vs. 55.4%); were living with a child or family member (88% vs. 92%); being married or in a de-facto relationship

Table 1
Characteristics of all informal carers across each selected wave of the HILDA study.

	Wave 1 (n = 737)	Wave 2 (n = 1028)	Wave 3 (n = 1073)
Gender n (%)			
Women	470 (63.77)	675 (65.66)	700 (65.24)
Men	267 (36.23)	353 (34.34)	737 (34.76)
Age (Mean (SD))	52.96 (14.84) [18–89]	53.92 (15.10) [18–92]	54.70 (14.70) [20–90]
Less than 40	125 (18.33)	179 (18.80)	186 (18.33)
40–50	149 (21.85)	174 (18.28)	185 (18.23)
50–65	260 (38.12)	376 (39.50)	384 (37.83)
65 and above	148 (21.70)	223 (23.42)	260 (25.62)
Remoteness			
Major City	415 (56.31)	600 (58.37)	561 (52.28)
Regional or remote Australia	322 (43.69)	428 (41.63)	512 (47.72)
Education			
Adv Diploma/Cert III or IV/ Bachelors/Grad diploma/ Postgrad/Doctorate	375 (50.88)	568 (55.25)	631 (58.81)
Year 12 and below	362 (49.12)	460 (44.75)	442 (41.19)
Living Setting			
Living with child/other family member	672 (91.18)	930 (90.74)	967 (90.12)
Living alone	65 (8.82)	98 (9.53)	106 (9.88)
Marital Status			
Married/de-facto	539 (73.13)	758 (73.74)	777 (72.41)
Not Married/separated/divorced/widowed	198 (26.87)	270 (26.26)	296 (27.59)
Country of Birth			
Born in Australia	592 (80.43)	783 (76.17)	826 (77.05)
Born outside Australia	144 (19.57)	245 (23.83)	246 (22.95)
Income^c			
<25000	67 (9.09)	66 (6.43)	55 (5.13)
25000–49999	176 (22.88)	273 (26.58)	250 (23.30)
50000–74999	136 (18.45)	180 (17.53)	202 (18.83)
≥75000	385 (48.58)	508 (49.46)	566 (52.75)
Health Conditions			
At least one physical condition^a			
Yes	41 (9.36)	68 (10.49)	84 (12.30)
No	397 (90.64)	580 (89.51)	599 (87.70)
At least one mental condition^b			
Yes	137 (31.28)	207 (31.94)	249 (36.46)
No	301 (68.72)	441 (68.06)	434 (63.54)
SF-6 score: mean sum (SD)	N = 698	N = 982	N = 1024
N	0.723 (0.125) [0.392–1]	0.719 (0.126) [0.37–1]	0.716 (0.126) [0.352–1]

Footnote: Numbers in the tables do not necessarily add up due to missing values.

^a Includes respondents who have reported having one of the following physical health conditions as told by the doctor or nurse-arthritis/osteoporosis, asthma, cancer, chronic bronchitis/emphysema, type 1 diabetes, type 2 diabetes, heart disease, high blood pressure/hypertension, and any other serious circulatory condition. This is irrespective of them having any mental health conditions.

^b Includes respondents who reported having depression or anxiety irrespective of reporting any physical health conditions.

^c Income is calculated in terms of Household income.

(65.3% vs. 75.1%); and a lower proportion of carers had income levels greater than \$75,000, (33.3% vs. 54.5%). Compared to the non-lonely informal carers, lonely informal carers reported a significantly higher proportions least one mental health condition (48.3% vs 25.3%) and a lower HRQoL utility value using the SF-6D (0.66 vs 0.74). Baseline distribution of respondents based on the two measures used to assess loneliness is provided (Supplementary Material 6). Using the one-item scale as sensitivity analysis also resulted in the similar results (Supplementary Material 7).

Table 3 provides baseline information on the HSU based on the respondent’s status of experiencing loneliness. Lonely informal carers reported a significantly higher number of mean visits to the GP (8.9 vs 5.4). Compared to the non-lonely informal carers, lonely carers,

Table 2
Baseline Characteristics of participants by levels of loneliness (3-item).

	All n (%) (n = 737)	Lonely 150 (20.35)	Not lonely 587 (79.65)
Gender			
Women	470 (63.77)	99 (66.00)	371 (63.20)
Men	267 (36.23)	51 (34.00)	216 (36.80)
Age mean (SD) [Min-Max]	52.96 (14.84) [18–89]	54.56 (15.34) [19–85]	52.55 (14.70) [18–89]
Less than 40	125 (18.33)	26 (18.44)	99 (18.30)
40–50	149 (21.85)	31 (21.99)	118 (21.81)
50–65	260 (38.12)	49 (34.75)	211 (39.00)
Above 65 years	148 (21.70)	35 (24.82)	113 (20.89)
Remoteness			
Major City	415 (56.31)	87 (58.00)	328 (55.88)
Regional or remote Australia	322 (43.69)	63 (42.00)	259 (44.12)
Education			
Adv Diploma/Cert III or IV/ Bachelors/Grad diploma/ Postgrad/Doctorate	375 (50.8)	50 (33.33)	325 (55.7)*
Year 12 and below	362 (49.12)	100 (66.67)	262 (44.63)
Living Setting			
Living with child/other family member	672 (91.2)	132 (88.0)	540 (91.9)*
Living alone	65 (8.82)	18 (12.00)	47 (8.01)
Marital Status			
Married/de-facto	539 (73.1)	98 (65.3)	441 (75.3)*
Not Married/separated/divorced/widowed	198 (26.87)	52 (34.67)	146 (24.87)
Country of Birth			
Born in Australia	592 (80.43)	112 (74.67)	480 (81.91)
Born outside Australia	144 (19.57)	38 (25.33)	106 (18.09)
Income⁺			
<25000	67 (9.09)	26 (17.33)	41 (6.9)*
25000–49999	176 (22.88)	45 (30.00)	131 (22.32)
50000–74999	136 (18.45)	29 (19.33)	107 (18.23)
≥75000	385 (48.58)	50 (33.33)	308 (54.47)
Health Conditions			
At least one physical condition^a			
Yes	397 (90.64)	103 (90.35)	294 (90.74)
No	41 (9.36)	11 (9.65)	30 (9.26)
At least one mental condition^b			
Yes	137 (31.8)	55 (48.25)	82 (25.31)*
No	301 (68.72)	59 (51.75)	242 (74.69)
N	N = 698	N = 142	N = 556
SF-6D score: mean sum (SD) [Min-Max]	0.723 (0.13) [0.392–1]	0.654 (0.13) [0.398–0.958]	0.741 (0.74)* [0.392–1]

Footnote: Numbers in the tables do not necessarily add up due to missing values.

*Significance test level (p < 0.05).

⁺Income is calculated in terms of Household income.

^a Includes respondents who have reported having one of the following physical health conditions as told by the doctor or nurse-arthritis/osteoporosis, asthma, cancer, chronic bronchitis/emphysema, type 1 diabetes, type 2 diabetes, heart disease, high blood pressure/hypertension, and any other serious circulatory condition. This is irrespective of them having any mental health conditions.

^b Includes respondents who reported having depression or anxiety irrespective of having any physical health conditions.

reported significantly higher proportions of hospital doctor visits (39.6% vs 22.7%), and a higher proportion of visits to the mental health professional visits (15.1.7% vs 9.7%). Lonely informal carers reported significantly lower proportions of visits to the dentist compared to non-lonely informal carers (47.3 % vs 61.7%). No statistically significant results were found in terms of the number of hospital visits between the lonely and non-lonely informal carers. Conducting a sensitivity analysis using the one-item scale yielded similar results, along with the additional observation of a higher proportion of visits to alternative health practitioners (16.81% vs. 7.06%) (Supplementary Material 8).

Table 4 presents the results of the GEE analysis investigating the association between loneliness with HSU and health state utility values,

Table 3
Health Service Utilization across levels of loneliness as measured by the 3-item scale (Baseline).

	All	Lonely	Not lonely
All	(n = 737)	150 (20.35)	587 (79.65)
Medical Professional (yes)^a	691 (93.76)	139 (92.67)	552 (94.04)
GP visits Yes	663 (89.96)	132 (88.00)	531 (90.46)
No of GP visits Mean (SD) [Min-Max]	N = 735 6.15 (7.321) [0–52]	N = 150 8.92 (9.98) [0–52]	N = 585 5.44 (6.28) [0–52]
Dentist Visits N (%)	433 (58.7)	71 (47.3)	362 (61.7) *
Family doctor N (%)	663 (89.96)	132 (88.00)	531 (90.46)
Hospital doctor visits N (%)	140 (26.2)	42 (39.6)	98 (22.9)*
Specialist doctor visits	258 (49.9)	58 (54.7)	200 (46.3)
Mental health professional visits	58 (10.78)	16 (15.09)	42 (9.72)
Podiatrist (foot doctor) visits	75 (13.94)	12 (11.30)	63 (14.58)
A chiropractor or osteopath	106 (19.70)	17 (16.04)	89 (20.69)
A physiotherapist	103 (19.14)	18 (16.98)	85 (19.68)
An optometrist	235 (43.7)	53 (50.0)	182 (42.1)
Any other allied health provider, such as an optometrist, speech therapist, audiologist or occupational therapist	76 (14.13)	10 (9.43)	66 (15.28)
An alternative health practitioner, such as a naturopath, acupuncturist or herbalist	49 (9.11)	19 (17.92)	30 (6.94)
A community nurse, practice nurse, nurse practitioner or midwife	25 (4.65)	7 (6.60)	18 (4.17)
Hospital Visits (yes)			
Any hospital admission ^b	196 (26.59)	46 (30.67)	150 (25.55)
Overnight stay	114 (15.47)	29 (19.33)	85 (14.48)
Day patient	110 (14.93)	27 (18.00)	83 (14.14)
No of admission (overnight)	N = 114	N = 29	N = 85
Mean [SD]	1.59 (0.98)	1.79 (1.32)	1.52 (0.84)
[Min-Max]	[1–7]	[1–7]	[1–5]
No of Nights in the hospital	N = 114	N = 85	N = 29
Mean [SD]	5.98 (7.67)	7.03 (8.95)	5.6 (7.23)
[Min-Max]	[1–42]	[1–40]	[1–42]

This table includes only those respondents who stated a yes to the visiting health professional survey question.

* Significance test level ($p < 0.05$).

^a This is the variable used in the analysis which includes visiting at least one of the health care providers as stated above: GP, family doctor, specialist, or any other health care providers.

^b This is the variable used in the analysis and includes respondents admitted to the hospital as either a day patient or overnight patient.

with individuals not experiencing loneliness serving as the reference group. Based on model fit indices, the model with the lowest QIC was selected as the final model. For GP visits as a binary outcome, no significant associations were observed across all four models. However, when examining the frequency of GP visits (count outcome), loneliness showed a statistically significant association with a higher number of GP visits where the significance persisted after adjusting for covariates in all four models (IRR = 1.18, 95% CI [1.04, 1.36], $p = 0.011$). Regarding hospital visits as a binary outcome, loneliness was found to be significantly associated with a higher likelihood of having hospital visits after adjusting for age, sex, education, marital status, and income. However, when adjusting for presence of other health conditions, it was no longer significant. Exploring the number of hospital admissions as count outcome suggested a lower number of hospital visits, but this association was not statistically significant. Findings also suggested that loneliness was associated with higher likelihood of visiting specialists (AOR = 1.31, 95% CI [1.02, 1.71], $p = 0.046$) and hospital doctors (AOR = 1.42, 95% [1.07, 1.87], $p = 0.013$) after adjusting for the covariates. The GEE results also revealed that lonely informal carers had a lower utility value

using the SF-6D (IRR = 0.91, 95% CI [0.89, 0.93], $p < 0.001$) compared to non-lonely informal carers across all four models.

A sensitivity analysis was conducted to explore the association between loneliness on HSU and utility values among informal carers using the one-item loneliness scale (Supplementary Material 9). In comparison to the use of the 3-item scale, similar results were observed regarding loneliness being associated with an increased number of GP visits (IRR = 1.08, 95% CI [1.03, 1.22], $p = 0.032$), an increased likelihood of visiting specialists (AOR = 2.25, 95% CI [1.68, 3.00], $p < 0.001$) and higher mental health professional visits (AOR = 1.53, 95% CI [1.11, 2.18], $p < 0.001$). Additional findings revealed a lower likelihood of dental visits (AOR = 0.70, 95% CI [0.56, 0.89], $p < 0.001$), optometrist (AOR = 0.74, 95% CI [0.56, 0.95], $p = 0.024$) and a reduced number of hospital admissions (IRR = 0.68, 95% CI [0.48, 0.95], $p = 0.026$). In terms of the association with utility values among informal carers, they also reported experiencing lower utility values (IRR = 0.76, 95% CI [0.72, 0.81], $p < 0.001$).

4. Discussion

The study findings underscore the significant HSU and health burden associated with loneliness among informal carers in Australia. In comparison to the 20% of carers experiencing loneliness in our study, another study conducted in Australia found that carers were three times more likely to experience loneliness regularly. Of the 11 % of the overall Australian population that are carers 35% of carers reported feeling lonely often or always (Carers Australia, 2021). This discrepancy underscores potential variations in loneliness prevalence among different caregiving populations. Factors such as sample demographics, caregiving intensity, cultural differences, or the methodology for measuring loneliness could contribute to these differences in reported loneliness levels (Majmudar et al., 2022). To the best of our knowledge, this research is the first study to explore the association between loneliness and HSU as well as health state utility values among informal carers using a longitudinal dataset in Australia. Our results show that, overall, informal carers experiencing loneliness tend to utilize more healthcare services compared to non-lonely carers; however, this relationship varies across types of healthcare services. Additionally, we found that informal carers experiencing loneliness exhibit lower overall utility values compared to non-lonely informal carers.

Even after accounting for caregivers' socio-demographic and health attributes, loneliness continued to emerge as a significant factor associated with increased healthcare use, particularly increase in the frequency of GP visits, and increased likelihood of visiting hospital doctors and specialists. While there is limited research comparing HSU between carers and non-carers (Shaffer and Nightingale, 2020), some studies have noted an increase in doctor visits among informal carers compared to non-carers, especially among carers caring for patients with Alzheimer's and other memory related problems (Chan et al., 2013; Rahman et al., 2019; Schubert et al., 2008; Schulz and Cook, 2011; Zhu et al., 2015). Studies that have explored the association between loneliness and HSU within the general population across all age groups have reported a higher use of primary care and GP visits among lonely individuals compared to non-lonely individuals (Taube et al., 2015; Zhang et al., 2018). Given the decline in physical health over time due to caring responsibilities (Vasileiou et al., 2017; Vitaliano et al., 2003) along with the significant health implications of loneliness on its own (Lara et al., 2019; Xia and Li, 2018), our findings thus highlight the exacerbated impact of experiencing loneliness among informal carers, revealing how this combined effect can have substantial implications for healthcare utilization and overall well-being.

Our study highlights a significant association between experiencing loneliness among informal carers and an increased frequency of visits to mental health professionals. Previous research has demonstrated the detrimental effects of being a carer on one's mental health, especially depressive symptoms and psychological distress (Hirst, 2005; Hussain

Table 4
Association between loneliness (using the 3-item measure) with health service utilization and Health-related quality of life across waves using GEE analysis.

	Model 1				Model 2				Model 3				Model 4			
	OR	95 % CI	p value	QIC value	AOR	95 % CI	p value	QIC value	AOR	95 % CI	p value	QIC value	AOR	95 % CI	p value	QIC value
Binary variables (Lonely, yes = 1)																
<i>Any health Professional visit</i>	0.81	0.55, 1.18	0.281	1255.32	0.79	0.53, 1.18	0.254	1171.47	0.85	0.56, 1.29	0.45	1172.02	0.54	0.24,1.27	0.162	331.201
<i>GP visits</i>	0.99	0.72, 1.35	0.932	1831.07	0.99	0.72, 1.34	0.962	1759.34	1	0.72, 1.39	0.978	1764.54	0.89	0.47,1.67	0.725	586.74
<i>Hospital visits</i>	1.3	1.06, 1.58	0.012	3408.75	1.3	1.06, 1.58	0.011	3398.433	1.27	1.03, 1.55	0.024	3389.77	1.05	0.85,1.38	0.509	2261.79
<i>Dentist Visit</i>	0.69	0.57, 0.83	<0.001	3874.79	0.69	0.57, 0.83	<0.001	3862.42	0.77	0.64, 0.94	0.009	3805.04	0.78	0.62, 1.0	0.051	2377.38
<i>Specialist Visit</i>	1.3	1.05, 1.61	0.015	2930.25	1.36	1.09, 1.69	0.005	2896.49	1.37	1.10, 1.71	0.005	2897.26	1.31	1.02,1.71	0.046	1952.78
<i>Mental Health Visit</i>	2.22	1.66, 2.97	<0.001	1538.57	2.01	1.49, 2.72	<0.001	1434.04	1.94	1.43,2.65	<0.001	1438.38	1.32	0.89,1.95	0.159	895.78
<i>Family Doctor</i>	0.98	0.71, 1.36	0.924	1717.6	1	0.71, 1.39	0.993	1656.98	1.02	0.72,1.42	0.928	1662.86	0.94	0.49,1.82	0.863	556.46
<i>Hospital Doctor</i>	1.77	1.41,2.22	<0.001	2376.85	1.72	1.36, 2.17	<0.001	2364.73	1.56	1.23, 1.98	<0.001	2338.39	1.42	1.07,1.87	0.013	1685.51
<i>Chiropractor Visit</i>	0.86	0.64, 1.16	0.34	1954.86	0.85	0.62, 1.14	0.276	1953.44	0.93	0.68, 1.28	0.628	1943.04	0.96	0.66,1.39	0.836	1280.59
<i>Physiotherapist Visit</i>	0.82	0.62, 1.08	0.155	2223.78	0.81	0.61, 1.06	0.123	2223.5	0.86	0.65, 1.12	0.272	2225.32	0.8	0.57,1.11	0.184	1559.41
<i>Optometrist Visit</i>	0.85	0.68, 1.05	0.134	2925.92	0.88	0.71, 1.10	0.263	2867.02	0.9	0.72, 1.14	0.355	2870.86	0.82	0.63,1.07	0.156	1969.69
<i>Allied Health Services Visit</i>	1.12	0.80, 1.58	0.486	1490.41	1.08	0.77, 1.53	0.643	1441.83	1.18	0.84, 1.67	0.341	1422.63	1.32	0.88,1.98	0.167	933.476
<i>Alternative Health Practitioner Visit</i>	1.64	1.18,2.27	0.003	1451.91	1.61	1.17, 2.24	0.004	1450.62	1.53	1.11, 2.13	0.011	1443.14	1.31	0.89,1.91	0.164	1073.01
<i>Community Nurse Visit</i>	1.01	0.66, 1.55	0.937	1044.13	1.06	0.69, 1.62	0.783	1035.98	1.08	0.70, 1.66	0.718	1023.19	1.22	0.76,1.93	0.397	786
Count Variables (Lonely, yes = 1)																
	RR	95 % CI	p value	QIC value	IRR	95 % CI	p value	QIC value	IRR	95 % CI	p value	QIC value	IRR	95 % CI	p value	QIC value
<i>Number of GP visits</i>	1.35	1.19, 1.53	<0.001	15529.38	1.34	1.19, 1.53	<0.001	15517.18	1.3	1.14, 1.48	<0.001	14774.98	1.18	1.04,1.36	0.011	9876.98
<i>Number of hospital admissions</i>	1.26	0.96, 1.64	0.09	1712.36	1.23	0.97, 1.62	0.08	1719.42	1.18	0.91, 1.55	0.211	1670.83	0.99	0.71,1.40	0.979	1175.24
<i>Health-Related Quality of Life</i>	0.89	0.88, 0.91	<0.001	58.392	0.89	0.88, 0.91	<0.001	58.39	0.89	0.88, 0.91	<0.001	56.24	0.91	0.89,0.93	<0.001	30.909

In the GEE model, health service use is the outcome variable, and presence/absence of loneliness was used as exposure variable. Further covariates were added in a stepwise manner.

*Model 1: Unadjusted Model; Model 2: Adjusted for age and sex; Model 3: Adjusted for age, sex, education, marital status, and income; Model 4: Adjusted for age, sex, education, marital status, income, having atleast one physical health conditions or having mental health conditions.

Reference group used in the analysis is the group of individuals who do not experience loneliness.

Quasi-likelihood information criterion (QIC) was used as a goodness-of-fit measure with lower QIC values indicating a better fit.

Rate ratios (RR); Incidence rate ratios (IRR); Odds Ratio (OR); Adjusted odds ratio (AOR).

et al., 2016) along with using mental health services twice as often as non-carers (Cochrane et al., 1997). Additionally, loneliness has been shown to further worsen overall mental well-being (Cacioppo et al., 2010; Kuiper et al., 2015) and leading to an increased use of mental health services (Meisters et al., 2021). It was observed in our sample that a larger proportion of lonely informal carers reported at least one mental health issue compared to their non-lonely counterparts. Thus, increased utilization of mental health services among informal carers may be attributed to their dual experience of loneliness and caregiving responsibilities.

The current study findings also revealed that lonely informal carers had lower rates of hospitalization, dentist visits, and ophthalmologist visits. These lower utilization rates could be attributed to practical and psychological barriers faced by caregivers in accessing healthcare services, such as difficulties with scheduling, limited time, and prioritizing the care recipient's needs above their own (Duplantier and Williamson, 2023; Flyckt et al., 2015; Sabo and Chin, 2021; Temple et al., 2021; Wolfs et al., 2012). Cost has also been reported as one of the barriers in seeking services which can potentially be reflected in the reduced visits to dentists and ophthalmologists as these services are not publicly subsidised in Australia (except for people on low incomes who are eligible for health care cards). As most informal carers have sacrificed their working hours and may undergo financial hardship, the impact is directly seen in using fewer healthcare resources (Gardiner et al., 2014). Additionally, informal carers might also postpone or avoid seeking certain health services, like elective surgeries, due to concerns about care replacement during that time. This decision can have serious long-term health implications, especially considering the evidence that individuals who underutilize healthcare services may experience more severe health consequences associated with caregiving (Lichtenthal et al., 2011). Also, the experience of loneliness in itself can intensify emotional isolation and demotivate or discourage informal carers from seeking help or medical attention (Pietrabissa and Simpson, 2020), which can also act as a barrier to accessing various health services. Thus, informal carers experiencing loneliness encounter additional challenges in accessing certain healthcare services, and such barriers could be the reason for the observed lower use of healthcare services such as dental, ophthalmologists, or hospital visits. Addressing these barriers is essential to support the well-being of informal carers and ensure they receive the necessary medical care they require.

In terms of HRQoL of informal carers, as measured by the SF-6D, our study revealed significantly lower utility values among lonely informal carers compared to their non-lonely counterparts. Furthermore, the utility value scores for lonely carers were found to be even lower than scores reported for the Australian population norm (Norman et al., 2013b). To the best of our knowledge, no previous study has explored the association between loneliness and the utility values of informal carers. While previous research highlighted lower utility values among informal carers as well as among lonely individuals compared to those who do not experience loneliness, our findings provide a unique contribution of exploring the joint effects of experiencing loneliness and providing informal care.

4.1. Strengths and limitations

The findings of this study make a significant contribution to the existing literature as it is the first study to provide valuable insights into the health service utilization and health implications of loneliness among informal carers in Australia. The longitudinal analysis in our study not only addresses endogeneity concerns inherent in cross-sectional studies but also employs GEE models to mitigate potential biases arising from correlated observations within individuals over time. By utilizing a longitudinal dataset, the study accounts for a more robust analysis of the relationship between loneliness with HSU and utility values among informal carers compared to previous cross-sectional studies. The study used two approaches to measure loneliness, thus

enhancing the robustness of its findings and providing a more well-rounded assessment of loneliness among informal carers.

In terms of study limitations, our study used the SF-6D, a generic measure which was unable to measure HRQoL specific to informal carers health outcomes. There are carer-specific measures available such as CarerQoL, CES, and ASCOT-Carer (Al-Janabi et al., 2011; Brouwer et al., 2006; Rand et al., 2015). Future research could incorporate these measures which can provide a more comprehensive understanding of the relationship between loneliness and caregiving burden. Previous studies have compared these measures and can guide the selection of outcome measures specifically tailored for carers, which is particularly valuable in economic evaluations where interventions may have varying impacts on carers and different aspects of informal care (Engel et al., 2020; McCaffrey et al., 2020; McLoughlin et al., 2020). Additionally, there are other generic MAUIs available and future research could examine which MAUI is more appropriate for loneliness research. Furthermore, the use of self-reported HSU data may be subject to recall bias, potentially affecting the accuracy of reported healthcare utilization. The study's sample size constraints prevented in-depth sub-group analysis. For example, loneliness has been found to be particularly pronounced in younger and older populations and we were unable to explore the association between age and HSU as well as utility values. In our research, we could not factor in ethnicity due to data unavailability. However, future studies should include ethnicity given the growing evidence that belonging to ethnic minority groups is linked to loneliness (Cotterell et al., 2024). Also, due to data unavailability, we were unable to capture the number of hours of care by carers. Lastly, the study doesn't detail the health conditions of care recipients, which could have offered valuable insights into how various caregiving needs connect to loneliness and healthcare use. The effect on the caregiving burden may vary for carers tending to individuals with distinct health conditions. Therefore, future studies that include the care recipient's type of condition would yield important findings. While this study explored the HSU associated with loneliness, future studies should assess the overall economic implications by attaching unit costs to health services and other resources used.

5. Conclusion

In conclusion, while this study has demonstrated the significant association between loneliness with HSU and utility values among informal carers, there is a pressing necessity for further research. Considering the health condition of the care recipients, age of carers, and utilizing appropriate measurement tools to assess the overall caregiving burden will contribute to a more comprehensive understanding. Ultimately, such research will lead to the development of more targeted interventions and support programs aimed at alleviating the adverse effects of loneliness and promoting the overall well-being of informal carers in our society. This study also highlights the urgent need for policymakers to develop targeted interventions to address loneliness among informal carers in Australia. Policymakers should prioritize the implementation of specialized mental health services, social support programs, and caregiver-specific assessment tools. These policy measures can improve the well-being of informal carers, encourage them to seek necessary healthcare, and ensure carers receive the necessary support to fulfill their caregiving responsibilities effectively.

Statement EA not required

Given the use of the pre-existing survey dataset (Household, income, and labour dynamics in Australia (HILDA)), ethics approval is not applicable.

CRedit authorship contribution statement

Ishani Kartik Majmudar: Writing – original draft, Project

administration, Methodology, Funding acquisition, Formal analysis, Data curation. **Cathy Mihalopoulos**: Supervision. **Julie Abimanyi-Ochom**: Writing – review & editing, Supervision, Conceptualization. **Mohammadreza Mohebbi**: Methodology, Conceptualization. **Lidia Engel**: Writing – review & editing, Supervision, Project administration.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2024.116821>.

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