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Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource

Social isolation and health service use

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Key Points

- This study explored two measures of possible social disconnectedness (social isolation and living alone) and their impact on health, health care and mortality using the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource (CES-P&CH).
- The demographic, social and health characteristics associated with living alone differed substantially from those associated with social isolation.
- Social isolation was not found to be associated with higher service use or mortality. However other studies have found associations between social isolation and increased service use and mortality.
- Living alone was found to be associated with increased use of general practice (GP) chronic disease management services (CDM).
- Living alone was also significantly associated with increased emergency department (ED) presentations and hospitalisation, but not mortality.
- The evidence both from our study and the literature, show that living alone is associated with an increased risk of presentation at ED and hospitalisation. Service providers should be aware that individuals who live alone may be more vulnerable, and should seek to provide or refer them to the necessary support services.
- Although it was not possible to explore loneliness in this analysis (because it was not included in the 45 and Up Study), questions on loneliness, using the De Jong Loneliness Scale, have now been included in the 2020 follow-up, and will be available in early 2021.

Executive Summary

The Third Annual Research Priorities Forum for the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource (CES-P&CH) in 2019, identified as a major issue, the need to better understand the impact of social isolation, loneliness and living alone, on health service delivery. This report aims to provide a better understanding of the impact of social isolation, loneliness and living alone, on health, health outcomes and health service use, using the CES-P&CH. However, the report focuses only on social isolation and living alone, as information on loneliness was not available in CES-P&CH.

The overall aim of this project was to explore the association between social isolation and demographic, social and health factors, health service use, continuity of care, and health outcomes. We also explored the association between living alone and demographic, social and health factors and health service use, and how social isolation and living alone differ.

This study included people who both enrolled in the 45 and Up Study and participated in the Social, Economic and Environmental Factors (SEEF) sub-study survey in 2010 (6,176 participants from Central and Eastern Sydney [CES] and 21,405 from Metropolitan Sydney). Social isolation was measured using the Duke Social Support Index (DSSI) social interaction subscale, using the lowest quintile as the socially isolated group (approx. 20%), and living alone was based on a question related to how many people live in the household.

Demographic, social and health factors were based on data reported in the SEEF survey. Health service use was based on linked data from Medical Benefits Schedule (MBS) claims with Admitted Patient Data Collection (APDC) and Emergency Department (ED) Data Collection. Mortality was based on linked data from the Death Registry. Annual health service use was averaged over three years (2009-2011) around the time of the SEEF survey (2010), and mortality and re-hospitalisations were measured between 2012 and 2016.

To assess if factors were independently associated with social isolation or living alone, we calculated adjusted prevalence ratios and associated 95% confidence intervals (Adj PR [95% CI]), controlling for other potentially confounding factors.

Social isolation

Association between social isolation and demographic, social and health factors

Socially isolated participants in CES were more likely to be from a culturally and linguistically diverse (CALD) background, be in full-time work, be psychologically distressed, report poor quality of life and report having heart disease. Socially isolated participants were less likely to be aged between 60 and 84 years, be female, have higher educational qualifications (certificate, diploma, university degree or higher), have private health insurance, live alone, be a parent, have adequate physical activity, have adequate fruit and vegetable intake, consume alcohol or report they needed help for their daily activities.

Association between social isolation and health service use and mortality

During the period 2009-2011, 97.9% of participants in CES had at least one GP encounter per year (mean of 7.9), and 16% had 13 or more encounters per year. During this period, just over 30% of participants at least one ED presentation per year, and a similar percentage had at least one hospitalisation per year. Social isolation was not associated with frequent GP encounters (13 or more per year), ED presentations (one or more per year) or hospitalisations (one or more per year), or with five-year mortality.

Based on data from the Sydney Metropolitan region, participants from a CALD background who were socially isolated, were more likely to be frequent GP users (13+/per year), compared with CALD

participants who were not socially isolated [Adj. PR (95% CI): 1.25 (1.06, 1.46)]. No significant associations were found between social isolation and ED presentations, hospitalisations or five-year mortality in this group.

Association between social isolation and access to GP chronic disease management services

During the period 2009-2011, 28.2% of CES participants had one or more MBS item claims for the preparation of GP Management Plans (GPMP) or Team Care Arrangements (TCA); 12.9% had claims for review of GPMP/ TCA, and 20.6% had claims for MBS subsidised allied health care services.

No association between social isolation and preparation of GPMP or TCA was observed. However, while participants who were socially isolated were more likely to have a claim for a review of the plan (Adj PR [95% CI]:1.22 [1.02, 1.45]), this was not the case for allied health services.

Any GPMP or TCA use in 2009-2011 for socially isolated participants (using Sydney Metropolitan area to have an adequate sample), was associated with a 36% higher risk of hospitalisation (Adj PR [95% CI]:1.36 [1.23, 1.50]) and a 42% increased risk of death (2012-2016) (Adj PR [95% CI]:1.42 [1.12, 1.80]).

Association between social isolation and continuity of GP care, re-hospitalisation and mortality

Continuity of GP care was defined in two ways: those who had seen the same GP 30 days before and 30 days after a hospitalisation, and those who had seen a GP over the same periods but not necessarily the same one. Continuity of GP care (using both measures) was more likely to be associated with re-hospitalisation within 12-months. However, when limited to those who were socially isolated, there was no association. There was also no significant association between continuity of GP care and five-year mortality.

Living alone

Association between living alone and demographic, social and health factors

Participants who lived alone were more likely to: be of an older age (60 years and older), be female, be a current smoker, have poor self-assessed quality of life, be treated for high blood pressure and have had at least one fall in the previous 12-months. Participants who lived alone were less likely to: be from a CALD background, have a higher income, have private health insurance, consume 14 or more alcoholic drinks per week, and report needing help with daily activities.

Association between living alone and health service use and mortality

Living alone was significantly associated with one or more ED presentations [Adj. PR (95% CI):1.32 (1.05, 1.64)] and one or more overnight hospitalisation [Adj. PR (95% CI):1.36 (1. 90, 1.68)] between 2009 and 2011. There was no association between living alone and frequent GP use (13 or more encounters) or five-year mortality.

Association between living alone and access to GP chronic disease management services

Living alone was associated MBS claims for GPMP/ TCA preparation [Adj. PR (95% CI):1.13 (1. 01, 1.27)], but not with reviews of GPMP or TCA, or use of allied health services.

Comparison between social isolation and living alone

The demographic, social and health characteristics associated with living alone appear to differ substantially from those associated with social isolation (see Table below). The only independent factors associated with both, were being more likely to self-report poor quality of life, and less likely to have private health insurance, be a parent or need help with daily activities. A larger proportion of participants who lived alone had higher health service use and used GP chronic disease management services, compared to those who were socially isolated.

Comparison of "independent factors" associated with social isolation and living alone

Characteristic		Social Isolation	Living alone
Demographic	More likely	Having CALD background	Older age (60 years and older) Being female
	Less likely	Aged between 60 and 84 years Being female Highest education qualification: certificate or diploma or university degree or higher **Having private health insurance**	Having CALD background Higher income ($20,000+/year) **Having private health insurance**
Social factors	More likely	Full-time work	
	Less likely	Living alone **Being a parent**	Working part-time or full-time **Being a parent** Live in a safe area
Health factors	More likely	Being psychologically distressed **Self-reported poor quality of life** Self-reported heart disease	Current smoking **Self-reported poor quality of life** Being treated for high blood pressure Fall in prior 12-months
	Less likely	Adequate physical activity Adequate fruit and vegetable intake Consumes 1+ alcoholic drinks/week **Needs help for their daily activities**	Consumes 14+ alcoholic drinks/week **Needs help for their daily activities**

Strengths and limitations

The CES-P&CH, based on the 45 and Up Study, is a unique data collection linking survey data about the participants with key health service data sources. CES-P&CH enabled the examination of the association of social isolation with a range of socio-demographic and health factors, and health services and outcomes for residents of CES. However, there are some limitation with the data and the analysis. The data are limited to what was collected and so our analysis may not include all the potential risk factors for social isolation identified in the literature, such as the presence of multiple co-morbidities and impairments which may impact the results. Also, the social interaction subscale of the DSSI is designed to measure social interactions not necessarily social isolation, although the authors have suggested that it can be used in this way. There are other social isolation tools which may have been better measures, such as the Friendship Scale or the Lubben Social Network Scale.

Where to next

The evidence from our study and the literature, shows that living alone is associated with an increased risk of ED presentation and hospitalisation. Our study did not show an increased risk of mortality; however, some overseas studies have. In 2016, approximately 25% of Australian households were lone person households, and this is expected to increase by up to 40% by 2036. Service providers should be aware that individuals who live alone, especially the elderly, may be more vulnerable and are at higher risk of requiring ED and hospital care. To manage this growing risk in the future, service providers should seek to provide or refer patients earlier to crucial health and community support services.

Although it was not possible to explore loneliness in this analysis, because it was not included in the 45 and Up Study, nor the SEEF sub-study, questions on loneliness, using the De Jong Loneliness Scale, have now been included in the 2020 45 and Up study follow-up, and data will be available in 2021. Further research is warranted to investigate the drivers and impact of social isolation and loneliness on health service use and outcomes for participants from CES. Non-admitted patient data will also be available in the CES-P&CH data in 2021, thus allowing further investigation into health service use for participants who are socially isolated, lonely and living alone.

Background

The purpose of the report

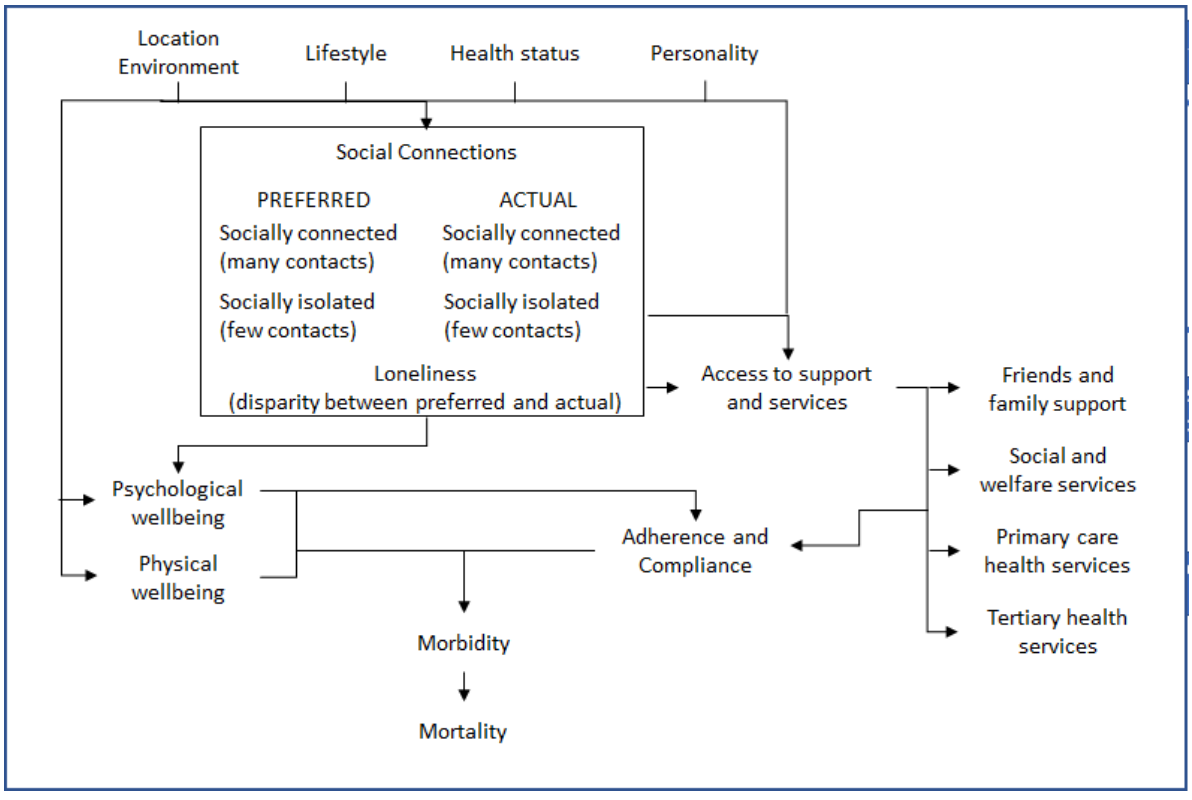
The need to better understand the impact of social isolation, loneliness and living alone on health service delivery, was identified as a major issue at the third annual Research Priorities Forum for the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource (CES-P&CH) in 2019, attended by over 30 health service providers and researchers (Barr et al., 2019). Specific service delivery examples identified were, management of medications following hospital discharge, management of chronic conditions, over/inappropriate use of primary health care services and over/inappropriate use of ED services and hospitalisations.

About social isolation, loneliness and living alone

Social isolation is defined as an objective state of having minimal social contact with other participants, while loneliness is the discrepancy between a person's preferred and actual level of social contact (Ong et al., 2016). Social isolation and loneliness may or may not co-exist. For example, a person may be socially isolated but not feel lonely, or a person may be socially connected but feel lonely (Australian Psychological Society, 2018).

Social isolation and social connection have been studied extensively, both in Australia and overseas, with authors agreeing on the importance of social connection on wellbeing across one's life span, and the detrimental effects of social isolation particularly in later life (Baumeister and Learly, 1995). Figure 1 highlights the importance of factors that influence social connectedness and the difference between social isolation and loneliness. Living alone is included as an environmental factor which can theoretically impact on health and wellbeing separately to social connectedness. The conceptual framework was informed by Grenade and Boldy (2008), Cacioppo and Cacioppo (2014), Pettigrew et al. (2014), Holt-Lunstad et al. (2015), Ong et al. (2016) and Evans et al. (2018).

Figure 1: Conceptual framework for understanding social isolation, living alone and loneliness



It is estimated that the prevalence of social isolation, living alone and loneliness among older people in Australia, is 17%, 25% and 19% respectively, and increasing (Mance, 2018; ABS, 2017). The Australian Bureau of Statistics (ABS) estimated that 962,000 older Australians aged 75 years and over, will be living alone by 2026 (ABS, 2017). The Household, Income and Labour Dynamics in Australia survey (HILDA) contains loneliness data (the Index of Social Support and a single question asking whether they often feel very lonely) on 13,000-18,000 participants (7,000 to 10,000 households) from 2001 to 2017 (Wooden and Watson, 2007). Mance (2018), in her analysis of the HILDA data, found that one in six participants felt lonely in any given year. She also found that the proportion of participants reporting feelings of loneliness increased with age, affecting 19% of participants aged 75 years and over.

In a recent meta-analytical review, Holt-Lunstad et al. (2015), found that people who were socially isolated, lived alone or were lonely, were at risk of premature mortality at rates comparable with other well-established risk factors, including lack of physical activity, obesity, substance abuse, poor mental health, injury and violence. The study, which examined 70 independent prospective studies from 1980 to 2014, comprising 3.4 million participants with a mean age of 66 years, found that after controlling for age, gender, socioeconomic status, health status, physical activity and smoking, the increased likelihood of death was 29% for social isolation, 32% for living alone and 26% for loneliness. However, only one (Lloyd et al., 2013) of the three Australian studies included in the meta-analysis (Korten et al., 1999, Gopinath et al., 2013, and Lloyd et al., 2013) found any increased association, and this was only for living alone in younger participants (aged 21 to 36 years). Rohde et al. (2016) examined the mental health effects of social isolation and estimated that a 10% reduction in loneliness scores could reduce mental health care costs by approximately $3 billion AUD, or around $150 AUD per person.

With regard to risk factors, Rohde et al. (2016), in their study of 20,000 HILDA survey participants, found that older participants who experienced separation from their spouse, changed jobs, retirement or deaths of family members or friends, were more likely to report social isolation than married participants with high incomes and education, and those in extended families. In the Australia-wide survey conducted by Beer et al. (2016) divorce/separation, loss of family members, major health problems, job loss, financial hardship, leaving one's neighbourhood and issues with family, were identified as causes of feeling social isolation.

Many countries now acknowledged the impact of loneliness among older people. For example, in the United Kingdom there has been the 'Campaign to End Loneliness' and in New Zealand there has been the 'Health of Older People Strategy' for reducing loneliness (United Kingdom Department for Digital, Culture, Media and Sport 2018, New Zealand Ministry of Health 2016). In Australia, the government announced an allocation of $46 million towards the community visitors' scheme in 2018, designed to reduce loneliness in older adults (Australian Government Media release 2018). Understanding if and how social isolation impacts on managing health conditions and the use of health services, is important in providing quality care and preventing premature mortality. Research has been undertaken on the determinants of isolation/loneliness (individual, social, community and environment), however less emphasis has occurred on the health determinants and how these might be mitigated.

Study aims and research questions

As the 45 and Up Study does not include a measure of loneliness, we limited the aim of this project to exploring the impact of social isolation and living alone on health service use and health outcomes in Central and Eastern Sydney (CES).

Specifically, the study aimed to answer the following five research questions about social isolation:

1. What demographic, social and health factors are associated with social isolation?
2. Did the pattern of health service use and mortality differ between participants who were socially isolated and those who were not?
3. How were social isolation and GP chronic disease management services (CDM) associated?
4. What was the association between social isolation and continuity of GP care before and after a hospitalisation, re-hospitalisation and mortality?
5. Did the pattern of health service use and mortality differ between participants according to CALD background and social isolation status?

See Box 1 for the sub-questions associated with each research question about social isolation.

The study also conducted a preliminary analysis to explore four research questions related to living alone and one to explore the relationship between living alone and social isolation:

1. What were the demographic, social and health factors associated with living alone?
2. Did the pattern of health service use and mortality differ between participants who lived alone and those who did not?
3. Was living alone and use of GP CDM services associated?
4. How did participants who lived alone differ from those who were socially isolated?

Box 1: Social isolation research sub-questions

1a. What was the pattern of GP encounters, ED presentations and hospitalisations for participants who were and were not socially isolated?

1b. Was social isolation associated with higher health service use?

1c. Was social isolation associated with higher rates of mortality?

2a. What were the annual rates of GP Management Plans (GPMP), Team Care Arrangements (TCA) and allied health services for CES participants who were and were not socially isolated?

2b. Did social isolation impact on the use of GPMP, TCA or allied health services?

2c. Among participants that were socially isolated, did having a GPMP and/or a TCA affect their risk of hospitalisation and death?

3a. What was the association between continuity of GP care before and after a hospitalisation, and re-hospitalisation and mortality for participants who were socially isolated?

3b. What was the association between continuity of GP care before and after a hospitalisation, social isolation and re-hospitalisation and mortality for participants who were socially isolated?

4a. What were the annual rates of health service use (including GP encounters, ED presentations, hospitalisations) in CES participants who were and were not socially isolated?

4b. Was social isolation associated with high health service use (including GP encounters, ED presentations, hospitalisations) for people with and without a CALD background?

4c. Was social isolation associated with higher rates of mortality for people from a CALD background?

Methods

Data source

This research used the CES-P&CH based on the Sax Institute's 45 and Up Study (45 and Up Study collaborators, 2008). There were 30,645 participants recruited within the CES region at baseline (267,153 at baseline). This research was limited to participants who were recruited to the 45 and Up Study and who participated in the Social, Economic, and Environmental Factors (SEEF) Sub-Study. These data were linked to administrative data collections including the Medical Benefits Schedule (MBS) provided by Services Australia (formerly the Australian Government Department of Human Services), Admitted Patient Data Collection (APDC), Emergency Department Data Collection (EDDC) and Deaths Registry data provided by the NSW Centre for Health Record Linkage (CHeReL)

Study population

The study population was limited to participants who had completed the SEEF sub-study of the 45 and Up Study, conducted in 2010 (Stamatakis et al., 2014). The SEEF study included enhanced questions about living arrangements and other social factors of participants, as well as repeating many of the demographic and health related questions of the baseline study. There were 6,176 participants from CES and 21,405 participants from Sydney Metropolitan region[1] who completed the SEEF questionnaire.

The CES social isolation study population was used to answer research questions 1-4, 6 and 7. The population selected to answer question 4 was limited to CES participants who had had a hospitalisation (n=3,562). Analysis for research question 5, examining the association between CALD background and social isolation, used the Sydney Metropolitan region study population because of small numbers of participants with a CALD background in CES (n=1,234).

See Appendix B for more details about data source and the study populations.

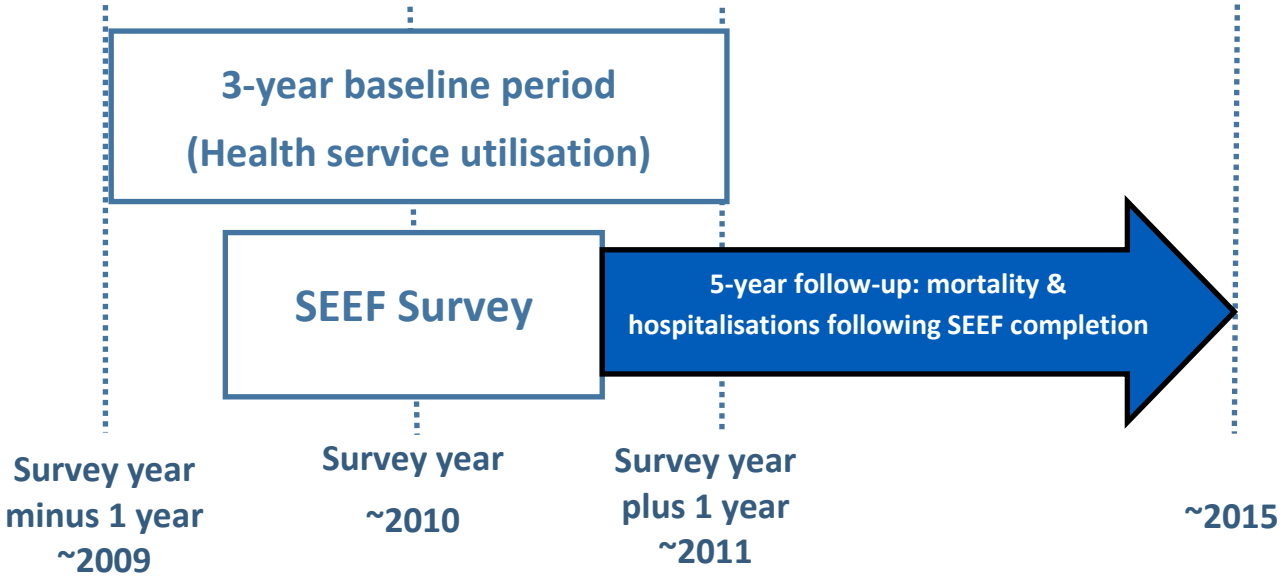
Figure 2 describes the research design for the study and the time periods used for examining the impact of social isolation on health service use and mortality. Annual health service use was averaged over the 'three-year baseline period' (2009-2011), one year prior to SEEF survey year (i.e. 2010) and one year following the SEEF survey year. Mortality and hospitalisations were measured in the 'five-year follow-up' period following the SEEF survey.

Measures

The main measures used were social isolation, living alone, socio-demographic and health characteristics, health services use and mortality. Social isolation was measured using the Duke Social Support Index (DSSI) social interaction subscale (George et al., 1989) which was included in the SEEF questionnaire. The tool comprised four questions about family connections, social contacts and interactions and attendance at groups. All questions needed to be answered for the participant to have a valid score. Responses were summarised to a score 4-12. The DSSI tool has been validated in older populations in Australia (Goodger et al., 1999). As recommended, scores were divided into two groups, with the bottom 20% (≤8) being classified as socially isolated and the remaining 80% (>8) being classified as not being socially isolated. Living alone was based on the participants response to the household number question 'Including yourself how many people in total live in your household' in the SEEF questionnaire. Socio-demographic and health characteristics were based on the relevant questions in the SEEF questionnaire and the 45 and Up Study baseline survey.

[1] Sydney Metropolitan area = Metropolitan Primary Health Network boundaries including: CES, Northern Sydney, Western Sydney, South Western Sydney and Nepean Blue Mountains.

Figure 2: Research project design



Mortality included deaths from all causes using the death registry data for 2012-2016.

Health service use was categorised for each participant according to average number of encounters, presentations or hospitalisations per year over the three-year baseline period (which included the year of SEEF survey, and one year before and one year after the SEEF survey year). Health service measures included any GP use, high GP use, any ED presentations and any hospitalisations. As well as any GPMP or TCAs, any GPMP or TCAs reviews and any allied health referral during the three-year baseline period.

Outcome measures included: (1) proportion of participants hospitalised in the five years following their completion of the SEEF survey; and (2) the proportion of participants who died in the five years following their completion of the SEEF survey.

For the continuity of care analysis, continuity of care was defined in two ways: Having a consultation with **any GP** or the **same GP** in the 30 days prior to and within 30 days following the index hospitalisation. The index hospitalisation was the first hospitalisation following completion of the SEEF survey. Outcomes for this analysis were re-hospitalisation within 12 months of the index hospitalisation, and deaths within five years of the index hospitalisation.

More details about the measures used and the covariates included in the analysis, are available in Appendix B.

Statistical Analysis

The statistical analysis included three components:

i. Descriptive analysis to calculate the proportion of participants within the CES region who were socially isolated, living alone, had various characteristics of interest and used health services.
ii. Crude or unadjusted prevalence ratios with 95% confidence intervals, to examine which demographic, social and health factors and service use were related to being socially isolated and living alone.
iii. Multivariable generalised linear models to estimate adjusted prevalence ratios with 95% confidence intervals, in order to: identify which demographic, social, health and health service use characteristics factors were independently associated with social isolation/living alone; determine if being socially isolated/living alone was associated with health service use.

iv. Multivariable generalised linear models were used to estimate adjusted mortality ratios with 95% confidence intervals in order to examine if being socially isolated/living alone was associated with increased mortality.

    To adjust for potential confounders in the multivariable models, all variables were included in the initial model if they met the 20% significance criteria. In the final model, age and sex were included and a backward elimination process was conducted for the other variables, including only variables which led to a 5% or greater change when removed.

Statistical significance was determined if the p values were <0.05%. Results in the tables that are ***bolded and in italics*** highlight variables that were statistically significantly less likely to be associated with social isolation, and results that are just **bolded** were statistically significantly more likely to be associated.

Further details on the statistical analysis are available in Appendix B.

Ethics

Ethical approval was granted for this research project by the New South Wales Population and Health Services Research Ethics Committee (Ref # 2016/06/642) and from the University of New South Wales Human Research Ethics Committee for the 45 and Up Study overall. All participants provided written consent before participating in the 45 and Up Study, this included consent to: follow them over time using their health and other records; contact them in the future about changes in health and lifestyle; and use their data for health research.

Results: Part A – Social Isolation

Research Question 1: Demographic, social and health factors associated with social isolation

Using the DSSI social interaction subscale, 1,213 (19.6%) participants in the CES cohort were classified as socially isolated (score ≤8). See Appendix C Table C 1 for a summary of the DSSI.

The demographic factors associated with social isolation (Figure 3): After controlling for other demographic factors, being from a CALD background was significantly more likely to be associated with social isolation. Being aged between 60 and 84 years, being female, having formal education qualifications (e.g. certificate, diploma or university degree) or having private health insurance were less likely to be associated with social isolation. See Table C 2 in Appendix B for the actual numbers, unadjusted and adjusted prevalence ratios and their 95% CI.

The social factors associated with social isolation (Figure 4): The social factors which were significantly more likely to be associated with social isolation, after controlling for all other social and health conditions, were: being a full-time worker. The social factors which were significantly less likely to be associated with social isolation were: living alone and being a parent. See Table C 3 in Appendix B for the actual numbers, PRs and their 95% CI.

Health factors associated with social isolation (Figure 4): The health factors which were significantly more likely to be associated with social isolation, after controlling for all other social and health conditions, were: being psychologically distressed, self-reported poor quality of life and self-reported heart disease. The health factors which were significantly less likely to be associated with social isolation were: undertaking adequate physical activity, eating adequate fruit and vegetables, consuming alcohol and reporting that they required help for their daily activities. See Table C 3 in Appendix B for the actual numbers, PRs and their 95% CI.

Summary

Participants who were socially isolated were more likely to come from a CALD background, be in full-time work, be psychologically distressed, report poor quality of life and report having heart disease.

Socially isolated participants were less likely to be aged between 60 and 84 years, be female, have higher educational qualifications (certificate or diploma or university degree or higher), have private health insurance, live alone, be a parent, have adequate physical activity, have adequate fruit and vegetable intake, consumes alcohol or report they needed help for their daily activities.

Discussion

Comparison with the literature

We compared our results to a number of other studies in the literature which independently examined the relationship between social isolation and a range of socio-demographic and health factors in Australia, Canada, USA and Europe (see Appendix C Table C 4 for a summary of the factors studied and their association with social isolation, and Appendix C C5 for a summary of the studies). It should be noted that many studies used different measures of social isolation, different combinations and cut-offs of the factors assessed, and were from a range of countries with different social, cultural and health environments. This may partly explain the differences between our study and those reported in the literature.

We found socially isolated participants were less likely to be aged between 60 and 84 years. Most other studies and reviews show increasing age associated with social isolation (Giuli et al., 2012; Robins et al., 2018; Menec et al., 2019). Our study found that social isolation was less likely in females. There is some

conflict between the studies reviewed with regard to gender: two studies (Cudjoe et al., 2020; Menec et al., 2019) found socially isolated participants were less likely to be females, two studies (Rohde et al., 2016; Giuli et al., 2012) found females were at higher risk of social isolation, and two studies showed that gender did not influence the risk of social isolation (Hawthorne et al., 2008; Robins et al., 2018). Coming from a CALD background and working full-time were the only two demographic variables associated with social isolation in our study. The association with CALD background was supported by Hawthorne (2008), but Robins (2018) found no association. While two studies found not working to be associated with social isolation (Hawthorne et al., 2008; Cantarero-Prieto et al., 2018).

Our study found that being married or in a relationship was not independently associated with social isolation. However, Hawthorne et al. (2008) and Cudjoe et al. (2020) found social isolation was less likely among those who were married or partnered. Our study found that living alone was less likely to be associated with social isolation. However, Cantarero-Prieto et al. (2018) and Robins et al. (2018) showed that living alone was associated with social isolation. Living alone has been perceived as a measure of social isolation and lack of support, but it can also be a measure of functional independence in older people (Michael et al., 2001; Evans et al., 2019). We did not find an association between social isolation and income, although three other studies have found lower income to be associated with social isolation (Cudjoe et al., 2020; Hawthorne et al., 2008; Menec et al., 2019).

Health factors associated with social isolation

Interestingly, many studies supported our findings that adequate physical activity and adequate fruit and vegetable intake were less likely among those who are socially isolated (Boulos et al., 2016; Kobayashi and Steptoe, 2018; Reed et al., 2011; Schrempft et al., 2019; Hammig et al.,2019). Like our study, Kobayashi and Steptoe (2018) found that those who consumed alcohol were less likely to be socially isolated. Although our study did not find an association between current smoking and social isolation, Kobayashi and Steptoe (2018), Chiew et al. (2011) and Hammig et al. (2019) did.

Our study found an association between social isolation and high psychological distress. Phongsavan et al. (2013) also examined the 45 and Up Study data and found an association between social isolation and high psychological distress in younger participants. While Teo et al. (2013) found an association between social isolation and social anxiety disorder. Three studies found that those who were socially isolated were more likely to have depression or depressive symptoms (Robins et al., 2018; Hawthorne et al., 2008; Hammig et al., 2019), but our study did not.

Two studies supported our finding that cardiovascular disease and social isolation are associated (Hakulinen et al., 2017 and Valtorta et al., 2016). Hakulinen et al. (2017) analysed data on 479,000 participants in the UK Biobank, and found isolated participants had an increased risk of cardiovascular disease (acute myocardial infarctions and stroke). Valtorta et al. (2016) conducted a meta-analysis of 19 studies and found that deficiencies in social relationships were associated with increased risk of coronary heart disease and stroke. While Robins et al. (2018) found heart failure, but not cardiovascular disease, associated with social isolation.

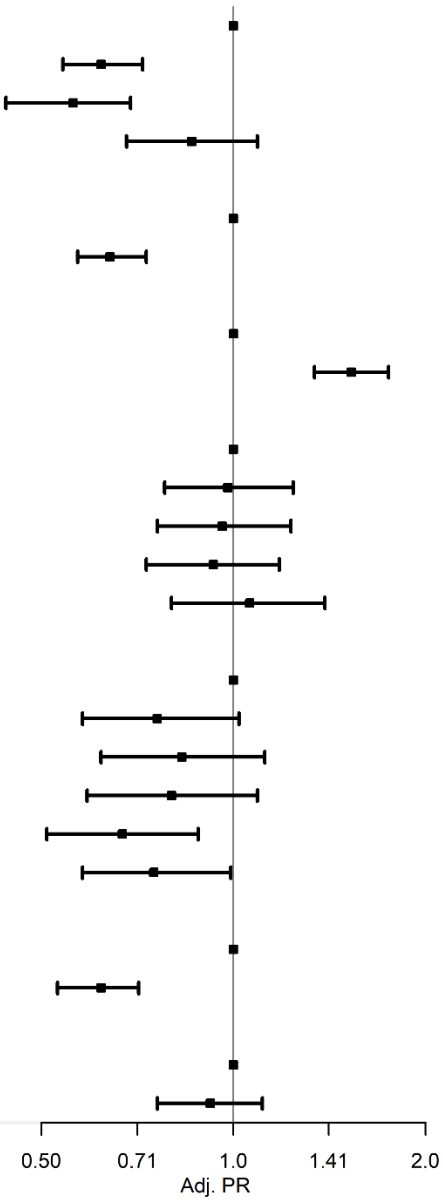
A number of studies supported our findings that there was no association between social isolation and certain health conditions, including asthma (Hawthorne et al., 2008), cancer (Robins et al., 2018), diabetes (Hawthorne et al., 2008; Robins et al., 2018) and falls (Robins et al., 2018).

We found no studies that examined self-reported quality of life, treated hypertension, treated high cholesterol or needing help for daily activities; although Robbins et al. (2018) and Hammig et al. (2019) found poor self-reported health was associated with social isolation, and Menec et al. (2019) found an association between functional impairment and social isolation. However, there were a number of health conditions and factors that were found to be associated with social isolation which we did not measure. These included multiple morbidity (Cantarero-Prieto et al., 2018; Hammig et al., 2019; Menec et al., 2019; Hawthorne et al., 2008), accumulated muscular-skeletal disorders (Hammig et al., 2019)

hearing impairment, incontinence, trauma exposure (Hawthorne et al., 2008) and dementia risk (Rafnsson et al, 2020).

Figure 3: Association between demographic characteristics and social isolation, CES

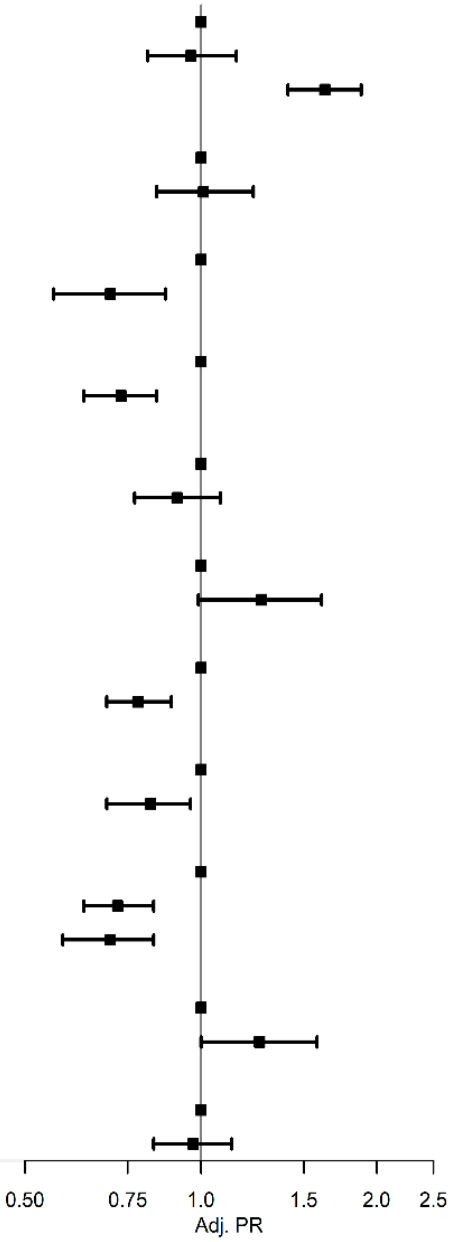
Demographic characteristics	Socially isolated n (%)	Not socially isolated n (%)
Age at recruitment, year		
47-59	599 (23.5)	1951 (76.5)
60-74	354 (15.3)	1959 (84.7)
75-84	144 (16.3)	740 (83.7)
85+	116 (27)	313 (73.0)
Gender		
Male	694 (23.6)	2252 (76.4)
Female	519 (16.1)	2711 (83.9)
Culturally and linguistically diverse (CALD)		
No	857 (17.3)	4085 (82.7)
Yes	356 (28.8)	878 (71.2)
Household income		
<$20,000	135 (22.4)	469 (77.6)
$20,000-39,999	177 (20.1)	704 (79.9)
$40,000-69,999	197 (18.7)	854 (81.3)
$70,000 or more	524 (19.3)	2196 (80.7)
Won't disclose	103 (20.7)	394 (79.3)
Highest qualification		
No school certificate or other qualification	79 (25.9)	226 (74.1)
School or intermediate certificate	165 (16.7)	821 (83.3)
Higher school or leaving certificate	151 (23.3)	498 (76.7)
Trade or apprenticeship	111 (22.8)	376 (77.2)
Certificate or diploma	222 (16.8)	1098 (83.2)
University degree or higher	459 (19.5)	1894 (80.5)
Private insurance		
No	390 (29.5)	930 (70.5)
Yes	823 (16.9)	4033 (83.1)
Health care card		
No	1004 (19.5)	4147 (80.5)
Yes	209 (20.4)	816 (79.6)



Notes: Adj PR=Adjusted Prevalence Ratio presented on a logarithmic scale, controlled for all variables in the figure.

Figure 4: Association between social and health factors and social isolation, CES

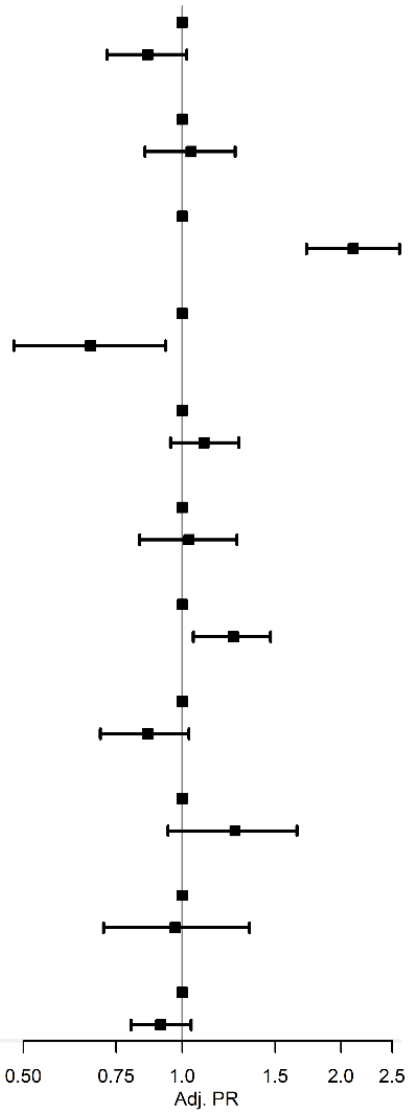
Social and health factors	Socially isolated n (%)	Not socially isolated n (%)
Working status		
Not working	508 (17.5)	2387 (82.5)
Part time	207 (15.7)	1108 (84.3)
Full time	481 (25.4)	1414 (74.6)
Currently married		
No	483 (21.2)	1800 (78.8)
Yes	730 (18.7)	3163 (81.3)
Living alone		
No	976 (20.1)	3889 (79.9)
Yes	223 (17.7)	1040 (82.3)
Parent of child		
No	306 (24.4)	948 (75.6)
Yes	907 (18.4)	4015 (81.6)
Live in safe area		
No	179 (25.1)	533 (74.9)
Yes	1004 (18.8)	4341 (81.2)
Currently smoking		
No	1124 (19.2)	4734 (80.8)
Yes	80 (29.1)	195 (70.9)
Adequate physical activity		
No	430 (25.6)	1249 (74.4)
Yes	783 (17.4)	3714 (82.6)
Adequate fruit and vegetable intake		
No	1030 (20.6)	3961 (79.4)
Yes	183 (15.4)	1002 (84. 6)
Alcohol consumption		
0 drinks/week	446 (25.5)	1302 (74.5)
1-13 drinks/week	543 (17.2)	2613 (82.8)
14+ drinks/week	195 (16.7)	974 (83.2)
Psychological distress		
Low (K10<3)	1095 (18.8)	4741 (81.2)
High	118 (34.7)	222 (65.3)
Being treated for high blood pressure		
No	940 (20.1)	3736 (79.9)
Yes	273 (18.2)	1227 (81.8)



Notes: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the figure 4.

Figure 4: Association between Social and health factors and social isolation, CES (continued)

Social and health factors	Socially isolated n (%)	Not socially isolated n (%)
Being treated for high cholesterol		
No	1016 (20.2)	4008 (79.8)
Yes	197 (17.1)	955 (82.9)
Self-reported poor health condition		
No	963 (18.1)	4371 (81.9)
Yes	250 (29.7)	592 (70.3)
Self-reported poor quality of life		
No	998 (17.5)	4656 (82.5)
Yes	215 (41.2)	307 (58.8)
Reported needing help with daily activities		
No	1155 (19.5)	4773 (80.5)
Yes	53 (23.0)	177 (77.0)
Reported at least one fall in 12 months prior		
No	971 (19.4)	4039 (80.6)
Yes	237 (20.9)	897 (79.1)
Self-reported diabetes diagnosis		
No	1103 (19.4)	4590 (80.6)
Yes	110 (22.8)	373 (77.2)
Self-reported heart disease		
No	1012 (19.3)	4230 (80.7)
Yes	201 (21.5)	733 (78.5)
Self-reported asthma		
No	1086 (19.8)	4400 (80.2)
Yes	127 (18.4)	563 (81.6)
Self-reported anxiety		
No	948 (18.5)	4165 (81.5)
Yes	265 (24.9)	798 (75.1)
Self-reported depression		
No	1002 (18.7)	4355 (81.3)
Yes	211 (25.8)	608 (74.2)
Self-reported cancer		
No	799 (20.6)	3072 (79.4)
Yes	414 (18.0)	1891 (82.0)



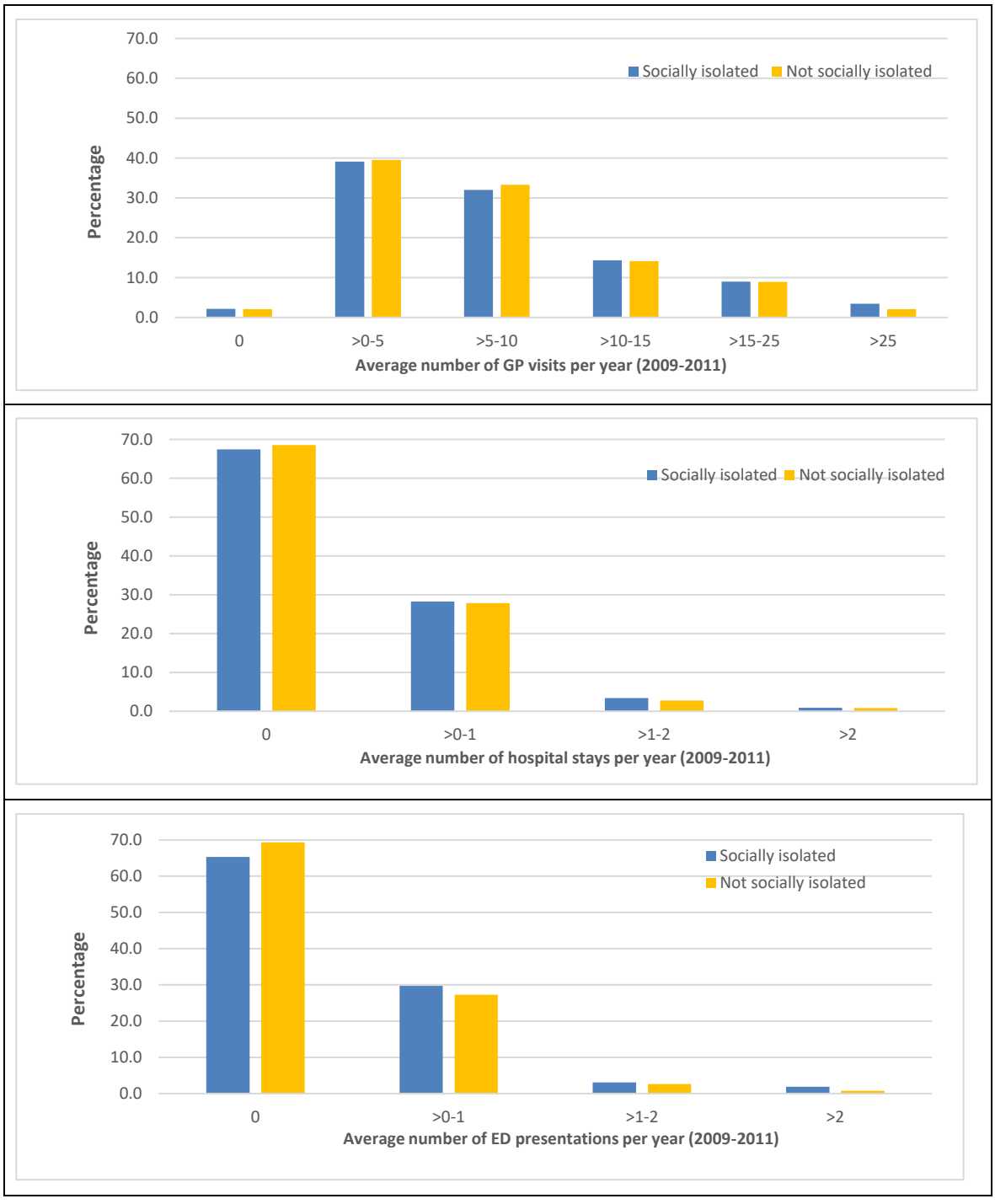
Notes: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the figure 4.

Research Question 2: Impact of social isolation on patterns of health service use and mortality.

Health service use

Over the three-year baseline period (~2009-2011), 97.9% of the CES participants had, on average, at least one GP encounter per year. The mean number of GP encounters per year was 7.9 (SD: ± 6.7) and the median number was 6.0 encounters/per year, with an interquartile range of 3.7-10.4. Just over 16% of the population had 13 or more encounters per year. During the same period, 31.4% of the CES participants had on average over the 3 years, at least one presentation to the ED, and 31.6% had at least one hospitalisation. (Figure 5; Appendix C Table C 6)

Figure 5: Health service use according to social isolation status, CES, 2009-2011



Association between social isolation and health service use

We defined higher health care use as an average of: 13 or more GP encounters per year (16% of the population), one or more hospitalisations per year, or one or more ED presentations per year during the three-year baseline period. Table 1 shows the association between social isolation and higher health service use. Similar proportions of participants who were or were not socially isolated had 13 or more GP encounters per year (16.6% vs 15.3%), hospitalisations (7.3% vs 6.9%) and ED presentation (8.2% vs 6.3%) per year. There was no significant association between social isolation and higher GP use (13 or more encounters/year) [Adj. PR (95% CI): 1.07 (0.91, 1.26)], overnight hospitalisations [Adj. PR (95% CI): 0.90, (0.70, 1.14)] or one or more ED presentations [Adj. PR (95% CI): 1.15 (0.91, 1.45)], between 2009-2011, when controlled for age, gender, self-reported poor quality of life and working status.

Association between social isolation and mortality

A slightly larger proportion of socially isolated participants died during five-year follow up period, between 2012 and 2016 (9.2% vs 6.5%). However, the association was not statistically significant, Adj. PR (95% CI): 1.07 (0.85, 1.34) after controlling for age, gender, self-reported poor quality of life and working status (Table 1).

Table 1: Association between social isolation and health service use and mortality, CES

Average annual health service use (~2009-11) and 5-year mortality	Not socially isolated n=4963		Socially isolated n=1213			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
Higher GP use (13+ encounters per year)	761	15.3	201	16.6	1.08 (0.92, 1.26)	1.07 (0.91, 1.26)
Any hospital use (1+ hospitalisations per year)	341	6.9	88	7.3	1.06 (0.83, 1.33)	0.90 (0.70, 1.14)
Any ED use (1+ presentations per year)	311	6.3	100	8.2	1.32 (1.05, 1.64)	1.15 (0.91, 1.45)
Died during the 5-year follow-up period	323	6.5	111	9.2	1.41 (1.13, 1.74)	1.07 (0.85, 1.34)

NOTES: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included;*Reference not socially isolated

Summary

Social isolation was not associated with high GP use, or any ED presentations or hospitalisations.

Social isolation was not associated with five-year mortality.

Discussion

Comparison with the literature

Although we did not find an association between service use and social isolation, a number of other studies have found that social isolation increased the use of GP, physician and hospital services and associated health costs. Longman et al. (2013) and Rohde et al. (2016) found that social isolation had an impact on primary health care use in Australia. NSW healthcare workers in the Longman et al. (2013) study, found that participants isolated from social groups frequently visited primary health care facilities more for social and psychological needs than for health care needs. In a multistage national longitudinal study among 3,530 participants aged 60 years and over, low social group connectedness was found to have an impact on health care utilization, including increased number of physician's visits (Cruwys et al., 2018).

Longman et al. (2013) also found that social isolation was an important contributor to frequent and avoidable hospitalisation of older patients with chronic diseases. Participants identified that social isolation may have limited opportunities for participants to obtain adequate pain relief, nutritional requirements and support to reinforce health behaviours, thus leading to increase hospitalisations.

Similarly, our analysis did not show an increased risk of mortality associated with social isolation. However, we found four studies that did find an increased risk of death among those who were socially isolated, (Alcaraz et al., 2018; Smith et al., 2018; Tanskanen and Anttila, 2016; Holt-Lunstad et al., 2015). In a recent meta-analytical review, Holt-Lunstad et al. (2015), found that people who were socially isolated, lived alone or lonely, were at risk of premature mortality at rates comparable with other well-established risk factors, including lack of physical activity, obesity, substance abuse, poor mental health, injury and violence. The study, which examined 70 independent prospective studies from 1980 to 2014, comprising 3.4 million participants with a mean age of 66 years, found that after controlling for age, gender, socioeconomic status, health status, physical activity and smoking, the increased likelihood of death was 29% for social isolation, 32% for living alone, and 26% for loneliness. Although the meta-analysis only included three studies from Australia (Korten et al, 1999; Gopinath et al, 2013; and Lloyd et al, 2013), with a total of 17,685 individuals aged 21 years and over) and all of them used living alone as the measure, and only one study, among 13,447 alcohol and drug treatment clients aged 21 to 36 years who were followed-up for 2.8 years, reported a significant effect of living alone on total mortality after controlling for covariates (Lloyd et al., 2013).

It is important to note, that the differences in the results of our study and the studies quoted above, may be due to the different measures of social isolation and health service use employed, different combinations of the factors controlled for in the analyses, and the fact that some studies were conducted in countries with different social, cultural and health environments to Australia.

Research Question 3: Association between social isolation and general practice Chronic Disease Management services

To understand the association between social isolation and GP Chronic Disease Management (CDM) services, we investigated MBS claims for preparation of and review of GP Management Plans (GPMPs) and Team Care Arrangements (TCAs) and for subsidised allied health care among the CES study population during the three-year baseline period.

During the three-year baseline period (~2009-2011), 28.2% of CES participants had one or more MBS claim for the preparation of a GPMP or a TCA, 12.9% for a review of GPMP or TCA, and 20.6% had a claim for MBS subsidised allied health care referral.

A slightly higher proportion of participants who were socially isolated had a GPMP or TCA (29.5% vs 27.8%), GPMP or TCA reviews (14.6% vs 12.5%) and allied health services (21.4% vs 21.5%) compared with those who were not socially isolated.

Association between social isolation and GPMPs, TCAs and reviews and allied health services in CES

Table 2 presents the association of social isolation with MBS claims for GPMP or TCA, GPMP or TCA reviews and allied health care services in the CES region during the three-year baseline period. We did not find any statistically significant association between social isolation and GPMP or TCA claims [Adj. PR (95% CI): 1.11 (0.94, 1.19)], but we did find that socially isolated participants were 22% more likely to have GPMP or TCA reviews compared to the not socially isolated participants [Adj. PR (95% CI): 1.22 (1.02, 1.45)]. We did not find any association between social isolation and allied health care claims [Adj. PR (95% CI): 1.07 (0.93, 1.23)].

Table 2: Association between social isolation and MBS claims for general practice Chronic Disease Management services, CES, 2009-2011

MBS claims for general practice chronic disease management services (2009-2011)	Not socially isolated n=4963		Socially isolated n=1213			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
GPMP or TCA	1382	27.8	358	29.5	1.06 (0.94, 1.19)	1.11 (0.94, 1.19)
GPMP or TCA review	621	12.5	177	14.6	1.17 (0.98, 1.37)	**1.22 (1.02, 1.45)**
Allied health services	1015	20.5	259	21.4	1.04 (0.91, 1.19)	1.07 (0.93, 1.23)

NOTES: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included; * Reference not socially isolated.

Association between GP care plan and team care arrangement use and hospitalisation and mortality among the socially isolated participants in metropolitan Sydney

To look at the association between any GPMP or TCA use and hospitalisations and deaths in subsequent five years among participants who were socially isolated, we extended our study population to the Sydney Metropolitan region (n=4,359 socially isolated participants) in order to have adequate statistical power. Of these, 1213 (27.8%) had a claim for at least one GPMP or TCA during the three-year baseline period (Table 3). Socially isolated participants who used any GPMP or TCA, were 36% more likely to have a hospitalisation [Adj. PR (95% CI): 1.36 (1.23, 1.50)] and 46% more likely to die [Adj. PR (95% CI): 1.42 (1.12, 1.80)] within the five-year follow-up, compared to those who did not use GMP or TCA.

Table 3: Association between any GPMP or TCA use, hospitalisation and mortality five-year follow-up among the socially isolated participants, Sydney Metropolitan region

Outcomes during 5-year follow-up period	Socially isolated participants					
	No GPMP or TCA claim (~2009-2011) n=3146		Had a GPMP or TCA claim (~2009-2011) n=1213			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
Hospitalisation	1318	(40.1)	692	(64.7)	1.61 (1.46, 1.76)	**1.36 (1.23, 1.50)**
Death	168	(5.1)	139	(12.9)	2.53 (2.02, 3.17)	**1.42 (1.12, 1.80)**

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included; * Reference category no GPMP or TCA claim.

Summary

There was no association between social isolation and GPMP or TCA use in CES region, but socially isolated participants in CES region were more likely to have GPMP or TCA reviews.

For socially isolated participants living in the Sydney Metropolitan region, any GPMP or TCA use during the SEEF service period was significantly associated with a 36% higher risk of hospitalisation and a 42% increased risk of death within five years of this period.

Discussion

We could not find any studies that looked at social isolation and CDM. Our study found that social isolation was associated with claims for GPMP or TCA reviews, but not for the preparation of GPMPs or TCAs or allied health services. One explanation for this association may be that GPs were more diligent about reviewing plans as they were aware that socially isolated individuals may need additional support and monitoring.

We found that among participants who were socially isolated, there was an increased risk of hospitalisation and death for those who had received a GPMP or TCA. Previous studies have found conflicting results about the impact of CDM services on hospitalisations. Caughey et al. (2016) and Vitry et al. (2014) found that GPMPs were associated with reduced hospitalisations for war veterans 65 years and older who had specific conditions (diabetes and heart failure). Using data from the 45 and Up Study, Welberry et al. (2019) found no effect of GPMPs or TCAs on avoidable hospitalisation of participants resident in CES and Comino et al. (2015) reported no effect on hospitalisations for participants with diabetes. Xia et al. (2020) also found that having a GPMPs or TCAs was associated with a greater likelihood of attending an ED. GPMP and TCAs are part of an approach to improving CDM, especially among GP patients with complex and severe chronic disease. Given that patients who are hospitalised and those that die are often older, more frail and more likely to have more severe co-morbidities, this may partially explain the increased risk of hospitalisations and deaths among those who are socially isolated with a GPMP or TCA.

Research Question 4: Association between social isolation and continuity of GP care, re-hospitalisation and mortality

The eligible cohort to answer this question, consisted of 3,562 participants from CES who had an index hospitalisation between 2011 and 2016 and had completed the SEEF questionnaire. Of these, 1,567 (44%) saw a GP 30 days before and after the index hospitalisation. Seventy percent (1,098) of these saw the same GP before and after the index hospitalisation (212 were socially isolated) and 469 (30%) saw a different GP after the index hospitalisation (87 were socially isolated).

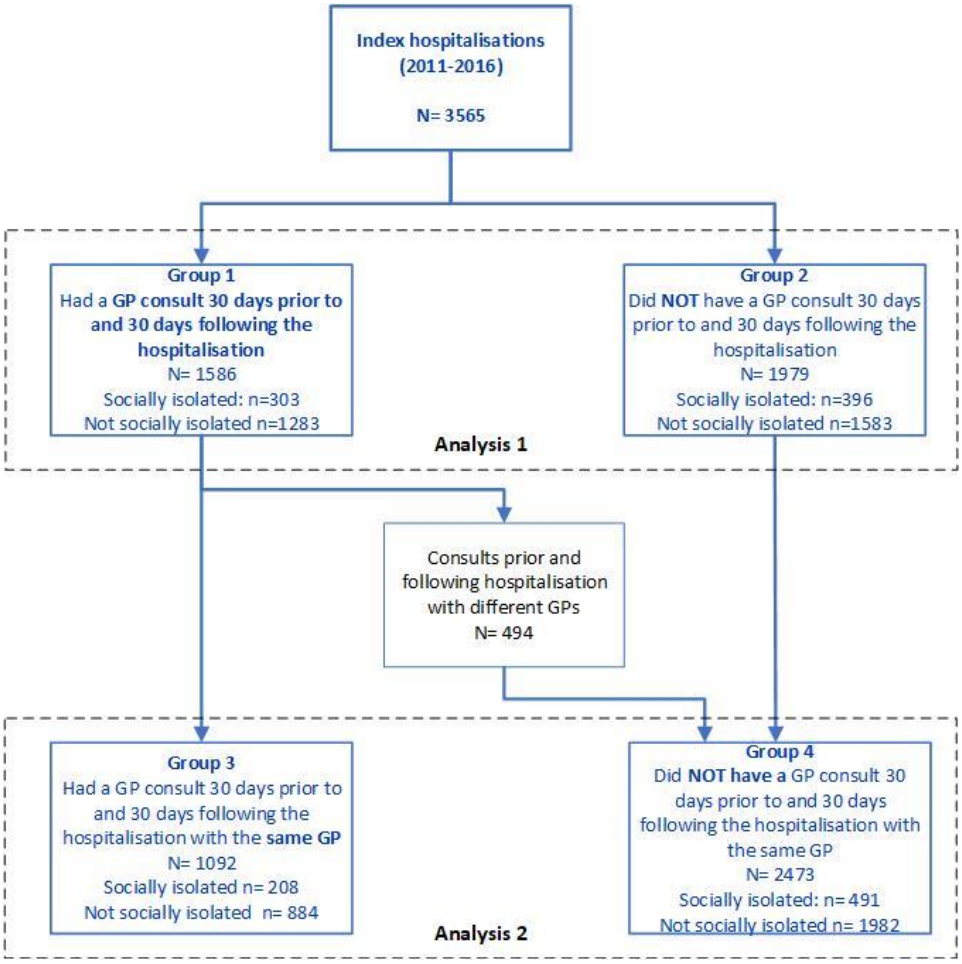
We defined 'continuity of care' in two ways to investigate the impact of continuity of care on re-hospitalisation within 12 months and mortality within five years (Figure 6):

Analysis 1: Having a consultation with **any GP** 30 days prior to and within 30 days following the index hospitalisation (Group 1). We compared Group 1 to Group 2 (those who had an index hospitalisation but did not meet the criteria to be in Group 1 (i.e. they did not see any GP before or after hospitalisation, or saw a GP before but not after the index hospitalisation or vice versa).

Analysis 2: Having a consultation with the **same GP** 30 days prior to and within 30 days following the index hospitalisation (Group 3). We compared Group 3 to Group 4 (those who had an index hospitalisation but did not meet the criteria to be in Group 3).

Figure 6 shows the eligible participants within the cohort for each analysis.

Figure 6: Eligibility for exploring the association between continuity of care before and after an index hospitalisation with re-hospitalisation within 12 months and mortality within five years, CES



Association between continuity of GP care and re-hospitalisation and mortality

The risk of re-hospitalisation within 12 months of the index hospitalisation for those participants who had an encounter with **any GP** 30 days before and within 30 days after the index hospitalisation, was 33% higher [Adj. PR (95% CI): 1.33 (1.19, 1.49)] compared to those who did not have an encounter with a GP in both time periods (Table 4). However, there was no significant association with five-year mortality [Adj. PR (95% CI): 1.16 (0.94, 1.43)]. Among the socially isolated participants, neither the rate of re-hospitalisation nor the five-year mortality for those who had an encounter with any GP before and after an index hospitalisation were significantly different [Adj. PR (95% CI): 1.19 (0.93, 1.53); Adj. PR (95% CI): 0.90 (0.59, 1.36)] compared those who did not have an encounter with any GP during the two time points.

Table 4: Analysis 1 - Continuity of GP care with any GP and re-hospitalisation and death, CES.

Re-hospitalisation and mortality	Had an encounter with any GP 30 days before and after the index hospitalisation					
	No (Group 2)		Yes (Group 1)			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
All participants	**n=**1989		n=1586			
Re-hospitalised within 12 months	582	29.4	663	41.8	1.42 (1.27, 1.59)	**1.33 (1.19, 1.49)**
Died during the 5-year follow-up period	163	8.2	193	12.2	1.48 (1.20, 1.82)	1.16 (0.94, 1.43)
Socially isolated participants ONLY	n=396		n=303			
Re-hospitalised within 12 months	126	31.8	124	40.9	1.29 (1.00, 1.65)	1.19 (0.93, 1.53)
Died during the 5-year follow-up period	48	12.1	43	14.2	1.17 (0.77, 1.77)	0.90 (0.59, 1.36)

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included. * Reference category: No Group 2)

Similarly, the risk of re-hospitalisation within 12 months of the index hospitalisation for the participants who had an encounter with **the same GP** 30 days before and within 30 days after the index hospitalisation, compared to those who did not have an encounter with the same GP in both time periods, was 23% higher [Adj. PR (95% CI): 1.23 (1.10, 1.39)] than those who did not have an encounter with the same GP during those two time points (Table 5: Analysis 2). However, there was no significant association with five-year mortality [Adj. PR (95% CI): 1.05 (0.84, 1.30)]. Among the socially isolated participants, neither the rate of re-hospitalisation nor the five-year mortality were significantly different for those who had an encounter with the same GP before and after an index hospitalisation [Adj. PR (95% CI): 1.07 (0.82, 1.40); Adj. PR (95% CI): 0.74 (0.46, 1.16)].

Table 5: Analysis 2 - Continuity of GP care with the same GP and re-hospitalisation and death, CES.

Re-hospitalisation and mortality	Had an encounter with the same GP 30 days before and after the index hospitalisation					
	No (Group 4)		Yes (Group 3)			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
All participants	**n**=2473		n=1092			
Re-hospitalised within 12 months	781	31.6	464	42.5	1.34 (1.20, 1.51)	**1.23 (1.10, 1.39)**
Died during the 5-year follow-up period	220	8.9	136	12.5	1.40 (1.13, 1.73)	1.05 (0.84, 1.30)
Socially isolated participants ONLY	n=491		n=208			
Re-hospitalised within 12 months	167	34.0	83	39.9	1.17 (0.90, 1.52)	1.07 (0.82, 1.40)
Died during the 5-year follow-up period	65	13.2	26	12.5	0.94 (0.59, 1.47)	0.74 (0.46, 1.16)

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included. * Reference category: (Group 4)

Summary

Participants who had an encounter with **any GP or the same GP** in the 30 days before and after the index hospitalisation, had a higher risk of re-hospitalisation in the following 12 months compared to the participants who had no GP encounters during the two time periods, or those who had an encounter in only one of the time periods. However, there was no significant association of either measure of continuity of care with five-year mortality.

For socially isolated participants, there was no association between either measure of continuity of GP care or re-hospitalisation within the following 12 months.

Discussion

We used two simplified measures of 'continuity of care' in this analysis to see if participants who were hospitalised for the first time after completing the SEEF survey had an encounter with any or the same GPs in the 30 days prior to the hospitalisation and the 30 days following the hospitalisation. The impact of 'continuity of care' as measured above, increased the likelihood of one or more hospitalisations in the following 12 months. This appears to be counter-intuitive, as we would expect improved continuity of primary care to reduce the chance of re-hospitalisation (Barker et al., 2017; van Loenen et al., 2014).

The results of our study may be influenced by a number of issues. These include the participants having health factors, such as multiple co-morbidities and more advanced or more severe disease, which were not adjusted for in our analysis, and which may increase the likelihood of re-hospitalisation for participants. We included all overnight hospitalisations, which included planned hospitalisations, emergency hospitalisations may have provided a better indicator of hospitalisation due to inconsistent care.

Our definition of 'continuity of care' may not have captured true 'continuity of care'. We included one GP encounter pre- and post the index hospitalisation, other studies have used a proportion of care where the patient attended the same GP or the same practice over a longer period of time (Barr et al., 2019; Wright, 2018) and more recently, Jackson and Ball (2018). These studies recommended the use of quantitative questionnaires to better assess whether 'continuity of care' was present.

Research Question 5: The association between social isolation according to CALD background and health service use and mortality.

This analysis examined the association between CALD background and social isolation using the Sydney Metropolitan region study population (n=3920), because of small numbers of participants with a CALD background in CES (n=1,234).

Of the 3920 participants from a CALD background in the Sydney Metropolitan region, 1,133 (28.9%) were socially isolated. Participants from a CALD background were 56% more likely to be socially isolated compared to the participants from a non-CALD background (<0.001) after adjusting for other demographic variables.

Health service use by participants with a CALD background

Over the three-year baseline period, 99.0 % of the Sydney Metropolitan participants with a CALD background had at least one encounter with a GP. The mean number of GP encounters per year was 8.8 (SD:± 7.1) and the median number was 7 encounters/per year with an interquartile range of 4.0-11.7. Just over 20.4% of the participants had 13 or more encounters per year. During the same period, 29.1% of Sydney Metropolitan participants with a CALD background, had at least one ED presentation per year, and 30.2% had at least one hospitalisation per year. (Figure 7; Appendix C Table C 7)

Association between social isolation and high health use.

Table 6 presents the association between social isolation and health service use for participants from a CALD background in the Sydney Metropolitan region. Among the participants with a CALD background, those who were socially isolated had a statistically significant 25% increased risk of more frequent GP encounters (13+/per year) than those who were not socially isolated [Adj. PR (95% CI): 1.25 (1.06, 1.46)]. There was no significant association found between social isolation and hospitalisation [Adj. PR (95% CI): 0.98 (0.72, 1.31)] or ED presentations [Adj. PR (95% CI): 0.94 (0.69, 1.26)] for those with a CALD background.

Association between social isolation and mortality.

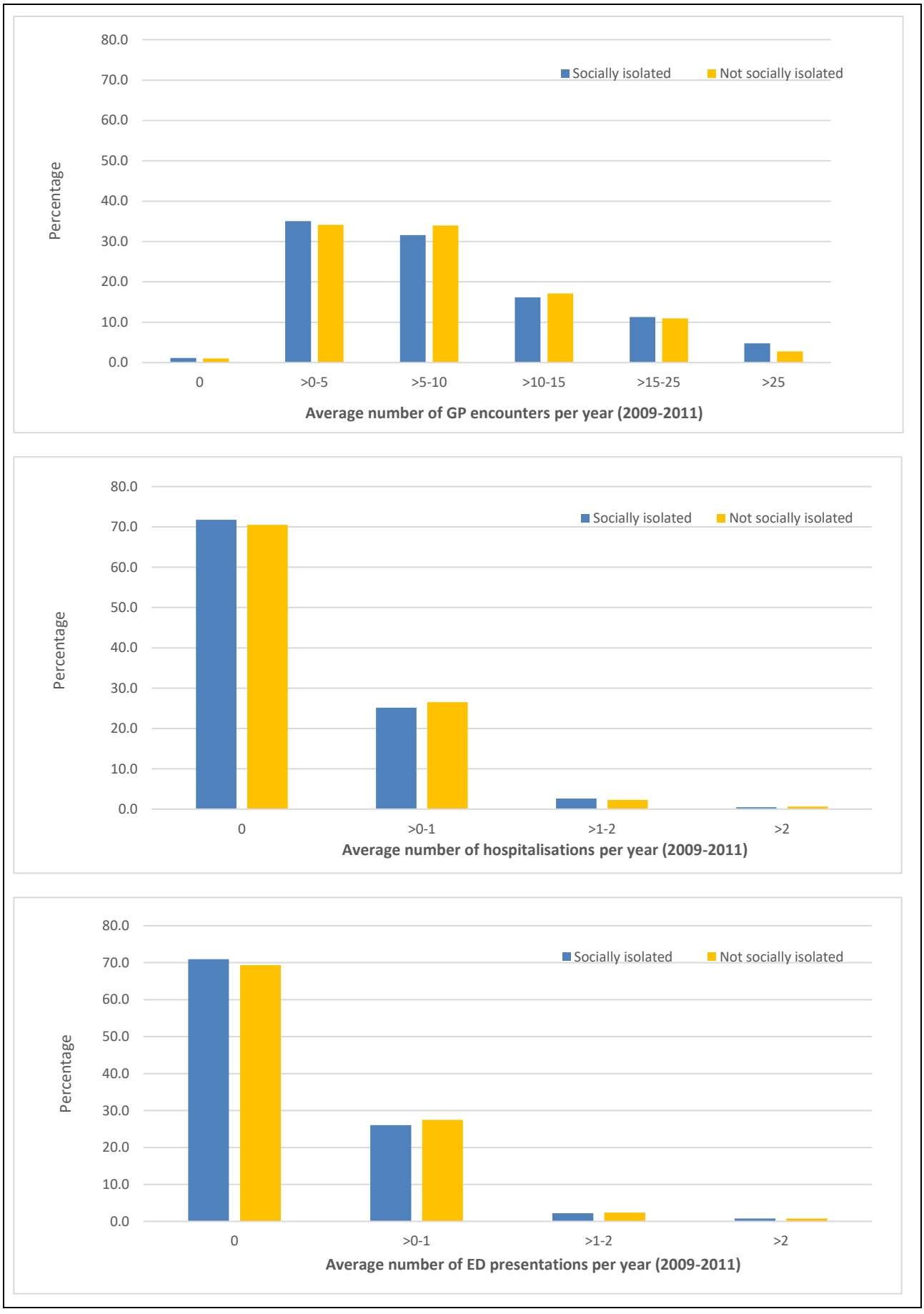
There was no significant association found between social isolation and five-year mortality [Adj. PR (95% CI): 1.10 (0.84, 1.43)]. (Table 6)

Table 6: Association between social isolation with health service use and mortality, participants from a CALD background, Sydney Metropolitan region.

Average annual health service use (~2009-11) and 5 year mortality	Participants from a CALD background (Metropolitan Sydney)					
	Not socially isolated n=2,787		Socially isolated n=1,133			
	n	%	n	%	Crude PR* (95% CI)	Adj. PR* (95% CI)
High GP use (13+ encounters per year)	514	18.4	244	21.5	1.17 (1.00, 1.36)	**1.25 (1.06, 1.46)**
Any hospital use (1+ hospitalisation per year)	160	5.7	65	5.7	1.00 (0.74,1.33)	0.98 (0.72, 1.31)
Any ED use (1+ presentations per year)	166	6.0	68	6.0	1.01 (0.76, 1.33)	0.94 (0.69, 1.26)
Died during the 5-year follow-up period	188	6.7	86	7.6	1.13 (0.87, 1.45)	1.10 (0.84, 1.43)

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included; * Reference category: not socially isolated.

Figure 7: Health service use according to social isolation status, for participants with a CALD background, Sydney Metropolitan Region, 2009-2011



Summary

For those with a CALD background in Sydney Metropolitan region:

i. Socially isolated participants had more frequent GP encounters compared to those who were not socially isolated.
ii. Social isolation was not associated with ED presentations and hospitalisations.
iii. Social isolation was not associated with high service use or five-year mortality.

Discussion

There is evidence to support our findings that ethnic and cultural groups appear to be more likely to experience social isolation (Wright-St Clair, 2017), especially those who are older (Ip et al., 2007; Rao et al., 2006; Wu and Penning, 2015) or who have language problems (Thomas, 2003). A study in the Netherlands, found that migrants experience more social and emotional loneliness and are less satisfied with their social relationships compared with those born in the Netherlands (ten Kate, et al, 2020). There is also evidence that social isolation and loneliness are dependent on the culture, language and network of relatives and friends. De Jong Gierveld et al. (2015) investigated three immigrant groups in Canada (immigrants from Europe of British or French origin, other European immigrants and non-European immigrants) and found that being from a non-European country was the strongest predictor of loneliness.

Results: Part B – Living Alone

Research Question 6: Demographic, social and health factors associated with living alone

Demographic, social and health factors associated with living alone

Overall, 20.5% of the cohort participants lived alone and 3.6% were both socially isolated and lived alone. The demographic, social and health factors associated with living alone, including the actual PR and 95% CIs, are provided in Figures 8-9 and Tables D1-D2.

After controlling for all other demographic factors, older age (60 years and older) and being female were significantly more likely to be associated with living alone, and having a CALD background, having a higher income and having private health insurance were significantly less likely to be associated with living alone. (Figure 9, Table D1).

Similarly, after adjusting for all other social and health variables, there were no social factors which were statistically more likely to be associated with living alone (Figure 10, Table D2). Living alone was less likely to be associated with working part-time or full-time, being a parent and living in a safe area.

The health factors statistically significantly associated with living alone were current smoking, having poor self-reported quality of life, being treated for high blood pressure and having at least one fall in the previous 12 months once adjusted for all social and health variables. Variables associated with a lower risk of living alone were consuming 14+ alcoholic drinks per week and reporting needing help with daily activities.

Summary

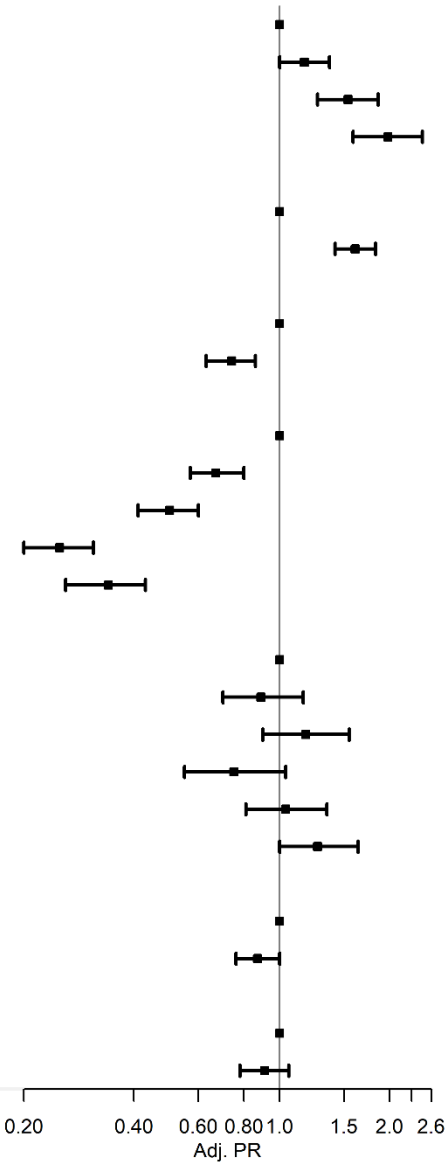
- Living alone was associated with older age (60 years and older) and being female, current smoking, having poor self-assessed quality of life, being treated for high blood pressure and having at least one fall in the previous 12 months.
- Having a CALD background, having a higher income and having private health insurance, consuming 14+ alcoholic drinks per week and reporting needing help with daily activities, were significantly less likely to be associated with living alone.

Discussion

Only one study, in Australia, Canada, USA and Europe, was found that examined a broad range of factors associated with living alone (Kharicha et al., 2007). This study focussed on understanding the health behaviours, health status and service use associated with living alone for GP patients in the UK, controlling for socio-demographic and condition specific variables. The results were similar to our study, participants who smoked, those who reported fair/poor health and those who had falls in the last 12 months being more likely to live alone. Kharicha et al. (2007) also found that living alone was associated with being socially isolated, having inadequate fruit and vegetable intake, functional impairment, activity limitations due to fear of falling, glaucoma, arthritis and having no emergency carer.

Figure 8 : Demographic factors associated with living alone, CES

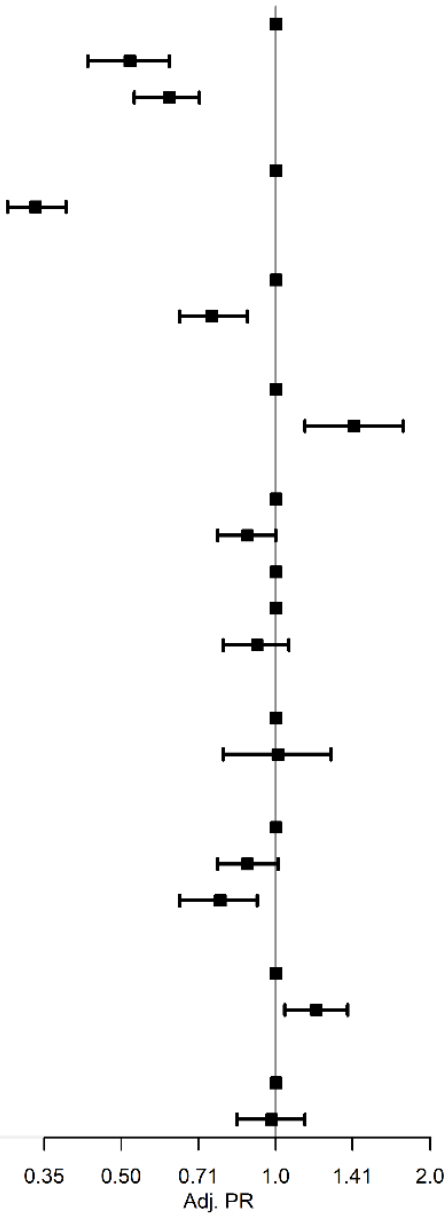
Demographic characteristics	Lived alone n (%)	Did not live alone n (%)
Age at recruitment, year		
47-59	343 (13.5)	2193 (86.5)
60-74	468 (20.4)	1825 (79.6)
75-84	276 (31.5)	599 (68.5)
85+	176 (41.5)	248 (58.5)
Gender		
Male	453 (15.5)	2468 (84.5)
Female	810 (25.3)	2397 (74.7)
Culturally and linguistically diverse (CALD)		
No	1047 (21.3)	3864 (78.7)
Yes	216 (17.7)	1001 (82.3)
Household income		
<$20,000	294 (49.4)	301 (50.6)
$20,000-39,999	270 (31.1)	599 (68.9)
$40,000-69,999	232 (22.2)	812 (77.8)
$70,000 or more	291 (10.7)	2419 (89.3)
Won't disclose	79 (16.0)	415 (84.0)
Highest qualification		
No school certificate or other qualification	97 (32.1)	205 (67.9)
School or intermediate certificate	242 (24.8)	734 (75.2)
Higher school or leaving certificate	151 (23.5)	492 (76.5)
Trade or apprenticeship	78 (16.2)	402 (83.8)
Certificate or diploma	259 (19.7)	1054 (80.3)
University degree or higher	422 (18.0)	1918 (82.0)
Private insurance		
No	395 (30.4)	904 (69.6)
Yes	868 (18)	3961 (82)
Health care card		
No	932 (18.2)	4182 (81.8)
Yes	331 (32.6)	683 (67.4)



Notes: Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the table.

Figure 9 : Social and health factors associated with living alone, CES

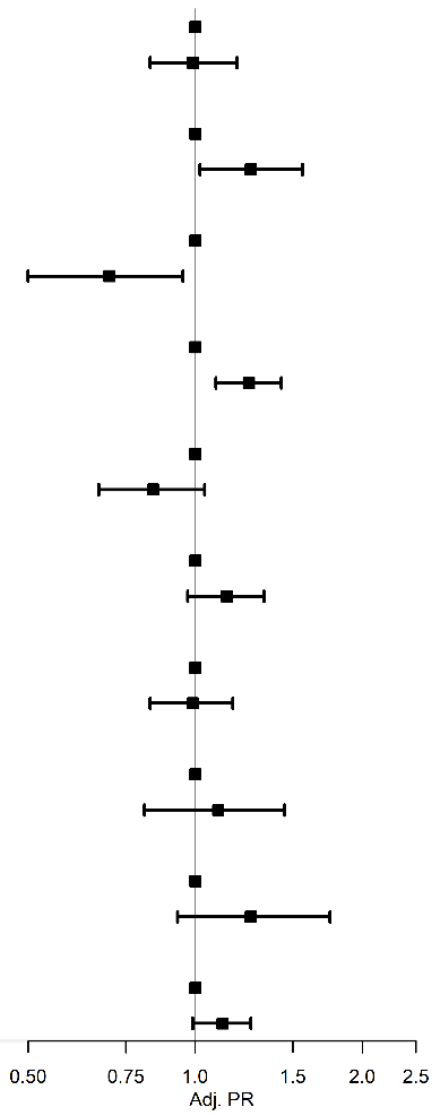
Social and health factors	Lived alone n (%)	Did not live alone n (%)
Working status		
Not working	758 (26.4)	2112 (73.6)
Part time	171 (13.1)	1136 (86.9)
Full time	305 (16.2)	1578 (83.8)
Parent of child		
No	534 (42.9)	711 (57.1)
Yes	729 (14.9)	4154 (85.1)
Live in safe area		
No	221 (31.2)	488 (68.8)
Yes	1003 (18.9)	4301 (81.1)
Currently smoking		
No	1160 (20.0)	4654 (80.0)
Yes	97 (35.8)	174 (64.2)
Adequate physical activity		
No	399 (24.1)	1258 (75.9)
Yes	864 (19.3)	3607 (80.7)
Adequate fruit and vegetable intake		
No	1032 (20.8)	3920 (79.2)
Yes	231 (19.6)	945 (80.4)
Psychological distress		
Low (K10<3)	1162 (20.1)	4628 (79.9)
High	101 (29.9)	237 (70.1)
Alcohol consumption		
0 drinks/week	442 (25.5)	1289 (74.5)
1-13 drinks/week	593 (18.9)	2546 (81.1)
14+ drinks/week	210 (18.1)	948 (81.9)
Being treated for high blood pressure		
No	887 (19.1)	3756 (80.9)
Yes	376 (25.3)	1109 (74.7)
Being treated for high cholesterol		
No	1004 (20.1)	3987 (79.9)
Yes	259 (22.8)	878 (77.2)



Notes: Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the table.

Figure 9: Social and health factors associated with living alone, CES (continued)

Social and health factors	Lived alone n (%)	Did not live alone n (%)
Self-reported poor health condition		
No	1016 (19.2)	4279 (80.8)
Yes	247 (29.7)	586 (70.3)
Self-reported poor quality of life		
No	1087 (19.4)	4526 (80.6)
Yes	176 (34.2)	339 (65.8)
Reported needing help with daily activities		
No	1206 (20.5)	4685 (79.5)
Yes	53 (23.6)	172 (76.4)
Reported at least one fall in 12 months prior		
No	944 (18.9)	4039 (81.1)
Yes	312 (27.9)	808 (72.1)
Self-reported diabetes diagnosis		
No	1158 (20.5)	4493 (79.5)
Yes	105 (22.0)	372 (78.0)
Self-reported heart disease		
No	1025 (19.7)	4184 (80.3)
Yes	238 (25.9)	681 (74.1)
Self-reported asthma		
No	1099 (20.2)	4344 (79.8)
Yes	164 (23.9)	521 (76.1)
Self-reported anxiety		
No	962 (19.0)	4114 (81.0)
Yes	301 (28.6)	751 (71.4)
Self-reported depression		
No	1015 (19.1)	4302 (80.9)
Yes	248 (30.6)	563 (69.4)
Self-reported cancer		
No	731 (19.1)	3106 (80.9)
Yes	532 (23.2)	1759 (76.8)



Notes: Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the figure 9.

Research Question 7: Impact of living alone on patterns of health service use and mortality.

We defined higher health care use as an average of: 13 or more GP encounters per year (16% of the population), one or more hospitalisations per year or one or more ED presentations per year during the three-year baseline period. Higher health service use and mortality for participants who did and did not live alone is described in Table 7. Overall, a greater proportion of those who lived alone had higher GP use (21.7% vs 13.9%), had one or more hospitalisation per year (10.2% vs 6.0%), had any ED presentations (10.1% vs 5.8%) and died between 2012 and 2016 (10.5% vs 6.1%), compared with those who did not live alone. Once the analysis was adjusted for age and gender, living alone was significantly associated with ED presentations [Adj. PR (95% CI): 1.32 (1.05, 1.64)] and hospitalisation [Adj. PR (95% CI): 1.36 (1. 90, 1.68)], but not with high GP use and five-year mortality.

Table 7: Association between living alone and health service use and mortality, CES

Average annual health service use (~2009-11) and 5-year mortality	Did not live alone n=4865		Lived alone n=1263			
	n	%	n	%	Crude PR* (95% 37	Adj. PR* (95% CI)
High GP use (13+ encounters per year)	677	13.9	274	21.7	1.56 (1.50, 1.79)	1.05 (0.90, 1.22)
Any hospitalisation (1+ hospitalisations per year)	292	6.0	134	10.6	1.77 (1.44, 2.16)	**1.36 (1.09, 1.68)**
Any ED presentations (1+ presentations per year)	290	5.8	128	10.1	1.76 (1.42, 2.16)	**1.32 (1.05, 1.64)**
Died (within 5 years of SEEF interview)	296	6.1	133	10.5	1.73 (1.41, 2.12)	1.14 (0.92, 1.42)

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included; * Reference category: Did not live alone.

Summary

- Living alone was associated with an increased risk of hospitalisation and ED presentations, but not associated with frequent GP encounters.
- Living alone was not associated with an increased risk of death in the following five years.

Discussion

We found an association between living alone and hospitalisations and ED presentations. There is some support for the results related to increased risk of ED presentations and hospitalisation found in our study. Dreyer et al. (2018) used linked and anonymised GP and hospital data to evaluate the impact of living alone on health service use. They found that participants 70 years and older who lived alone had a higher risk of at least one ED presentation and at least one in-patient hospitalisation. The study also reported an increased likelihood of 12 or more GP appointments for the participants who lived alone. Three other studies also support the impact of living alone on hospital stays (Ennis et al.,2014; Hu et al., 2019; Pimouguet et al., 2017).

We did not find an association between living alone and mortality. Results of a 10-year follow-up period of the Blue Mountain Eye Study, also found that living alone was not associated with mortality in the overall cohort, after multivariate adjustment. However, among participants aged 49-75 years, living alone was associated with a 36% increased risk of all-cause mortality, while in those 75 years or older, living alone was not associated with all-cause mortality. This is not surprising given that living alone is both a measure of normative behaviour and functional independence in the very elderly (Udell et al., 2012).

Research Question 8: Association between living alone and general practice Chronic Disease Management services

To understand the association between living alone and GP Chronic Disease Management (CDM) services, we investigated MBS claims for preparation of and review of GP Management Plans (GPMPs) and Team Care Arrangements (TCAs) and for subsidised allied health care among the CES study population during the three-year baseline period.

A higher proportion of participants who were living alone had GPMP or TCA (37.5% vs 25.7%), GPMP or TCA reviews (17.3% vs 11.7%) and allied health services (26.4% vs 19.1%) compared with those who did not live alone.

Association between living alone and GPMPs, TCAs and reviews and allied health services in CES

MBS claims for a GPMP or TCA, GPMP or TCA reviews and allied health care during the three-year baseline period in the CES region for participants who did and did not live alone, is provided in Table 8. Overall, participants who lived alone had higher rates of care plan use than those who did not live alone (37.5% vs 25.7% for GPMP or TCA plans); 17.3% vs 11.7% for GPMP or TCA reviews and 26.2% vs 19.1% for Allied health services). Living alone was associated with GPMP or TCA use [Adj. PR (95% CI): 1.13 (1. 01, 1.27)], but not with GPMP or TCA reviews [Adj. PR (95% CI): 1.15 (0. 97, 1.36)] nor use of allied health services [Adj. PR (95% CI): 1.08 (0. 94, 1.23], once the analysis was adjusted for age, gender, self-reported quality of life and working status.

Table 8: Association between living alone and MBS claims for general practice Chronic Disease Management services, CES, 2009-2011

MBS claims for general practice chronic disease management services (2009-2011)	Did not live alone n=4865		Lived alone n=1263			
	n	%	n	%	Crude PR* (95% Ci)	Adj. PR* (95% CI)
GPMP or TCA	1248	25.7	473	37.5	1.46 (1.31, 1.62)	**1.13 (1.01, 1.27)**
GPMP or TCA review	567	11.7	219	17.3	1.49 (1.27, 1.74)	1.15 (0.97, 1.36)
Allied health services	930	19.1	331	26.2	1.37 (1.21, 1.55)	1.08 (0.94, 1.23)

Notes: Crude PR = crude prevalence ratio; Adj. Model: Adjusted by variables identified as potential confounders, if their inclusion in the model made a 5% change compared to the crude model plus age and sex if not already included. *Reference did not live alone.

Summary

- Living alone was associated with an increased risk of having an MBS claim for a GPMP or TCA.
- Living alone was not associated with having an MBS claim for a GPMP or TCA review or allied health services.

Discussion

We could not find any literature about the use of CDM services and living arrangements. CDM services are subsidised by Medicare where the patient has one or more chronic medical conditions and complex care needs, usually requiring ongoing care from a multidisciplinary team. One would expect that individuals who require CDM services, such as GPMP and TCAs, would have one or more chronic illnesses and would have more frequent GP encounters. Although neither frequent GP encounters nor any of the chronic diseases (such as asthma, cardiovascular disease, diabetes, cancer, depression and anxiety) reported by participants were associated with living alone, there was an association between living alone and being older, having poor self-assessed quality of life, being treated for high blood pressure and having at least one fall in the previous 12 months, which may explain the increased use of GPMP and TCAs.

Research Question 9: How did participants who lived alone differ from those who were socially isolated?

Table 9 compares the demographic, social and health characteristics associated with living alone, with those associated with being socially isolated, after controlling for other relevant factors. Participants who were socially isolated had quite different socio-demographic and health profiles to those who lived alone. Only four factors, were consistently associated with both social isolation and living alone across the two groups: being more likely to report poor quality of life, and being less likely to be a parent, have private health insurance or report needing help with daily activities.

Table 9: Comparison of "independent factors[a] associated with social isolation and living alone

Characteristic		Social Isolation	Living alone
Demographic	More likely	Having CALD background	Older age (60 years and older) Being female
	Less likely	Aged between 60 and 84 years Being female Highest education qualification: certificate or diploma or university degree or higher **Having private health insurance**	Having CALD background Higher income ($20,000+/year) **Having private health insurance**
Social factors	More likely	Full-time work	
	Less likely	Living alone **Being a parent**	Working part-time or full-time **Being a parent** Living in a safe area
Health factors	More likely	Being psychologically distressed **Self-reported poor quality of life** Self-reported heart disease	Current smoking **Self-reported poor quality of life** Being treated for high blood pressure Fall in prior 12 months
	Less likely	Adequate physical activity Adequate fruit and vegetable intake Consumes 1+ alcoholic drinks/week **Needs help for their daily activities**	Consumes 14+ alcoholic drinks/week **Needs help for their daily activities**

[a] *Statistically significant after controlling for other demographic, social and health factors.*

Health service use differs markedly between those who are socially isolated and those who live alone. A higher proportion of participants who lived alone had higher health service use than those who were socially isolated (Table 10). The proportions who died were similar between the groups.

Table 10: Association between social isolation and* living alone and *health service use and mortality, CES, 2009-2011

Average annual health service use (~2009-11) and 5-year mortality	Socially isolated		Lived alone	
	No n=4,963	Yes n=1213	No N=4865	Yes N=1263
Higher GP use (13+ encounters per year)	761 (15.3%)	201 (16.6%)	677 (13.9%)	274 (21.7%)
Any hospital use (1+ hospitalisations per year)	341 (6.9%)	88 (7.3%)	292 (6.0%)	134 (10.6%)
Any ED use (1+ presentations per year)	311 (6.3%)	100 (8.2%)	280 (5.8%)	128 (10.1%)
Died during the 5-year follow-up period	323 (6.5%)	111 (9.2%)	296 (6.1%)	133 (10.5%)

Again, a higher proportion of participants who lived alone used GP CDM services than those who were socially isolated (Table 11).

Table 11: Association between social isolation and **living alone and general practice chronic disease services***, CES, 2009-2011*

Any general practice chronic disease management services (2009-2011)	Socially isolated		Lived alone	
	No n=4,963	Yes n=1213	No N=4865	Yes N=1263
GPMP or TCA	1382 (27.8%)	358 (29.5%)	1248 (25.7%)	**473 (37.5%)***
GPMP or TCA review	621 (12.5%)	**177 (14.6%)***	567 (11.7%)	219 (17.3%)
Allied health services	1015 (20.5%)	259 (21.4%)	930 (19.1%)	331 (26.2%)

Notes: *significantly higher after adjusting for age, sex and other significant factors

Summary

Those who live alone appear to have different characteristics and health service use compared to those who are socially isolated.

- The demographic, social and health characteristics associated with living alone differ substantially from those who are socially isolated.
- The only independent factors associated with both were being more likely to self-report poor quality of life, and less likely to be a parent, have private health insurance or need help with daily activities.
- A higher proportion of participants who lived alone had higher health service use and higher use of GP CDM services, than those who were socially isolated.

Discussion

Our study found that living alone was associated with a lower risk of social isolation, based on the DSSI. Interestingly, many studies use living alone as a measure or a component of a scale for social isolation, and some studies have shown that they are both directly associated (Iliffe et al., 2007).

The demographic, social and health characteristics associated with living alone differed substantially from those associated with social isolation. Only four factors were associated with both: being more likely to self-report poor quality of life, and less likely to be a parent, have private health insurance or need help with daily activities. Hawton et al. (2011) also found that both social isolation and living alone were associated with a range of measures indicating poorer health status and quality of life. Other studies have shown that both social isolation and living alone are associated with falls (Petersen et al., 2020), cardiovascular risk (Palacio et al., 2020) and chronic illness (Cantarero-Prieto, 2018).

A larger proportion of participants who lived alone had higher health service use and higher use of GP CDM services than those who were socially isolated.

Different measures of social disconnectedness have been shown to have differential effects on health (Beller and Wagner, 2018). The differences between participants who were socially isolated and those who lived alone was substantial. These differences may be partially due to the DSSI measure used to classify participants as social isolated in our analysis. Therefore, future efforts to understand social isolation for participants of the 45 and Up Study, will need to include new measures of social disconnectedness to fully understand its impact.

Overall Discussion

This study was a preliminary investigation of the associations between social isolation and living alone and health, health services use and mortality among 45 and Up Study participants who completed the SEEF sub-study.

Key findings

Association between social isolation and demographic, social and health factors

Socially isolated participants were more likely to have a CALD background, be in full-time work, be psychologically distressed, report poor quality of life and report having heart disease. They were less likely to be aged between 60 and 84 years, be female, have higher educational qualifications (certificate or diploma or university degree or higher), have private health insurance, be a parent, have adequate physical activity, have adequate fruit and vegetable intake, consumes alcohol or report they needed help for their daily activities.

Association between social isolation and health service use and mortality.

During 2009-2011 97.9% of participants had at least one GP encounter per year (mean: 7.9 [SD: ± 6.7]; median: 6.0 [interquartile range of 3.7-10.4]) and 16% had 13 or more encounters per year. During this period, just over 30% of participants at least one ED presentation per year, and a similar percentage had at least one hospitalisation per year.

Social isolation was not associated with 13+ GP encounters, 1+ ED presentations, 1+ hospitalisations nor five-year mortality.

Association between social isolation and access to general practice chronic disease management services

No association between social isolation and preparation of GPMP or TCA was observed. However, while participants who were socially isolated were more likely to have a claim for a review of the plan (Adj PR [95% CI]:1.22 [1.02, 1.45]) they were no more likely to have a claim for allied health services.

For socially isolated participants living in the Sydney Metropolitan region, any GPMP or TCA use during the SEEF service period was significantly associated with a 36% higher risk of hospitalisation (Adj PR [95% CI]:1.36 [1.23, 1.50]) and a 42% increased risk of death within five years of this period (Adj PR [95% CI]:1.42 [1.12, 1.80]).

Association between social isolation and continuity of GP care, re-hospitalisation, and mortality

Participants who had claims for consultations with the same or a different GP within 30 days before and within 30 days after the index hospitalisation, were more likely to be re-hospitalised within 12 months (Adj PR [95% CI]:1.23 [1.10, 1.39]; Adj PR [95% CI]:1.33 [1.19, 1.49]). However, there was no significant association with five-year mortality.

Association between health service use and mortality with CALD background and social isolation status

Metropolitan Sydney participants with a CALD background who were socially isolated, were more likely to have frequent encounters (13+/per year) for GP care than CALD participants who were not socially isolated [Adj. PR (95% CI): 1.25 (1.06, 1.46)]. There was no significant association found between social isolation and ED presentations, hospitalisation or five-year mortality for participants with a CALD background.

Association between living alone and demographic, social and health factors

Living alone was associated with older age (60 years and older) and being female, being a current smoking, having poor self-assessed quality of life, being treated for high blood pressure and having at least one fall in the previous 12 months.

Having a CALD background, having a higher income and having private health insurance, consuming 14+ alcoholic drinks per week and reporting needing help with daily activities were significantly less likely to be associated with living alone.

Association between living alone and health service use and mortality

Living alone was significantly associated with at least one ED presentation [Adj. PR (95% CI): 1.32 (1.05, 1.64)] and one or more hospitalisation [Adj. PR (95% CI): 1.36 (1. 90, 1.68)] between 2009 and 2011. There was no association between living alone and 13 or more GP encounters, or mortality.

Association between living alone and access to general practice chronic disease management services

Living alone was associated with GPMP and TCA use [Adj. PR (95% CI): 1.13 (1. 01, 1.27)], but not with GPMP or TCA reviews nor use of allied health services.

Difference between participants who lived alone and those who were socially isolated

The demographic, social and health characteristics associated with living alone appear to differ substantially from those who are socially isolated. The only independent factors associated with both were: being more likely to self-report poor quality of life, and less likely to be a parent, have private health insurance or need help with daily activities. A higher proportion of participants who lived alone had higher health service use and higher use of GP CDM services than those who were socially isolated.

Strengths and limitations of the study

The 45 and Up Study and associated CES-P&CH Resource, contain a unique data collection linking survey data about the participants with key health data sources. Using the data from the 45 and Up Study enabled the examination of the association of social isolation with a range of socio-demographic and health factors, and with health services and outcomes for residents of CES and metropolitan Sydney. This would not have been possible without huge investment in a time consuming and costly study.

There are a number of limitations to this study.

- As part of this study was cross sectional, we cannot determine if there is a causal relationship between the socio-demographic and health factors and social isolation and living alone. For example, did living alone or being socially isolated lead to a person having a particular characteristic or condition, or did having that characteristic or condition lead to a person living alone or being socially isolated?
- The social interaction subscale of the DSSI is designed to measure social interactions not necessarily social isolation, although the authors have suggested that it can be used in this way. There are other social isolation tools which may have been better measures, such as the Friendship Scale or the Lubben Social Network Scale.
- As is the case with many studies using existing data collections, it is not always possible to include all potential risk factors for social isolation identified in the literature, such as physical impairment, the presence of multiple co-morbidities and other conditions which may impact the results.
- Data for a number of health behaviours and conditions are subjective, based on self-reported measures which may be underreported (e.g. alcohol consumption) or over reported (physical activity). This may introduce non-differential bias as the study participants were not aware of the outcome of the study. As a result, our PR estimates are conservative.
- The study timeframe 2009-2011 focused on the years around the conduct of the SEEF sub-study, which may limit the generalisation of the findings to 2020.

Implication for practice and future research

The evidence from our study and the literature show that living alone is associated with an increased risk of presentation at ED and hospitalisation. Our study did not show an increased risk of mortality, however some overseas studies have. In 2016, approximately 25% of Australian households were lone person households (ABS. Stat) and this is expected to increase by up to 40% by 2036 (AIHW 2017). Service providers should be aware that individuals who live alone may be more vulnerable and are at higher risk of requiring ED and hospital care. To manage this growing risk in the future, service providers should seek to provide or refer patients early to the necessary support services.

Additional questions about social isolation and loneliness have now been included in the latest follow-up wave of the 45 and Up Study and sent to over 80,000 participants. Once data is available from this follow-up wave, further research is warranted to investigate the drivers and impact of social isolation and loneliness on health service use and outcomes for participants from CES and metropolitan Sydney. Non-admitted patient data will be available in the CES-P&CH data in 2021, thus allowing further investigation of loneliness, social isolation and living alone, together with further investigation into health service use for participants who are social isolated, lonely and living alone.

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Appendix A: Abbreviations and Acronyms

ABS	Australian Bureau of Statistics
Adj PR	Adjusted prevalence ratio
AIHW	Australian Institute of Health and Welfare
APDC	Admitted Patient Data Collection
CALD	Culturally and Linguistically Diverse
CDM	Chronic Disease Management (services)
CES	Central and Eastern Sydney
CES-P&CH	Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource
CHeReL	Centre for Health Record Linkage
CI	Confidence Interval
DSSI	Duke Social Support Index
ED	Emergency Department
EDDC	Emergency Department Data Collection
ESB	English speaking background
GP	General Practice
GPMP	General Practice Management Plan
HILDA	Household, Income and Labour Dynamics in Australia
IQR	Inter-Quartile range
K10	Kessler 10 (measure of psychological distress)
LOTE	Language other than English
MBS	Medical Benefits Schedule
NESB	Non-English-speaking background
PBS	Pharmaceutical Benefits Scheme
PIP	Practice Incentives Program
PR	Prevalence Ratios
SD	Standard deviation
SEEF	Social, Economic and Environmental Factors sub-study
TCA	Team Care Arrangement

Appendix B: Detailed Methods

Data source

The 45 and Up Study comprises more than 250,000 residents of NSW, Australia. Details of the recruitment of this cohort have been described previously. Potential study participants aged 45 years or older in NSW were randomly sampled from the Department of Human Services enrolment database. They were sent an invitation to participate, a description of the study, a self-administered questionnaire and a consent form. Participants joined the study by completing the baseline questionnaire and providing consent for long-term follow up, including linkage of their questionnaire data to health records being collected by public health authorities. Recruitment occurred between 2006 and 2009, with 70% of the sample being recruited in 2008. The baseline questionnaire collected information on a range of participant characteristics (45 and Up Study Collaborators 2008). The response rate was 18%.

This research used the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource (CES-P&CH) based on the Sax Institute's 45 and Up Study, to identify a community-dwelling population in Central and Eastern Sydney (CES) to be used to answer policy relevant research questions. There were 30,645 participants recruited within the CES region at baseline. The CES-P&CH includes 45 and Up Study questionnaire data linked to Medical Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) data for the period 2006-2017 by the Sax Institute and using a unique identifier. It also includes data from the Admitted Patient Data Collection (APDC), Emergency Department Data Collection (EDDC) and Cancer Registry and Deaths Registry linked by the NSW Centre for Health Record Linkage (CHeReL) (Figure B 1) using probabilistic techniques. (Irvine and Moore, 2015; NSW Ministry of Health, 2018) CES-P&CH, based on the 45 and Up Study, was used to answer the research questions because it contained demographic and health behaviour data linked to MBS, hospitalisations and death administrative data.

Figure B 1: CES-P&CH data

Modified from figure in Bureau of Health Information. Data Matters – Linking data to unlock information. The use of linked data in healthcare performance assessment. Sydney (NSW). 2015; BHI

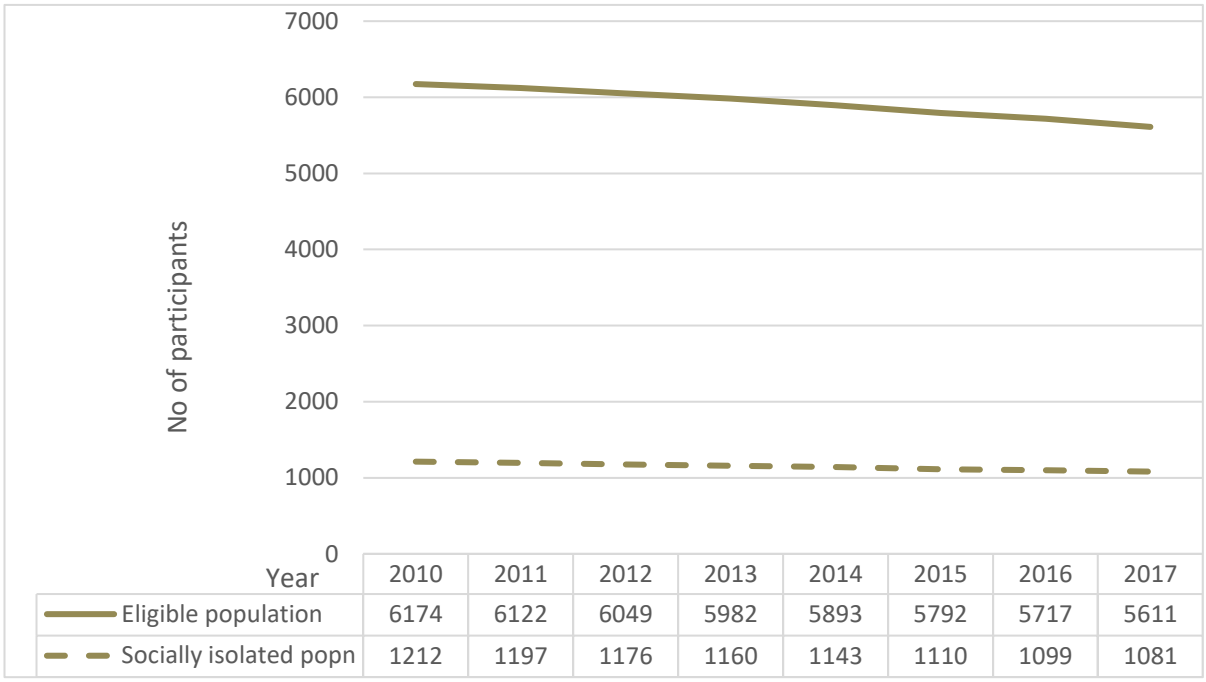
The Social, Economic, and Environmental Factors (SEEF) sub-study: The first 100,000 45 and Up Study participants were invited to be part of the SEEF sub-study in 2010. The SEEF questionnaire included most of the baseline questions, as well as additional questions on social, psychological, economic and environmental factors (Stamatakis et al., 2014).

Study populations

The study populations were limited to participants who had completed the SEEF sub-study (Stamatakis et al., 2014) of the 45 and Up Study, which included questions on social isolation, living alone and other social factors. Participants were excluded from the analysis if they had not completed the social isolation question in the SEEF or if the date of SEEF interview was after the date of death recorded in the death data, or the individual had multiple dates of death.

There were 6,176 participants from CES and 21,405 participants from Sydney Metropolitan region[2] who completed the SEEF questionnaire. The CES study population was used to answer research questions 1-4, 6 and 7. Analysis for research question 5, about the association of CALD and social isolation, used the Sydney Metropolitan region study population because of the small numbers of participants with a CALD background in CES (n=1,234). The population selected to answer question 4 was limited to CES participants who had an index hospitalisation. (n=3,562) Figure B 2 presents the eligible participants and those who were socially isolated between 2010 and 2017.

Figure B 2: No of eligible participants and socially isolated participants, CES, 2010-2017



Year	2010	2011	2012	2013	2014	2015	2016	2017
Eligible population	6174	6122	6049	5982	5893	5792	5717	5611
Socially isolated popn	1212	1197	1176	1160	1143	1110	1099	1081

Note: The decline in the populations between 2010 and 2017 was mainly due to participants dying.

Measures

The main measures used were social isolation, living alone, socio-demographic and health characteristics, health services use and mortality.

Social isolation was measured using the Duke Social Support Index (DSSI) social interaction subscale which was included in the SEEF questionnaire. The DSSI tool has also been validated in older populations in Australia by Goodger et al. (1999). Details of this tool has been described elsewhere (Koenig et al., 1993). In brief, the DSSI social interaction subscale (George et al., 1989) measures:

- number of family members within one hour that the subject can depend on or feel close to
- number of times in the past week spent time with someone they are not living with
- number of times in the past week talked with friends/relatives on telephone
- number of times in the past week attended meetings of clubs, religious groups or other groups that you belong to (other than at work).

Responses were recoded into a three-point Likert format, thus giving a social interaction score of between 4 and 12 (AIHW, 2004). The actual questions and scoring are included in Appendix B Table B2. Respondents needed to answer all questions to be included. As per George et al. (1989), the scores were then divided into quintiles and the bottom quintile (20%) was categorised as 'socially isolated' and compared to the other four higher quintiles

[2] Sydney Metropolitan area = Metropolitan Primary Health Network boundaries including: CES, Northern Sydney, Western Sydney, South Western Sydney and Nepean Blue Mountains.

(80% not socially isolated) [19]. This resulted in 1,213 participants being classified as socially isolated and 4,963 as not socially isolated in the CES study population.

Table B 1: Duke Social Support Index (DSSI) social interaction subscale questions and coding

Question	Original response	Recoding
How many people outside your home, but within one hour of travel, do you feel you can depend on or feel very close to?	Mean of 6.70 Min 0 Max 1000	1=None 2=1-2 people 3=More than 2 people
How many TIMES in the LAST WEEK did you: spend time with friends or family who do not live with you?	Mean of 3.72. Min: 0 Max: 100	1=None 2=Once or twice 3=Three or more times
How many TIMES in the LAST WEEK did you: talk to someone (friends, relatives or others) on the telephone?	Mean of 5.71 Min: 0 Max: 300	1=None or once 2=Two to five times 3=Six or more times
How many TIMES in the LAST WEEK did you: go to meetings of social clubs, religious groups or other groups you belong to?	Mean of 1.26. Min: 0 Max: 50	1=None or once 2=Two to five times 3=Six or more times
Social isolation score		≤ 8

Living alone was based on the participants response of the household number question 'Including yourself how many people in total live in your household' in the SEEF questionnaire. If the participant answered 1 then they were defined as living alone. This resulted in 2,163 participants living alone and 4865 not living alone.

Socio-demographic and health characteristics (co-variates) were based on the relevant questions in the SEEF questionnaire and the 45 and up study baseline survey.

Culturally and Linguistically Diverse (CALD) background was based on three variables from the baseline questionnaire: (i) in which country you were born (with response options being: Australia, UK, New Zealand, Ireland, Italy, China, Greece, Germany, Lebanon, Philippines, Netherlands, Vietnam, Malta, Poland and other-please specify); (ii) what is your ancestry (with response options being: Australian, English, Irish, Chinese, Italian, Greek, Scottish, German, Lebanese, Dutch, Maltese, Polish, Filipino, Indian, Croatian, Vietnamese and other-please specify); and (iii) Do you speak a language other than English at home?. Participants were classified as CALD if they were born in a non-English speaking country and/or had ancestry from a non-English speaking country and/or spoke a language other than English (LOTE) at home.

Details of all covariates used in the analysis are presented below in Table B2.

Table B 2: Demographic. social and health related characteristics, data sources and descriptions

Characteristics	**Data source**	**Question**	**Categorisation for analysis**
Demographic characteristics			
Age group	SEEF	Age at SEEF interview	47-59 years 60-74 years 75-84 years 85+ years
Gender	SEEF	Sex	Male Female
Household income	SEEF	Self-reported household income category	<$20,000 $20,000-39,999 $40,000-69,999 $70,000 or more Won't disclose

Characteristics	Data source	Question	Categorisation for analysis
Highest qualification	45 and Up Study Baseline	Self-reported highest level of educational qualification	No school certificate or other qualification School or intermediate certificate Higher school or leaving certificate Trade or apprenticeship Certificate or diploma University degree or higher
Private insurance	45 and Up Study Baseline	Private insurance status	Yes: Has private health insurance No: No private health insurance
Health care card	45 and Up Study Baseline	Healthcare card status	Yes: Has a healthcare card No: No healthcare card
CALD definition (yes to any of the 3 characteristics below)			
Language other than English	45 and Up Study Baseline	Whether speaks a language other than English at home?	Yes: Speaks language other than English at home No: Speaks only English at home
Country of birth	45 and Up Study Baseline	Self-reported country of birth	Yes: Overseas – non-English speaking country No: Australia or an English-speaking country
Ancestry	45 and Up Study Baseline	What is your ancestry?	Yes: Not Australian or country where English is spoken No: Australian/English/other English-speaking country
Social characteristics			
Work status	SEEF	Working status at SEEF:	Not working Working part-time Working full-time
Currently married/partnered	SEEF	Current marital status: or not	Yes: currently married/partnered No: Nor currently married/partnered
Living alone	SEEF	Self-reported number of people in total live in the household.	Yes: 1 only lives in the house No: 2 or more in the house
Parent of child	45 and Up Study Baseline	Self-reported number of children given birth to or fathered	Yes: 1 or more children No: 0 children
Live in safe area	SEEF	Does your area have a reputation for being a safe place?	Yes: Area is safe No: Area is not safe
Social isolation	SEEF	See Table B1	Duke social index score <8 (bottom 20%)
Health characteristics			
Smoking Status	SEEF	Smoking status at SEEF	Yes: Currently smoking No: Non-smoker or ex-smoker
Adequate physical activity	SEEF	Based on the amount of moderate and vigorous exercise reported: see AIHW definition	Yes: Adequate physical activity No: Inadequate physical activity
Adequate fruit/vegetable consumption	SEEF	Self-reported fruit and vegetable consumption	Yes: Adequate intake of fruit and vegetables (5+ serves of vegetables and 2+ serves of fruit per day) No: Inadequate intake of fruit and vegetables
Alcohol consumption	SEEF	Self-reported number of standard drinks each week	zero low (<=14 drinks per week) high (>14 drinks per week)

Characteristics	Data source	Question	Categorisation for analysis
Treatment for high blood pressure	SEEF	Self-reported as currently taking treatment for high blood pressure	Yes: Treated for high blood pressure No: Not treated for high blood pressure
Treatment for high cholesterol	SEEF	Self-reported as currently taking treatment for high cholesterol	Yes: Treated for high cholesterol No: Not treated for high cholesterol
Self-reported poor Health	SEEF	Based on the Short Form 1 (SF1) – classified as yes if responded as fair or poor	Yes: Fair or poor health No: Excellent, very good or good health
Self-reported poor quality of life	SEEF	Self-rated quality of life question – classified as yes if responded as good; very good or excellent	Yes: Fair or poor quality of life No: Excellent, very good or good quality of life
Reported needing help with daily activities	SEEF	Do you regularly need help with daily tasks because of long-term illness or disability?	Yes: Needs help with daily activities No: No need of help with daily activities
Reported at least one fall in 12 months prior	SEEF	Self-reported falls in last 12 months	Yes: 1 or more falls in last 12 months No: No falls in last 12 months
Self-reported diabetes diagnosis	SEEF	Has a doctor EVER told you that you have diabetes	Yes: Told have diabetes No: N**ot told** they had diabetes
Self-reported heart disease	SEEF	Has a doctor EVER told you that you have heart disease?	Yes: Told have heart disease No: N**ot told** they had heart disease
Self-reported asthma	SEEF	Has a doctor EVER told you that you have asthma?	Yes: Told have asthma No: N**ot told** they had asthma
Psychological distress	SEEF	K-10 questions	Low (K10<3) High (K10≥3)
Self-reported anxiety	SEEF	Has a doctor EVER told you that you have anxiety?	Yes: Told have anxiety No: N**ot told** they had anxiety
Self-reported cancer	SEEF	Has a doctor EVER told you that you have skin cancer, melanoma, breast cancer, prostate cancer or other cancer?	Yes: Told have skin cancer, melanoma, breast cancer, prostate cancer or other cancer No: N**ot told** they had cancer

Health service use

Health service use was categorised for each participant according to the average number of encounters, presentations or hospitalisations per year over the three-year baseline period (which included the year of SEEF survey, and one year before and one year after the SEEF survey year) see Figure 2. Health service measures included:

- Any GP use: Average of one or more GP encounters/year over the three-year baseline period, based on MBS GP attendance items claimed. Items are described in Appendix B Table B3.
- High GP use: Average of 13 or more GP encounters/year over the three-year baseline period, based on MBS GP attendance items claimed. Items are described in Appendix B Table B3. Thirteen or more was used because it represented the top 20-25% of attenders, and cut-offs of 9–14 encounters per year have been used to define high attendance in other studies (Gill and Sharpe, 1999, Jiwa et al., 2000, Vedsted et al., 2001, Sheehan et al., 2003 and Vedsted et al., 2004).

- Any ED presentation: Average of one or more ED presentation[3] per year over the three-year baseline period, using the EDDC data
- Any hospitalisation: At least one overnight hospitalisation[4] per year, over the three-year baseline period, using APDC data.

Outcome measures:

Five-year mortality included deaths of study participants from all causes in the five years following their completion of the SEEF survey based on death registry data.[5]

Five-year hospitalisations included one or more hospitalisations of study participants in the five years following their completion of the SEEF survey:

General practice chronic disease management services were assessed using the following measures:

- GPMP or TCA use: At least one GPMP or TCA prepared during the three-year baseline period, based on MBS Group 15 items claimed. Items are described in Appendix B Table B3.
- GPMP or TCA review use: At least one GPMP or TCA review during the three-year baseline period, based on MBS Group 15 items claimed. Items are described in Appendix B Table B3.
- Allied health service use: At least one allied health services during the three-year baseline period, based on MBS Allied health services claimed. Items are described in Appendix B Table B3.

See Appendix B Table B 3 for details of the MBS claim item numbers used

Continuity of care was defined in two ways:

- Having a consultation with **any GP,** 30 days prior to and within 30 days following the index hospitalisation.
- Having a consultation with the **same GP** 30 days prior to and within 30 days following the index hospitalisation.

Data Management

We examined the data for errors and inconsistencies within each dataset separately, such as duplicate records, missing data and range checks for each variable and then errors/inconsistencies for participants (e.g. age, date of birth), and event variables such as dates (e.g. being discharged before being admitted). We then examined inconsistencies between the datasets (e.g. different demographics, deaths prior to service events). Where the inconsistencies could not be resolved, we either created rules to manage them or excluded the record, depending on the best evidence and documenting the decisions.

Statistical Analyses

The statistical analysis included three components:

(i) Descriptive analysis included calculations of the proportions of participants within the CES region by social isolation status and living situation (alone or not alone), and participants from Metropolitan Sydney who had a CALD background by social isolation status. Descriptive analyses were also conducted to examine the proportion of participants who were and were not categorised as being socially isolated for each socio-demographic and health factor, and for use of health services.

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[3] Where the date of a participant's ED visits occurred after the death date in the death registry data, the patient record was excluded.

[4] Where multiple admissions for a single episode of a condition occurred (e.g. consecutive admissions for a single person—the separation date of the previous episode and the admission date for the following episode was the same and the mode of transfer for the previous separation was 'inter-hospital transfer'—and overlapping and nested transfers in a single episode of care for a condition) we considered them as a single episode of hospitalisation.

[5] Participant records were excluded from the analysis if date of SEEF interview for an individual was after the date of death recorded in the death data the participant had multiple dates of death.

ii) Crude or unadjusted prevalence ratios with 95% confidence intervals, were calculated using univariate generalised linear model with Poisson family and log link function to examine which demographic, social and health factors were related to being socially isolated and living alone.

About Prevalence Ratios

$$\text{Crude (unadjusted) prevalence ratio} = \frac{\text{Prevalence of an outcome (e.g. social isolation) among those } \textbf{with} \text{ the specific exposure or characteristic (e.g. high GP use)}}{\text{Prevalence of an outcome (e.g. social isolation) among those } \textbf{without} \text{ the specific exposure of characteristic (e.g. high GP use)}}$$

Interpreting prevalence ratios:

- If the prevalence of the outcome (e.g. social isolation) is the same for those with the characteristic and those without the characteristic, the ratio will equal 1.0
- If prevalence of the outcome (e.g. social isolation) for those with the characteristic is higher than in without the characteristic, the ratio will be greater than 1.0.
- If the prevalence of the outcome (e.g. social isolation) for those with the characteristic is lower than in those without the characteristic, the ratio will be less than 1.0.

(iii) Adjusted prevalence ratios with 95% confidence intervals were calculated using multivariable generalised linear models with Poisson family and log link function:

- to identify which demographic, social, health and health service use characteristic factors were independently associated with social isolation (and living alone). Thus, considering other factors that may influence social isolation and living alone
- to determine if social isolation/living alone was associated with health service use between 2009 and 2011
- to examine if being socially isolated/living alone was associated with increased mortality between 2012-2016.

Initially all variables were included in the model if they met the 20% significance criteria. A backward elimination process was conducted, where variables were included if when removed from the model, they led to a change of 5% or greater.

We set $p<0.05$ as statistically significant for all statistical tests. We used SAS9.4 (SAS institute, 2011) for data management and R version 3.5.1 for statistical analyses (R Core Team, 2019).

Table B 3: MBS Groups claim item codes for GP attendance and care plans and allied health services.

MBS Group	Name of Group	Item numbers
Group A1	GP attendances to which no other item applies	1,2,3, 4, 13, 20, 23, 24, 25, 33, 35, 36, 37, 38, 40, 43, 44, 47, 48, 50, 51
Group A2	Other non-referred attendances to which no other item applies	52, 53, 54, 57, 58, 59, 60, 65,81, 83, 84, 86, 87, 89, 90, 91, 92, 93, 95, 96 97,98 (non-GP)
Group A5	Prolonged attendances to which no other item applies	160, 161, 162, 163, 164
Group A7	Acupuncture and non-specialist practitioner items	173, 193, 195, 197, 199
Group A11	Emergency after-hours attendances	602, 603, 696, 697, 698
Group A14	Health assessments	700, 701, 702, 703, 704, 705, 706,707, 708,709,7010, 711-14,715, 716-19
Group A15	GP care plans and TCAs[6]	GPMP/TCA preparation: 721, 723, 729, 731 GPMP/TCA review: 725, 727, 732
Group A17	Medication management review	900, 903
Group A18	GP attendance associated with Practice Incentive Program (PIP)	2497, 2501, 2503, 2504, 2506, 2507, 2509, 2517, 2518, 2521, 2522, 2525, 2526, 2546, 2547, 2552, 2553, 2558, 2559
Group A19	Other non-referred attendances associated with PIP incentive payments to which no other item applies	2598, 2600, 2603, 2606, 2610, 2613, 2616, 2620, 2622, 2624, 2631, 2633, 2635, 2664, 2666, 2668, 2673, 2675, 2677
Group A20	GP mental health care	2700, 2701, 2702, 2710, 2712, 2713, 2715, 2717, 2721, 2723, 2725, 2727, 2729, 2731
Group A22	GP after-hours attendances to which no other item applies	5000, 5003, 5007, 5010, 5020, 5023, 5026, 5028, 5040, 5043, 5046, 5049, 5060, 5063, 5064, 5067
Group A23	Other non-referred after-hours attendances to which no other item applies	5200, 5203, 5207, 5208, 5220, 5222, 5223, 5227, 5228, 5240, 5243, 5247, 5248, 5260, 5263, 5265, 5267
Allied health services	Access to MBS subsidised private allied health services including: podiatry; physiotherapy; exercise physiology; diabetes education; psychology; chiropractic; dietetics; audiology; speech therapy.	10950-10970, 80000, 80001, 80005, 80010, 80011, 80015, 80020, 80021, 80100, 80101, 80105, 80110, 80111, 80115, 80120, 80121, 80125, 80126, 80130, 80135, 80136, 80140, 80145, 80146, 80150, 80155, 80160, 80161, 80165, 80170, 80171, 81100, 81105, 81120, 81125, 81110, 81115, 81300, 81305, 81310, 81315, 81320, 81325, 81330, 81335, 81340, 81345, 81350, 81355, 81360,

[6] Items 735-880 (case-conferences) were excluded as they do not involve a patient attendance

Appendix C: Additional Figures and Tables associated with the Social Isolation Analysis

Table C 1: Summary of social interaction index

Social Interaction Subscale of the Duke Social Support Index (DSSI)	N	Percentage
	6176	
Mean (SD) Score	8.8 (1.6)	
Median (IQR) Score	9.0 (8.0, 10.0)	
Quintiles		
20th percentile (score=≤8)	1213	19.6
40th and 60th percentile (score=9)	2677	43.4
80th percentile (score=10)	1501	24.3
100thpercentile (score=12)	785	12.7
Social Isolation		
Yes (bottom 20th percentile, score <8)	1213	19.6
No	4963	80.4

Table C 2: Demographic characteristics associated with social isolation, CES, 2010

Participant characteristics	Not socially isolated N=4963 n (%)	Socially isolated n (%) n=1213	PR (95% CI)	Adj. PR (95% CI)
Age at recruitment, year				
47-59	1951 (76.5)	599 (23.5)	1	1
60-74	1959 (84.7)	354 (15.3)	0.65 (0.57, 0.74)	**0.62 (0.54, 0.72)**
75-84	740 (83.7)	144 (16.3)	0.69 (0.58, 0.83)	**0.56 (0.44, 0.69)**
85+	313 (73.0)	116 (27)	1.15 (0.94, 1.40)	0.86 (0.68, 1.09)
Gender				
Male	2252 (76.4)	694 (23.6)	1	1
Female	2711 (83.9)	519 (16.1)	0.68 (0.61, 0.76)	**0.64 (0.57, 0.73)**
Culturally and linguistically diverse (CALD)				
No	4085 (82.7)	857 (17.3)	1	1
Yes	878 (71.2)	356 (28.8)	1.66 (1.47, 1.88)	**1.53 (1.34, 1.75)**
Household income				
<$20,000	469 (77.6)	135 (22.4)	1	1
$20,000-39,999	704 (79.9)	177 (20.1)	0.9 (0.72, 1.13)	0.98 (0.78, 1.24)
$40,000-69,999	854 (81.3)	197 (18.7)	0.84 (0.67, 1.05)	0.96 (0.76, 1.23)
$70,000 or more	2196 (80.7)	524 (19.3)	0.86 (0.72, 1.05)	0.93 (0.73, 1.18)
Won't disclose	394 (79.3)	103 (20.7)	0.93 (0.72, 1.2)	1.06 (0.80, 1.39)
Highest qualification				
No school certificate or other qualification	226 (74.1)	79 (25.9)	1	1
School or intermediate certificate	821 (83.3)	165 (16.7)	0.65 (0.50, 0.85)	0.76 (0.58, 1.02)
Higher school or leaving certificate	498 (76.7)	151 (23.3)	0.9 (0.69, 1.18)	0.83 (0.62, 1.12)
Trade or apprenticeship	376 (77.2)	111 (22.8)	0.88 (0.66, 1.18)	0.80 (0.59, 1.09)
Certificate or diploma	1098 (83.2)	222 (16.8)	0.65 (0.50, 0.84)	**0.67 (0.51, 0.88)**
University degree or higher	1894 (80.5)	459 (19.5)	0.75 (0.60, 0.96)	**0.75 (0.58, 0.99)**
Private insurance				
No	930 (70.5)	390 (29.5)	1	1
Yes	4033 (83.1)	823 (16.9)	0.57 (0.51, 0.65)	**0.62 (0.53, 0.71)**
Health care card				
No	4147 (80.5)	1004 (19.5)	1	1
Yes	816 (79.6)	209 (20.4)	1.05 (0.90, 1.21)	0.92 (0.76, 1.11)

Notes: * p<0.05; Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all variables in the table.

Table C 3: Social and health factors associated with social isolation, CES, 2010

Social and health factors	Not socially isolated n (%)	Socially isolated n (%)	PR (95% CI)	Adj. PR (95% CI)
Working status				
Not working	2387 (82.5)	508 (17.5)	1	1
Part time	1108 (84.3)	207 (15.7)	0.90 (0.76, 1.05)	0.96 (0.81, 1.15)
Full time	1414 (74.6)	481 (25.4)	1.45 (1.28, 1.64)	**1.63 (1.41, 1.88)**
Currently married/de facto/living with partner				
No	1402 (79.7)	357 (20.3)	1	1
Yes	3524 (80.7)	845 (19.3)	0.95 (0.84, 1.08)	1.01 (0.84, 1.23)
Living alone¥				
No	3889 (79.9)	976 (20.1)	1	1
Yes	1040 (82.3)	223 (17.7)	0.88 (0.76, 1.02)	**0.70 (0.56, 0.87)**
Parent of child				
No	948 (75.6)	306 (24.4)	1	1
Yes	4015 (81.6)	907 (18.4)	0.76 (0.66, 0.86)	**0.73 (0.63, 0.84)**
Living in safe area				
No	533 (74.9)	179 (25.1)	1	1
Yes	4341 (81.2)	1004 (18.8)	0.75 (0.64, 0.88)	0.91 (0.77, 1.08)
Currently smoking				
No	4734 (80.8)	1124 (19.2)	1	1
Yes	195 (70.9)	80 (29.1)	1.52 (1.20, 1.89)	1.27 (0.99, 1.61)
Adequate physical activity				
No	1249 (74.4)	430 (25.6)	1	1
Yes	3714 (82.6)	783 (17.4)	0.68 (0.60, 0.77)	**0.78 (0.69, 0.89)**
Adequate fruit and vegetable intake				
No	3961 (79.4)	1030 (20.6)	1	1
Yes	1002 (84.6)	183 (15.4)	0.75 (0.64, 0.87)	**0.82 (0.69, 0.96)**
Alcohol consumption				
0 drinks/week	1302 (74.5)	446 (25.5)	1	1
1-13 drinks/week	2613 (82.8)	543 (17.2)	0.67 (0.60, 0.76)	**0.72 (0.63, 0.83)**
14+ drinks/week	974 (83.2)	195 (16.7)	0.65 (0.55, 0.77)	**0.70 (0.58, 0.83)**
Psychological distress				
Low (K10<3)	4741 (81.2)	1095 (18.8)	1	1
High	222 (65.3)	118 (34.7)	1.85 (1.52, 2.23)	**1.26 (1.00, 1.58)***
Being treated for high blood pressure				
No	3736 (79.9)	940 (20.1)	1	1
Yes	1227 (81.8)	273 (18.2)	0.91 (0.79, 1.03)	0.97 (0.83, 1.13)
Being treated for high cholesterol				
No	4008 (79.8)	1016 (20.2)	1	1
Yes	955 (82.9)	197 (17.1)	0.85 (0.72, 0.98)	0.86 (0.72, 1.02)
Self-reported poor health condition				
No	4371 (81.9)	963 (18.1)	1	1
Yes	592 (70.3)	250 (29.7)	1.64 (1.43, 1.89)	1.04 (0.85, 1.26)

Social and health factors	Not socially isolated n (%)	Socially isolated n (%)	PR (95% CI)	Adj. PR (95% CI)
Self-reported poor quality of life				
No	4656 (82.3)	998 (17.7)	1	1
Yes	307 (58.8)	215 (41.2)	2.33 (2.01, 2.7)	2.11 (1.72, 2.58)
Reported needing help with daily activities				
No	4773 (80.5)	1155 (19.5)	1	1
Yes	177 (77.0)	53 (23.0)	1.18 (0.89, 1.54)	**0.67 (0.48, 0.93)**
Reported at least one fall in 12 months prior				
No	4039 (80.6)	971 (19.4)	1	1
Yes	897 (79.1)	237 (20.9)	1.08 (0.93, 1.24)	1.10 (0.95, 1.28)
Self-reported diabetes diagnosis				
No	4590 (80.6)	1103 (19.4)	1	1
Yes	373 (77.2)	110 (22.8)	1.18 (0.96, 1.42)	1.03 (0.83, 1.27)
Self-reported heart disease				
No	4230 (80.7)	1012 (19.3)	1	1
Yes	733 (78.5)	201 (21.5)	1.11 (0.96, 1.29)	**1.25 (1.05, 1.47)**
Self-reported asthma				
No	4400 (80.2)	1086 (19.8)	1	1
Yes	563 (81.6)	127 (18.4)	0.93 (0.77, 1.11)	0.86 (0.70, 1.03)
Self-reported anxiety				
No	4165 (81.5)	948 (18.5)	1	1
Yes	798 (75.1)	265 (24.9)	1.34 (1.17, 1.54)	1.26 (0.94, 1.65)
Self-reported depression				
No	4355 (81.3)	1002 (18.7)	1	1
Yes	608 (74.2)	211 (25.8)	1.38 (1.18, 1.59)	0.97 (0.71, 1.34)
Self-reported cancer				
No	3072 (79.4)	799 (20.6)	1	1
Yes	1891 (82.0)	414 (18.0)	0.87 (0.77, 0.98)	0.91 (0.80, 1.04)

Notes: * p<0.05; Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the table. ¥ Missing value: n=48

Table C 4: Frequency distribution of service use by social isolation status, CES

Categories of service use	Socially isolated n (%)	Not socially isolated n (%)
GP encounters		
0	26 (2.1)	103 (2.1)
>0-5	474 (39.1)	1961 (39.5)
>5-10	388 (32.0)	1653 (33.3)
>10-15	174 (14.3)	701 (14.1)
>15-25	109 (9.0)	442 (8.9)
>25	42 (3.5)	103 (2.1)
Hospitalisations		
0	818 (67.4)	3403 (68.6)
>0-1	343 (28.3)	1381 (27.8)
>1-2	41 (3.4)	137 (2.8)
>2	11 (0.9)	42 (0.8)
Emergency department presentations		
0	792 (65.3)	3443 (69.4)
>0-1	361 (29.8)	1352 (27.2)
>1-2	37 (3.1)	131 (2.6)
>2	23 (1.9)	37 (0.7)

Table C 5: Frequency distribution of service use by social isolation status for participants from CALD background, Sydney Metropolitan region

Categories of service use	Socially isolated n (%)	Not socially isolated n (%)
GP encounters		
0	13 (1.1)	29 (1.0)
>0-5	397 (35.0)	951 (34.1)
>5-10	358 (31.6)	947 (34.0)
>10-15	183 (16.2)	477 (17.1)
>15-25	128 (11.3)	305(10.9)
>25	54 (4.8)	78 (2.8)
Hospitalisations		
0	813 (71.8)	1966 (70.5)
>0-1	285 (25.2)	739 (26.5)
>1-2	30 (2.6)	64 (2.3)
>2	5 (0.4)	18 (0.6)
Emergency department presentations		
0	804 (71.0)	1933 (69.4)
>0-1	295 (26.0)	765 (27.4)
>1-2	25 (2.2)	67 (2.4)
>2	9 (0.8)	22 (0.8)

Defining CALD background

A person was categorised as CALD if they were born in a non-English speaking country or if their ancestry was from a non-English speaking country and they spoke a language other than English at home. This resulted in 1,234 participants in CES. In order to have adequate statistical power to consider differences in health service use and mortality, the sample needed to be increased, and so we expanded the area to the Sydney Metropolitan region (metropolitan Primary Health Network boundaries including: CES, Northern Sydney, Western Sydney, South Western Sydney and Nepean Blue Mountains). There were 21,405 participants from Sydney Metropolitan region who completed the SEEF questionnaire, and 3,920 (18.3%) were from a CALD background. Of these, 1,133 (28.9%) were socially isolated. As shown in Table C6, participants from a CALD background were 56% more likely to be socially isolated compared to participants from a non-CALD background.

Table C 6: CALD population in the Sydney Metropolitan region

Participant Background	n	Socially isolated n (%)	Not socially isolated n (%)
All participants	21,405		
Born in Australia and ancestry Australian/English/other ES country	12,673	2,229 (17.6%)	10,444 (82.4)
Born in ESB country (UK/ New Zealand/other ES country) and ancestry Australian/English/other ES country	2,282	486 (21.3%)	2,206 (78.7%)
Born in Australia/ESB country and ancestry NOT Australian/English and speak English at home	2,530	512 (20.2%)	2,018 (79.8%)
Born in Australia/ESB country and ancestry NOT Australian/English and speak LOTE at home	239	64 (26.8%)	175 (73.2%)
Born in NESB country	3,681	1,069 (29.0%)	2,612 (71.0%)
CALD background			
No	17,485	3,226 (18.5%)	14258 (81.5%)
Yes (Born in NESB country and/or ancestry from NESB country and/or speak LOTE at home)	3,920	1,133 (28.9%)	2787 (70.1%)

Appendix D: Summary of the Social Isolation Literature

Table D 1: Summary of studies identifying factors independently associated with social isolation

Factors	Showing association between factor and social isolation		
	More likely	**Less likely**	**No association**
Socio-demographic factors			
Age - older age	Cantarero-Prieto 2018 Giuli 2012 Robins 2018	Hawthorne 2008	Menec 2019 Iliffe 2007
Age - 60-84 years		**Our study**	
Gender – female	Rohde 2016 Giuli 2012	**Our study** Cudjoe 2020 Menec 2019 Iliffe 2007	Cantarero-Prieto 2018 Hawthorne 2008 Robbins 2018
CALD/ethnicity/race	**Our study** Hawthorne 2008	Cudjoe 2020 (Afro-American and Hispanic)	Robins 2018
Income - higher		Menec 2019 Hawthorne 2008 Cudjoe 2020	**Our study** Iliffe 2007 (pension)
Education – higher	Menec 2019	**Our study** Cantarero-Prieto 2018 Cudjoe 2020	Hawthorne 2008 Iliffe 2007
Private health insurance		**Our study**	
Working status - fulltime	**Our study**	Hawthorne Cantarero-Prieto 2018	
Being married /partnered		Hawthorne 2008 Cudjoe 2020	**Our study**
Living situation - alone	Cantarero-Prieto 2018 Robins 2018 Iliffe 2007		**Our study**
Being a parent		**Our study**	
Living in a safe area			**Our study**
Health risk factors			
Smoking	Kobayashi 2018 Hammig 2019		**Our study**
Physical activity - adequate		**Our study** Reed 2011 Schrempft 2019 Kobayashi 2018 Hammig 2019	Robins 2018
Adequate fruit and vegetable intake		**Our study** Kobayashi 2018 Hammig 2019	
Consumes 1+ alcoholic drinks/week		**Our study** Kobayashi 2018	
Other health factors			
Psychological distress	**Our study** Teo 2013 Phongsavan 2013		
Depressed mood	Iliffe 2007		
Self-rated health - poor	Robins 2018 Hammig 2019 Iliffe 2007		**Our study**
Quality of life - poor	**Our study**		
Falls past 12 months		**Our study**	
Obesity		Kobayashi 2018	Hawthorne 2008
Trauma exposure	Hawthorne 2008		
Use of psychotropic medicines	Hammig 2019		

Factors	Showing association between factor and social isolation		
	More likely	**Less likely**	**No association**
Health conditions			
Number of chronic diseases or comorbidity	Cantarero-Prieto 2018 (3+) Menec 2019 Hawthorne 2008 Hammig 2019		Robins 2018 (1+)
Arthritis			Hawthorne 2008
Asthma			**Our study** Hawthorne 2008
Cancer/malignancy			**Our study** Robins 2018
Dementia risk	Rafnsson 2020		
Diabetes			**Our study** Hawthorne 2008 Robins 2018
Depression and anxiety	Robins 2018 Hawthorne 2008 Hammig 2019		**Our study**
Falls			**Our study** Robins 2018
Heart/CV disease including heart failure	**Our study** Hakulinen 2017 Valtorta 2016 Robins 2018 (heart failure)		Robins 2018 (CVD)
Hypertension treated		**Our study**	
Hyperlipidaemia treated			**Our study**
Musculo-skeletal disorders	Hammig 2019		
Parkinson's disease			Robins 2018
Stroke			Robins 2018
Functional capacity / support			
Functional Impairment	Menec 2019		Iliffe 2007 (IADL; BADL; decreasing functional ability))
Hearing impairment	Hawthorne 2008		
Incontinence	Hawthorne 2008		
Memory impairment	Iliffe 2007		
Vision impairment			Hawthorne 2008
Needed help for their daily activities		**Our study** Cantarero-Prieto 2018	

Table D 2: Summary of the characteristics of studies assessing the independent factors associated with social isolation

Study, region, country	Aim, design, analysis methods	Population, number of participants	Social isolation (SI) definition, outcomes and predictors evaluated
Cantarero-Prieto et al., 2018 9 European countries	Aim: Investigate the association between social isolation and chronic disease Design: Panel data from the Survey on Health, Ageing and Retirement in Europe (SHARE) Analysis: Logit/logistic regression models	Community dwelling participants ≥50 years n=37,864	SI Defn: Measure based on 3 proxies: living alone, help received, club attendance Outcomes: 3+ chronic diseases Exposure variable: Social isolation Co-variates: Quality of life; socio-demographic variables
Cudjoe et al., 2020 USA	Aim: To identify subgroups of older adults at risk for social isolation Design: National Health and Aging Trends Study (NHATS) Analysis: Multinomial multivariable logistic regression	Community-dwelling older adults ≥65 years N=6649	SI Defn: Adapted Berkman-Syme Social Network Index Outcomes: Social isolation Exposure variables: Socio-demographic variables
Giuli et al., 2012 Fermo, Italy	Aim: To analyse associations between psychological, socio-demographic, functional aspects on the risk of social isolation, mortality and re-hospitalisation in older persons Design: Longitudinal study of hospitalised patients Analysis: Logistic regression	Hospitalized elderly admitted with acute conditions, aged ≥70 years N=580	SI Defn: Lubben Social Network Scale Outcomes: social isolation Exposure variables: Comorbidity, severity index, cognition, depression, functional status, quality of life, socio-demographic variables
Hammig et al., 2019 Switzerland	Aim: To examine the prevalence of association of social isolation with various health conditions and behaviours Design: Cross sectional survey 0- Swizz Health Survey 2012 Analysis:	Adolescents and adults ≥15 years N=21,597	SI Defn: 5 questions related to social disconnectedness and perceived isolation Outcomes: Social isolation Exposure variables: General health, musculoskeletal health, mental health, multimorbidity, health behaviours (physical activity, fruit and vegetable intake, smoking status, use of psychotropic medicines) Co-variates: Socio-demographic variables
Hakulinen et al., 2017 UK	Aim: To examine whether social isolation and loneliness (1) predict acute myocardial infarction and stroke, (2) are related to mortality risk, and (3) the extent to which these associations are explained by known risk factors or pre-existing chronic conditions Design: The UK Biobank Analysis:	Participants aged 40–69 years recruited to the UK Biobank n=479, 054	SI Defn: Measure based on 3 proxies: persons living in household, friends visit, social/leisure activities Outcomes: AMI, stroke, mortality Exposure variables: Social isolation, loneliness, Co-variates: Known risk factors including socio-demographic variables, health risk factors (e.g. smoking alcohol intake and BMI) and chronic conditions
Hawthorne et al., 2008 South Australia, Australia	Aim: Assess prevalence of social isolation and associated factors Design: 2004 South Australian Health Omnibus Survey (SAHOS) Analysis: Multivariate analyses using logistic regression	Community dwelling adults N=3,015	SI Defn: Friendship scale Outcomes: Social isolation Exposure variables: Socio-demographic variables, comorbidity (asthma, diabetes, arthritis, depression), impairments (hearing vision, incontinence), obesity, lifetime exposure to trauma
Iliffe et al., 2007 UK	To explore the clinical significance of social isolation and investigate its associations with health behaviours, health status, and service use Secondary analysis of baseline data from a RCT Logistic regression	Community-dwelling adults aged 65+ years registered at a general Practice N=2,641	SI Defn: Lubben Social Network Scale Outcomes: Social isolation Exposures : Health, functioning, Mood, health risk factors Control variables: Socio-demographic variables
Kobayashi et al., 2018 England	Aim: Examine the associations between social isolation, loneliness and engagement in health behaviours Design: Population cohort: English Longitudinal Study of Ageing	Adults aged ≥50 years with complete data collection (2004-2015) N=3,392	SI Defn: 5-item index (monthly contact with children, family and friends; lived alone; belonged to an organisation/club) Outcomes: Social isolation, loneliness Exposure variables: Health risk factors (e.g. physical activity and fruit and

Study, region, country	Aim, design, analysis methods	Population, number of participants	Social isolation (SI) definition, outcomes and predictors evaluated
	Analysis: A modified Poisson regression for binary outcome data with log link function and robust error variance		vegetable intake, smoking, alcohol intake, BMI) Co-variates: Socio-demographic variables; impairments
Menec et al., 2019 Canada	Aim: Examine personal (e.g., sex, income) and geographic (rural/urban and sociodemographic) factors and their association with social isolation and loneliness Design: Baseline data from the Canadian Longitudinal Study on Aging Analysis: Multilevel logistic regression	National sample of Canadian adults 45-85 years N=47,752	SI Defn: 5-item index: marital status; living arrangements; social contact outside the household, and social participation. Outcomes: Social isolation, loneliness Exposure variables: Socio-demographic variables, functional status; chronic conditions (33)
Phongsavan 2013 NSW, Australia	Aim: To examine the relationships between social contact types and psychological distress among mid-older adults Design: Cohort : 45 and Up Study Analysis: multiple logistic regression model	Community dwelling adults 45 years and older N=236,490	SI Defn: Social contact index: number of people to depend on; telephone calls; social group contact; social visits Outcomes: Risk of psychological distress Exposure variable: social contacts Co-variates: Socio-demographic variables, physical functioning, self-rated health; hearing loss
Rafnsson et al., 2020 UK	Aim: To understand how different aspects of social experience (loneliness and social relationships) predict dementia Design: English Longitudinal Study of Ageing (ELSA) Analysis: Cox proportional hazards regression models	Community dwelling adults 50years and older N= 6,677	SI Defn: Social relationships (extent of social network and involvement in social Outcomes: Dementia Exposure variables: Loneliness and close relationships Co-variates: Socio-demographic variables, mobility, depression; baseline cognition status
Reed et al., 2011 USA	Aim: To examine the relationship between physical inactivity and social isolation Design: Nationally representative cross-sectional survey, the Third National Health and Nutrition Examination Survey, (1988-1994) Analysis: Multivariate logistic regression	Older US adults	SI Defn: Social support: telephone contact with friends, family or neighbours; visits with friends, family or neighbours; attend religious services; member of club/ organisation. Outcomes: Physical activity (leisure-time) Exposure variable: Social isolation Co-variates: Socio-demographic variables, chronic conditions
Robins et al., 2018 Victoria, Australia	Aim: To determine whether a relationship exists between physical activity and social isolation Design: Cross-sectional analysis of telephone survey data Analysis: Multivariable ordered logistic regression analyses	Community dwelling adults 75 years and older N=245	SI Defn: Friendship Scale for social isolation Outcomes: Social isolation Exposure variable: Physical activity Co-variates: Socio-demographic variables, chronic conditions (7), comorbidity
Rohde et al., 2016 Australia	Aim: To investigate the mental health consequences of social isolation Design: Australian HILDA survey (panel study) Analysis: Regression models	20,000 adults recruited since 2001	SI Defn: Subjective social satisfaction questions Outcomes: Mental health Exposure variables: Social isolation Co-variates: Socio-demographic variables, self-rated health smoking, alcohol intake, mobility, depression; long standing limiting illness
Schrempft et al., 2019 England	Aim: To investigate whether social isolation and loneliness were associated with physical activity and more sedentary behaviour Design: A small sample from the English Longitudinal Study of Ageing (ELSA) Analysis:	Sub-sample of ELSA study - Community-based adults 50–81 years who wore a wrist mounted accelerometer N=267	SI Defn: Index based on social contact with family and friends and participation in social, religious groups or committees. Outcomes: Physical activity (objective measure) Exposure variables: Loneliness and social isolation Co-variates: Socio-demographic variables, self-rated health smoking,

Study, region, country	Aim, design, analysis methods	Population, number of participants	Social isolation (SI) definition, outcomes and predictors evaluated
			alcohol intake, mobility, depression; long standing limiting illness
Teo et al., 2013 Systematic review	Aim: To describe the role and measurement of social isolation in those with social anxiety disorder Design: Systematic review Analysis: Metanalyses	34 studies	SI Defn: 20 formal instruments and four other measures of social isolation Outcomes: Social anxiety disorder Exposure variables: Social isolation Co-Variates: various
Valtorta et al., 016 Systematic review	Aim: To investigate the association between loneliness or social isolation and incident coronary heart disease (CHD) and stroke Design: Systematic review Analysis: Metanalyses	11 CHD studies and 8 stroke studies	SI Defn: Outcomes: Incident CHD and stroke Exposure variables: Social isolation; loneliness Co-Variates: Various

Appendix E: Additional Tables associated with the Living Alone Analysis

Table E 1: Demographic characteristics associated with living alone, CES 2010

	Did not live alone n (%)	Lived alone n (%)	PR (95% CI)	Adj. PR (95% CI)
TOTAL	4865(79.55)	1263 (20.45)		
Age at recruitment, year				
47-59	2193 (86.5)	343 (13.5)	1	1
60-74	1825 (79.6)	468 (20.4)	1.51 (1.31, 1.74)	**1.17 (1.00, 1.37)***
75-84	599 (68.5)	276 (31.5)	2.33 (1.99, 2.73)	**1.54 (1.27, 1.86)**
85+	248 (58.5)	176 (41.5)	3.07 (2.55, 3.67)	**1.98 (1.59, 2.46)**
Gender				
Male	2468 (84.5)	453 (15.5)	1	1
Female	2397 (74.7)	810 (25.3)	1.63 (1.45, 1.83)	**1.61 (1.42, 1.83)**
Culturally and linguistically diverse				
No	3864 (78.7)	1047 (21.3)	1	1
Yes	1001 (82.3)	216 (17.7)	0.83 (0.72, 0.96)	***0.74 (0.63, 0.86)***
Household income				
<$20,000	301 (50.6)	294 (49.4)	1	1
$20,000-39,999	599 (68.9)	270 (31.1)	0.63 (0.53, 0.74)	***0.67 (0.57, 0.80)***
$40,000-69,999	812 (77.8)	232 (22.2)	0.45 (0.38, 0.53)	***0.50 (0.41, 0.60)***
$70,000 or more	2419 (89.3)	291 (10.7)	0.22 (0.18, 0.26)	***0.25 (0.20, 0.31)***
Won't disclose	415 (84.0)	79 (16.0)	0.32 (0.25, 0.41)	***0.34 (0.26, 0.43)***
Highest qualification				
No school certificate or other qualification	205 (67.9)	97 (32.1)	1	1
School or intermediate certificate	734 (75.2)	242 (24.8)	0.77 (0.61, 0.98)	0.89 (0.70, 1.16)
Higher school or leaving certificate	492 (76.5)	151 (23.5)	0.73 (0.57, 0.95)	1.18 (0.90, 1.55)
Trade or apprenticeship	402 (83.8)	78 (16.2)	0.51 (0.37, 0.68)	0.75 (0.55, 1.04)
Certificate or diploma	1054 (80.3)	259 (19.7)	0.61 (0.49, 0.78)	1.04 (0.81, 1.35)
University degree or higher	1918 (82.0)	422 (18.0)	0.56 (0.45, 0.70)	1.27 (1.00, 1.64)#
Private insurance				
No	904 (69.6)	395 (30.4)	1	1
Yes	3961 (82)	868 (18)	0.59 (0.53, 0.67)	***0.87 (0.76, 1.00)****
Health care card				
No	4182 (81.8)	932 (18.2)	1	1
Yes	683 (67.4)	331 (32.6)	1.79 (1.58, 2.03)	0.91 (0.78, 1.06)

Notes: * p<0.05; # p>0.05 (not significant); Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio

Table E 2: Social and health factors associated with living alone, CES

Social and health factors	Did not live alone n (%)	Live alone n (%)	PR (95% CI)	Adj. PR (95% CI)
Working status				
Not working	2112 (73.6)	758 (26.4)	1	1
Part time	1136 (86.9)	171 (13.1)	0.50 (0.42, 0.58)	***0.52 (0.43, 0.62)***
Full time	1578 (83.8)	305 (16.2)	0.61 (0.54, 0.70)	***0.62 (0.53, 0.71)***
Parent of child				
No	711 (57.1)	534 (42.9)	1	1
Yes	4154 (85.1)	729 (14.9)	0.35 (0.31, 0.39)	***0.34 (0.30, 0.39)***
Live in safe area				
No	488 (68.8)	221 (31.2)	1	1
Yes	4301 (81.1)	1003 (18.9)	0.61 (0.53, 0.70)	***0.75 (0.65, 0.88)***
Currently smoking				
No	4654 (80.0)	1160 (20.0)	1	1
Yes	174 (64.2)	97 (35.8)	1.79 (1.45, 2.19)	**1.42 (1.14, 1.77)**
Adequate physical activity				
No	1258 (75.9)	399 (24.1)	1	1
Yes	3607 (80.7)	864 (19.3)	0.80 (0.71, 0.90)	0.88 (0.77, 1.00)#
Adequate fruit and vegetable intake				
No	3920 (79.2)	1032 (20.8)	1	1
Yes	945 (80.4)	231 (19.6)	0.94 (0.82, 1.08)	0.92 (0.79, 1.06)
Psychological distress				
Low	4628 (79.9)	1162 (20.1)	1	1
High	237 (70.1)	101 (29.9)	1.49 (1.21, 1.81)	1.01 (0.79, 1.28)
Alcohol consumption				
0 drinks/week	1289 (74.5)	442 (25.5)	1	1
1-13 drinks/week	2546 (81.1)	593 (18.9)	0.74 (0.65, 0.84)	0.88 (0.77, 1.01)
14+ drinks/week	948 (81.9)	210 (18.1)	0.71 (0.60, 0.84)	***0.78 (0.65, 0.92)***
Being treated for high blood pressure				
No	3756 (80.9)	887 (19.1)	1	1
Yes	1109 (74.7)	376 (25.3)	1.33 (1.17, 1.49)	**1.20 (1.04, 1.38)**
Being treated for high cholesterol				
No	3987 (79.9)	1004 (20.1)	1	1
Yes	878 (77.2)	259 (22.8)	1.13 (0.99, 1.30)	0.98 (0.84, 1.14)
Self-reported poor health condition				
No	4279 (80.8)	1016 (19.2)	1	1
Yes	586 (70.3)	247 (29.7)	1.55 (1.34, 1.77)	0.99 (0.83, 1.19)
Self-reported poor quality of life				
No	4526 (80.6)	1087 (19.4)	1	1
Yes	339 (65.8)	176 (34.2)	1.76 (1.50, 2.06)	**1.26 (1.02. 1.56)**

Social and health factors	Did not live alone n (%)	Live alone n (%)	PR (95% CI)	Adj. PR (95% CI)
Reported needing help with daily activities				
No	4685 (79.5)	1206 (20.5)	1	1
Yes	172 (76.4)	53 (23.6)	1.15 (0.86, 1.50)	***0.70 (0.50, 0.95)***
Reported at least one fall in 12 months prior				
No	4039 (81.1)	944 (18.9)	1	1
Yes	808 (72.1)	312 (27.9)	1.47 (1.29, 1.67)	**1.25 (1.09, 1.43)**
Self-reported diabetes diagnosis				
No	4493 (79.5)	1158 (20.5)	1	1
Yes	372 (78.0)	105 (22.0)	1.07 (0.87, 1.30)	0.84 (0.67, 1.04)
Self-reported heart disease				
No	4184 (80.3)	1025 (19.7)	1	1
Yes	681 (74.1)	238 (25.9)	1.32 (1.14, 1.51)	1.14 (0.97, 1.33)
Self-reported asthma				
No	4344 (79.8)	1099 (20.2)	1	1
Yes	521 (76.1)	164 (23.9)	1.19 (1.00, 1.39)	0.99 (0.83, 1.17)
Self-reported anxiety				
No	4114 (81.0)	962 (19.0)	1	1
Yes	751 (71.4)	301 (28.6)	1.51 (1.32, 1.72)	1.10 (0.81, 1.45)
Self-reported depression				
No	4302 (80.9)	1015 (19.1)	1	1
Yes	563 (69.4)	248 (30.6)	1.60 (1.39, 1.84)	1.26 (0.93, 1.75)
Self-reported cancer				
No	3106 (80.9)	731 (19.1)	1	1
Yes	1759 (76.8)	532 (23.2)	1.22 (1.09, 1.36)	1.12 (0.99, 1.26)

Notes: * p<0.05; # p>0.05 (non-significant); Crude PR = crude prevalence ratio: Adj PR=Adjusted Prevalence Ratio, which is controlled for all other variables in the table.