Health service use amongst participants aged over 75 years
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Website: https://cphce.unsw.edu.au/research/central-and-eastern-sydney-primary-and-community-health-cohort


For further information, please contact Centre for Primary Health Care and Equity (CPHCE).

This report was prepared for the Sydney Local Health District under the Central and Eastern Sydney consortium using the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource. 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.

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Key Points

- This study explored, in participants over 75 years of age, the differences between frequent health services users (GP, medical specialist, ED and overnight hospitalisations) and non-frequent users, using the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource.

- Factors more likely to be associated with frequent service use that were common across the health services (GP, medical specialist, ED and hospital) were being ex-smokers, having at least one fall in the last 12 months and ever having been diagnosed with cardiovascular disease.

- Common factors less likely to be associated with frequent service use were adequate physical activity, reporting good quality of life and drinking up to two alcoholic drinks a day.

- The seven-year mortality rate of those who were frequent service users was around 50% higher than those who presented to services less frequently. Those who had two or more ED presentations in a year were nearly twice as likely to die in the next seven years compared to those with one or none.

- The proportion of participants who were frequent services users increased by approximately 30% between 2006 and 2017 (from 15.2% to 19.8% for GPs; 13.5% to 18.8% for medical specialists; 7.5% to 12.4% for ED; and 8.3% to 10.7% for overnight hospitalisations).

- Frequent health service users were not common across services, with most participants only being frequent users of one service type. Only 2% of the participants were frequent users of all the services (GP, Specialist, ED and hospital).
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 the need to better understand the frequency of health service use among individuals over 75 years of age. This research’s aims were to provide a better understanding of the factors influencing frequent service use, the association of frequent service use and mortality, trends in service use between 2006 and 2017 and the overlap of frequent service use across the health services for participants aged over 75 years. The health services investigated were General Practitioner (GP) encounters, medical specialist encounters, Emergency Department (ED) presentations and overnight hospitalisations.

This study included participants who were enrolled in the 45 and Up Study, were older than 75 years and resided in Central and Eastern Sydney (CES). Demographic, social and health factors were based on data reported in the 45 and Up Study baseline survey. Health service use was based on linked administrative data from the Medicare Benefits Schedule (MBS) claims, the Admitted Patient Data Collection (APDC) and the Emergency Department Data Collection (EDDC). Mortality data was based on linked data from the Death Registry.

To assess if socio-demographic and health factors were independently associated with frequent service use, we calculated adjusted prevalence ratios and associated 95% confidence intervals (Adj PR [95% CI]), controlling for other potentially confounding factors. To assess the association between frequent service use and mortality, we calculated adjusted hazard ratios (HR).

We defined frequent service use as 21 or more GP encounters, ten or more medical specialist encounters, two or more ED presentations and two or more overnight hospital stays in a 12-month period.

Factors associated with frequent service use

After controlling for all factors, the factors which were significantly more likely to be associated with participants who had frequent GP encounters compared to those who had non-frequent GP encounters (less than 14 encounters) were: being aged 81-85 years, speaking a language other than English, having private health insurance, having a healthcare concession card, being an ex-smoker, reporting treatment for high blood pressure, and reporting cardiovascular disease. The factors significantly less likely to be associated with frequent GP encounters were: having a university degree or higher, having a household income of $20,000-$39,999 or $70,000 or more, reporting 1-13 or 14 or more alcoholic drinks per week, and reporting good quality of life.

After controlling for all factors, participants who had private health insurance, were ex-smokers, reported at least one fall in the last 12 months, or had osteoporosis, cardiovascular disease or cancer, were significantly more likely to have frequent medical specialist encounters compared with participants who were non-frequent medical specialist visitors (<10). The factors that were significantly less likely to be associated with frequent medical specialist visits were: being aged >90 years, having adequate physical activity and reporting good quality of life.

After controlling for all factors, being aged >85 years, reporting at least one fall in the last 12 months and reporting cardiovascular disease, were significantly more likely to be associated with having two or more ED presentations compared with participants who were with non-frequent ED visitors (<2). The factors significantly less likely to be associated with having two or more ED presentations were: being female, having private health insurance, having adequate physical activity, consuming 1-13 alcoholic drinks per week and reporting good quality of life.

After controlling for all factors, being aged >80 years, being an ex-smoker, reporting at least one fall in the last 12 months, having cardiovascular disease, diabetes or cancer, were significantly more likely to be associated with having frequent (two or more) hospitalisations compared to participants who had less than two hospitalisations. The factors significantly less likely to be associated with having two or more hospitalisations were: being female, speaking a language other than English at home, having a health concession card, being married or having a partner, having adequate physical activity, consuming 1-13 alcoholic drinks per week and reporting good quality of life.
Table A summarises the factors more and less likely to be independently associated with participants who had frequent GP encounters, medical specialist encounters, ED presentations and hospitalisations. The characteristics common across different services have been underlined.

*Table A: Comparison of “independent factors” associated with frequent use of health services*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequent GP encounters (21 or more)</th>
<th>Frequent medical specialist encounters (10 or more)</th>
<th>Frequent ED presentations (2 or more)</th>
<th>Frequent hospitalisations (2 or more)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-demographic</td>
<td>Aged 81-85 years</td>
<td>Being female</td>
<td>Older age (85+)</td>
<td>Older age (80+)</td>
</tr>
<tr>
<td>Factors</td>
<td>Speaks language other than English at home</td>
<td>Private health insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health care concession card</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education university degree or higher</td>
<td>Older age (90+)</td>
<td>Being female</td>
<td>Being female</td>
</tr>
<tr>
<td></td>
<td>Household income ($20,000-39,000; $70,000+/year)</td>
<td></td>
<td>Private health insurance</td>
<td>Speaks language other than English at home</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Health care concession card</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Currently married</td>
</tr>
<tr>
<td>Health factors</td>
<td>Ex-smoker</td>
<td>Ex-smoker</td>
<td>Fall(s) in prior 12 months</td>
<td>Ex-smoker</td>
</tr>
<tr>
<td></td>
<td>Self-reported heart disease</td>
<td></td>
<td>Self-reported heart disease</td>
<td>Fall(s) in prior 12 months</td>
</tr>
<tr>
<td></td>
<td>Being treated for high blood pressure</td>
<td></td>
<td>Self-reported diabetes</td>
<td>Self-reported heart disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self-reported cancer</td>
<td>Self-reported diabetes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self-reported osteoporosis</td>
<td>Self-reported cancer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-reported good quality of life</td>
<td>Self-reported good quality of life</td>
<td>Self-reported good quality of life</td>
<td>Self-reported good quality of life</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequate physical activity</td>
<td>Adequate physical activity</td>
<td>Adequate physical activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1-14 alcoholic drinks/week</td>
<td>1-14 alcoholic drinks/week</td>
</tr>
</tbody>
</table>

Note: Underline signifies that the characteristic was associated with more than one health service.

**Association between frequency of attendance and mortality**

Those who were frequent service users were 1.5-2.0 times more likely to die within seven years compared to those who were less frequent users, even after controlling for all the socio-demographic, health risk and health status factors identified as being significant. Participants who presented to ED two or more times were almost twice as likely to die; while those who had 21 or more GP encounters or ten or more specialist encounters, were almost 50% more likely to die than those with less frequent presentations or encounters. Those who had two or more hospitalisations had a 67% higher risk of dying than those who attended once or did not attend at all.

**Trends in frequent health service use**

The following figure shows the increase in the proportion of participants who were frequent users of health services between 2006 and 2017. During the 12-year period from 2006 to 2017, there were statistically significant increases of approximately 30% in the proportion of participants aged over 75 years who had frequent GP encounters (21 or more/year), frequent medical specialist encounters (10 or more), frequent ED presentations (2 or more) or frequent hospitalisations (2 or more). The increasing trends in frequent ED presentations and hospitalisations is also reported in other Australian and international studies.
Frequent health service users were not common across services, with most participants only being frequent users of one service type and only 2% of participants being frequent users of all the services (GP, medical specialist, ED and hospital).

**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 health service use using a wide range of socio-demographic and health factors for residents of CES. This would not otherwise have been possible without huge investment in a time consuming and costly study.

However, there are some limitations with the data and the analysis. The data on socio-demographics risk factors and conditions was limited to the information collected during the baseline survey in 2006-2009, and so our analysis may not include all the potential risk factors for frequent service use identified in the literature, such as the presence of multiple co-morbidities and impairments, which may impact the results. 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 frequent service use. The study timeframe 2006-2009 focused on the years around the initial recruitment of participants to the 45 and Up Study. This may limit the generalisation of the findings to 2021.

**Implication for practice and future research**

Frequent health service use across all services investigated increased between 2006 and 2017 and is associated with increased mortality. Although there are a number of interventions in place to manage those at risk of re-presentation at EDs and hospitals, further effort is required.

The characteristics of those over 75 years of age found to be associated with frequent health service use, can provide a basis to identify at risk groups and direct them to appropriate additional assessment and care. For example, those who were ex-smokers, had one or more falls in previous 12 months or had heart disease, were at risk of frequent use of multiple health services. Such individuals could be channelled into programs to help them manage their conditions more efficiently and effectively.
Background

Purpose of the report

The third annual Research Priorities Forum for the Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource (CES-P&CH) was held in 2019. Health service providers from the two Sydney health districts, raised concerns about patients over 75 years of age who were frequent users of Emergency Departments (ED). They wanted to understand the drivers for their attendance as these patients present a burden to hospital services due to return presentations, increased likelihood of hospital admission and longer ED and hospital lengths of stay.

Identifying and then targeting at-risk individuals through appropriate care activities, can be an effective and efficient way to increase quality of health care for these individuals and may ultimately reduce re-attendances and hospitalisation (Goodman et al., 2016).

Australia’s older population

The Australian population is ageing. In 2017 people aged 75 years and over comprised 6.7% of Australia’s population, this is projected to increase by more than 77% to approximately 11.9% by 20661. Individuals aged 85 years and over comprised 2.0% of the population in 2017 (ABS, 2018). This is expected to double by 2050, increasing to approximately 4.6% of the population by 2066.

Health service use by older people2

A higher percentage of older individuals use health services than those who are younger. Analysis by the Australian Institute of Health and Welfare (AIHW) found that patients 65 years and older were responsible for 20-45% of health services use in 2016/17, even though they represented only 14-15% of the Australian population (AIHW, 2018a) (Table 1). People aged 65 years and over made almost 2.3 times the number of claims for general practitioner (GP) encounters, more than four times as many claims for medical specialist services and almost four times as many presentations to EDs than people aged less than 65 years.

Table 1: Health service use of older Australians compared with all Australian, 2016-17, Australia

<table>
<thead>
<tr>
<th>Health service</th>
<th>All patients Number</th>
<th>Patients 65 years and older Number</th>
<th>Average claims per person: 65+ vs &lt;65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicare claims for GP encounters</td>
<td>130 million</td>
<td>~38 million</td>
<td>29%</td>
</tr>
<tr>
<td>Medicare claims for Specialist encounters</td>
<td>30.9 million</td>
<td>13.9 million</td>
<td>45%</td>
</tr>
<tr>
<td>ED presentations</td>
<td>7.8 million</td>
<td>1.6 million</td>
<td>~20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same day hospitalisations</td>
<td>6.6 million</td>
<td>2.8 million</td>
<td>42%</td>
</tr>
<tr>
<td>Overnight hospitalisations</td>
<td>4.4 million</td>
<td>1.8 million</td>
<td>41%</td>
</tr>
</tbody>
</table>


In 2018/19 in NSW, almost 23% of hospital admissions were for patients aged 75 years and over (n=698,350)3. Of the 2,880,287 ED presentations in 2017/18, over 395,815 (approximately 14%) were for people aged 75 years and over (AIHW, 2018b).

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1 Data extracted on 07 Sep 2020 05:35 UTC (GMT) from ABS.Stat © Commonwealth of Australia.

2 Most published data focuses on people 65 years and older, where available we have sourced data for individuals over 75 years of age.

3 NSW Combined Admitted Patient Epidemiology Data and ABS population estimates (SAPHaRI). Centre for Epidemiology and Evidence, NSW Ministry of Health.
Unplanned ED presentations

Unplanned ED presentations are presentations that were not pre-arranged, with the majority classified as emergency presentations. The rate of unplanned ED presentations in NSW increased with age, with the highest rates being among those 75 years and older (Centre for Epidemiology and Evidence) (Figure 1).

Figure 1: Unplanned presentations to 86 EDs by age, NSW, 2017-18

Table 2 shows the patterns of unplanned presentations to 86 NSW EDs by age group for the periods 2007-08, 2012-13 and 2017-18. In 2017-18, 13.7% of unplanned ED presentations (n=338,139) were for patients aged 75 years and older. The rate of presentations per 100 population for this age group increased by 9.1% between 2007-08 and 2017-18 (61.2 per 100 population vs 52.1 per 100 population) (Centre for Epidemiology and Evidence). Similar trends were found in the NSW DESTINY study (Dinh et al., 2016).

Table 2: Unplanned presentations to 86 EDs by age, NSW, 2007-08, 2012-13, 2017-18*

<table>
<thead>
<tr>
<th>Age-group (years)</th>
<th>2007-8</th>
<th>2012-13</th>
<th>2017-8</th>
<th>% increase 2007-8 to 2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69</td>
<td>69,668</td>
<td>93,121</td>
<td>114,667</td>
<td>4.0</td>
</tr>
<tr>
<td>70-74</td>
<td>70,427</td>
<td>85,010</td>
<td>115,723</td>
<td>36.8</td>
</tr>
<tr>
<td>75-79</td>
<td>77,170</td>
<td>84,552</td>
<td>104,881</td>
<td>46.8</td>
</tr>
<tr>
<td>80-84</td>
<td>75,175</td>
<td>86,305</td>
<td>97,230</td>
<td>61.5</td>
</tr>
<tr>
<td>85-89</td>
<td>53,053</td>
<td>69,529</td>
<td>80,774</td>
<td>76.7</td>
</tr>
<tr>
<td>90-94</td>
<td>23,846</td>
<td>32,769</td>
<td>43,122</td>
<td>85.9</td>
</tr>
<tr>
<td>95-99</td>
<td>5,547</td>
<td>7,586</td>
<td>10,963</td>
<td>83.4</td>
</tr>
<tr>
<td>100+</td>
<td>876</td>
<td>886</td>
<td>1,169</td>
<td>96.5</td>
</tr>
<tr>
<td>75+</td>
<td>235,667</td>
<td>281,609</td>
<td>338,139</td>
<td>61.2</td>
</tr>
<tr>
<td>All ages</td>
<td>1,939,029</td>
<td>2,135,101</td>
<td>2,465,193</td>
<td>30.7</td>
</tr>
</tbody>
</table>

Note:*Centre for Epidemiology and Evidence, NSW Ministry of Health.
An Australian study by Burkett et al. (2017), projected that between 2010 and 2050, ED presentations by older Australians would increase by 242% for those aged 65–84 years and 411% for those aged and 85 years.

It is anticipated that by 2030 the number of older people and people living with long term conditions will also significantly increase (Denton and Spencer, 2010). A prospective 16-year longitudinal study of 1,000 Australians 65 years and older, described three ageing groups; those ageing well (30%), those initially aging well then deteriorating (50%) and those who consistently aged poorly (20%). This suggests an increasing burden of disease for many older people and thus, an additional demand for health and support services into the future (Browning et al., 2017).

**Frequent use of health services**

A report by the Australian National Health Performance Authority (NHPA) found that one third of very high GP users and 20% of frequent users were aged 75 years and older. Frequent attenders were more likely to have accessed more non-hospital funded services, such as pathology and imaging, seen many different GPs and accounted for 41% of non-hospital Medicare expenditure ($6.5 billion) in 2012-13 (NHPA, 2015). They were also more likely to attend EDs and have multiple hospitalisations.

Older adults who present at the ED more frequently were also found to be more likely to be transported to ED by ambulance, were sicker, required more urgent care, stayed longer in the ED, were more likely to be admitted to ED or hospital, and had higher rates of adverse outcomes following discharge (Dinh et al., 2016; Lowthian et al., 2013; Leonard et al., 2014; Aminzadeh et al., 2002). Although only representing about 5% of all older patients, older frequent ED users were responsible for approximately 19% of ED presentations for their age group (Street et al., 2018). An Australia study at a regional hospital in 2008, compared those with frequent (three or more) hospital re-admissions to the general ED population and found that age and the number of chronic conditions were associated with frequent readmissions (Kirby et al., 2010). Mazza et al. (2015) studied ED presentations in Melbourne for patients 70 years and older and found individuals who visited the ED multiple times were responsible for 30% of the potentially avoidable ED presentations (those presentations that could be treated in general practice).

**Predictors of health service frequent use**

**General practice**

A report by the NHPA on frequent GP users of all ages, found that compared with less frequent users, frequent (12-19 visits per year) and very frequent GP users (20 or more visits per year) were older, lived in areas of social disadvantage, had lower rates of private insurance, were more likely to rate their health as fair or poor and had three or more conditions (NHPA, 2015). Long term conditions such as arthritis, osteoporosis, circulatory conditions, asthma, injuries, mental health conditions, diabetes and cancer, were more common among frequent and high users than less frequent users.

Pymont et al. (2015) investigated factors associated with more frequent GP consultations in a community cohort in Canberra, and found that for men, diabetes diagnosis, asthma, cancer, limitation with stairs, worrying about health, not being in the labour force status and a range of medication use were associated with more frequent consultations. For women, diabetes, pain, depression, rumination (repetitive focus on negative thoughts) and blood pressure medication use were associated with more frequent consultations.

A systematic review of the frequent use of primary care services by older people in Europe, reported that compared with less frequent older users of GP services, frequent older users often presented with more severe and complex conditions (Welzel et al., 2017). A number of European studies also found that multiple morbidity was associated with frequent attendance at primary care services (Buczak-Stec et al., 2020; Rennemark et al., 2009; van den Bussche et al., 2016).

**Medical specialists encounters**

We found only one study, a German study, which looked at the factors associated with frequent encounters with medical specialists, in this case for community dwelling adults 40 years and older (Hajek et al., 2018). They found
those who had frequent medical specialist encounters were younger and self-reported poor health, decreased physical functioning and increased physical illness.

**ED presentations**

We identified three international studies, from Sweden Italy and Canada, that examined frequent ED attendance among older community dwelling individuals (Doheny et al., 2019, Franchi et al., 2017; Neufeld et al., 2016). Independent factors associated with frequent ED attendance identified by these studies included: having one or more complex chronic conditions, such as diabetes, cardiovascular disease, and chronic obstructive pulmonary disease; reduced physical ability; and poor self-rated health.

Only one Australian study since 2007 has investigated the independent factors associated with frequent re-attendance at EDs by older patients (Street et al., 2018). The researchers analysed data for patients 65 years and older from three metropolitan hospitals who had four or more ED presentations in the previous year. They found that frequent ED attendance (four or more ED presentations) versus less frequent attendance (one to three presentations) was associated with being age 75 years and over, being male, speaking a language other than English, or having one of the following discharge diagnoses: cardiac, respiratory, genitourinary or gastrointestinal.

**Hospitalisations**

Although there is an abundance of studies which explore risk factors and predictors of hospital admission or hospital re-admissions, including those that may be potentially preventable, we found only one recent study that examined the factors associated with frequent hospitalisations for older (65 years and older) community dwelling individuals (Amini et al., 2019). This research found that those who had a fall, a heart attack, lung disease, mild or moderate cognitive impairment or certain types of physical limitations were more likely to be frequently admitted to hospital.

Two Australian studies looked at factors associated with re-admission or frequent hospitalisations. A study of 142 patients 50 years and older in a Brisbane teaching hospital, found hospital re-admission to be associated with the presence of chronic conditions, higher body mass index (BMI), and depressive symptoms (Mudge et al., 2012). While a study of residents of the NSW North Coast who were 65 years and older and who had had three or more hospital admissions for selected chronic ambulatory care sensitive conditions within a 12-month period, found that individuals with four or more hospitalisations compared with three admissions, were more likely to have congestive heart failure, be socially isolated and have a higher co-morbidity score (Longman et al., 2012).

Understanding the predictors of health services use in older people is imperative for planning to ensure health care is provided in the most effective and efficient way for individuals in this age group.

**Study aims and research questions**

The aim of this project was to explore the differences between frequent health services users (GP, medical specialist, ED and overnight hospitalisations) and non-frequent users among study participants over 75 years of age.

For study participants over 75 years of age, the research questions were:

1. What demographic, social and health factors are independently associated with frequent health service use?
2. What is the association between frequent health service use and mortality?
3. Has frequency of health service use changed over time?
4. Are frequent service users common across services and has this changed over time?
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 area at baseline. The 45 and Up Study baseline questionnaire data was linked to Medicare Benefits Schedule (MBS), Admitted Patient Data Collection (APDC), Emergency Department Data Collection (EDDC) and Deaths Registry data.

Study population

The study population included participants who resided in CES and were aged over 75 years of age (6,327). Additional criteria are defined in the methods section for each of the research questions. 347 participants were excluded if the individual had multiple dates of death or died within one-year of joining the 45 and Up Study. This gave a study population of 5,980 participants.

Research Design

Figure 2 describes the research design. Participants were recruited between 2006 and 2009, with most recruited during 2008. Frequency of health service use was assessed over the three-year baseline period, the year of recruitment in the 45 and Up Study, one year before and one year after the recruitment year (~2007-2009). Frequency of use was calculated according to the highest number of encounters, presentations or hospitalisations in any calendar year of the three-year baseline period. Deaths were based on the Death Registry.

Figure 2: Research design
Measures

The main measures used were socio-demographic and health characteristics, frequency of health service use and mortality.

**Socio-demographic and health characteristics** were based on the relevant questions in the 45 and Up Study baseline survey. These included age, gender, qualifications, income, work status, health insurance, marital status, smoking, alcohol, BMI, treatment for high blood pressure and cholesterol, quality of life, falls, osteoporosis heart disease, diabetes and cancer (see Appendix B Table B1).

**Health services investigated** included:

- GP encounters which were based on MBS general practice attendance and activity items claimed, as described in Appendix B Table B2
- Medical specialist encounters which were based on MBS medical specialist attendance and activity items claimed, as described in Appendix B Table B2
- ED presentations were based on EDDC data
- Overnight hospitalisations were based on APDC data.

**The frequency of health service use** was categorised for each participant according to their highest number of encounters/presentations/hospitalisations in any calendar year in the three-year baseline period (which included the registration year and one year before and one year after the registration year). We categorised each study participant according to their highest annual service use in any year of the three-year baseline period for each of the health services. See Appendix B and Figure B3 for an explanation and graphic representation of how the number of attendances were chosen to define frequent users for each health service.

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

Statistical Analysis

A description of the statistical analysis is presented in the statistical analysis section for each research question.

We used SAS9.4 (SAS Institute, 2011) for data management and R version 3.5.1 (R Core Team, 2019) for statistical analyses. Statistical significance was determined if the p values were <0.05%. Results in the tables that are **bolded** were significantly more likely to be associated with frequent health service use and those that are **bolded and in italics** were significantly less likely to be associated with frequent health service use.

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.
Q1. Factors associated with frequency of health service use

Research question 1
What demographic, social and health factors are independently associated with frequent health service use?

Statistical analyses
The statistical analysis included three components:

i. Descriptive analyses
ii. Calculation of crude or unadjusted prevalence ratios with 95% confidence intervals
iii. Multivariable Poisson regression models for estimating adjusted prevalence ratios with 95% confidence intervals to: identify which demographic, social, health and health service use characteristics of the study population were independently associated with frequency of health service use.

Results

Factors associated with frequent GP encounters (21 or more)

Figure 3 shows the factors associated with frequent (21 or more) GP encounters and less frequent (14-20) GP encounters compared with non-frequent (less than 14) GP encounters (see Supplementary Data Table S1).

After controlling for all factors, the factors which were significantly more likely to be associated with participants who had frequent GP encounters compared to those who had non-frequent GP encounters were: being aged 81-85 years, speaking a language other than English, having private health insurance, having a healthcare concession card, being an ex-smoker, reporting treatment for high blood pressure and reporting cardiovascular disease.

The factors significantly less likely to be associated with frequent GP encounters were: having a university degree or higher, having a household income of $20,000-$39,999 or $70,000 or more, reporting 1-13 or 14 or more drinks per week, and reporting good quality of life.
Figure 3: Factors associated with frequent GP encounters, participants aged over 75 years, CES-P&CH
**Figure 3 cont’d: Factors associated with frequent GP encounters, participants aged over 75 years in CES**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequent GP encounters (21 or more), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate physical activity</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>564 (43.44)</td>
</tr>
<tr>
<td>Yes</td>
<td>501 (32.96)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>770 (43.82)</td>
</tr>
<tr>
<td>1-13 drinks</td>
<td>518 (33.62)</td>
</tr>
<tr>
<td>14+ drinks</td>
<td>176 (28.48)</td>
</tr>
<tr>
<td>BMI category</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>260 (33.87)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>561 (34.79)</td>
</tr>
<tr>
<td>Overweight</td>
<td>578 (38.33)</td>
</tr>
<tr>
<td>Obese</td>
<td>236 (41.76)</td>
</tr>
<tr>
<td>Being treated for high BP</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>952 (34.11)</td>
</tr>
<tr>
<td>Yes</td>
<td>603 (43.86)</td>
</tr>
<tr>
<td>Being treated for high cholesterol</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1279 (36.87)</td>
</tr>
<tr>
<td>Yes</td>
<td>366 (40.18)</td>
</tr>
<tr>
<td>Self-reported good quality of life</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>369 (52.21)</td>
</tr>
<tr>
<td>Yes</td>
<td>1072 (33.34)</td>
</tr>
<tr>
<td>Reported at least one fall in 12 months</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>965 (34.15)</td>
</tr>
<tr>
<td>Yes</td>
<td>513 (44.38)</td>
</tr>
<tr>
<td>Self-reported osteoporosis</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1354 (36.21)</td>
</tr>
<tr>
<td>Yes</td>
<td>291 (46.04)</td>
</tr>
<tr>
<td>Self-reported cardiovascular disease</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>969 (32.76)</td>
</tr>
<tr>
<td>Yes</td>
<td>670 (47.68)</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1363 (33.59)</td>
</tr>
<tr>
<td>Yes</td>
<td>252 (50.30)</td>
</tr>
<tr>
<td>Self-reported cancer</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1234 (37.67)</td>
</tr>
<tr>
<td>Yes</td>
<td>411 (37.53)</td>
</tr>
</tbody>
</table>

**Notes:** Based on the highest annual GP encounters in the 3-year baseline period; Comparator: participants with less-frequent GP encounters (less than 21). Adj PR=Adjusted Prevalence Ratio presented on a logarithmic scale, controlled for all variables in the figure.
Factors associated with frequent medical specialist encounters (ten or more)

Figure 4 shows the factors associated with frequent medical specialist (ten or more) encounters compared with non-frequent (less than ten) encounters (see Supplementary Data Table S2). After controlling for all factors, participants who had private health insurance, were ex-smokers, reported at least one fall in the last 12 months, or reported osteoporosis, cardiovascular disease or cancer, were significantly more likely to have frequent medical specialist encounters compared with participants who had non-frequent medical specialist encounters. The factors significantly less likely to be associated with frequent medical specialist visits were: being older than 90 years of age, having adequate physical activity and reporting good quality of life.

*Figure 4: Factors associated with frequent medical specialist encounters, participants aged over 75 years in CES*
**Figure 4 cont’d: Factors associated with frequent medical specialist encounters, participants aged over 75 years in CES**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequent medical specialist encounters (10 or more), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate physical activity</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>816 (30.80)</td>
</tr>
<tr>
<td>Yes</td>
<td>862 (25.88)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>662 (27.24)</td>
</tr>
<tr>
<td>1-13 drinks</td>
<td>712 (28.65)</td>
</tr>
<tr>
<td>14+ drinks</td>
<td>248 (29.28)</td>
</tr>
<tr>
<td>BMI category</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>228 (26.03)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>586 (25.84)</td>
</tr>
<tr>
<td>Overweight</td>
<td>621 (30.29)</td>
</tr>
<tr>
<td>Obese</td>
<td>243 (30.92)</td>
</tr>
<tr>
<td>Being treated for high BP</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1023 (26.77)</td>
</tr>
<tr>
<td>Yes</td>
<td>695 (30.35)</td>
</tr>
<tr>
<td>Being treated for high cholesterol</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1314 (27.56)</td>
</tr>
<tr>
<td>Yes</td>
<td>364 (30.01)</td>
</tr>
<tr>
<td>Self reported good quality of life</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>338 (33.83)</td>
</tr>
<tr>
<td>Yes</td>
<td>1190 (26.98)</td>
</tr>
<tr>
<td>Reported at least one fall in 12 months</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1021 (25.99)</td>
</tr>
<tr>
<td>Yes</td>
<td>517 (32.21)</td>
</tr>
<tr>
<td>Self-reported osteoporosis</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1376 (27.04)</td>
</tr>
<tr>
<td>Yes</td>
<td>302 (33.89)</td>
</tr>
<tr>
<td>Self-reported cardiovascular disease</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>974 (23.94)</td>
</tr>
<tr>
<td>Yes</td>
<td>704 (36.82)</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1421 (27.03)</td>
</tr>
<tr>
<td>Yes</td>
<td>257 (35.60)</td>
</tr>
<tr>
<td>Self-reported cancer</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1177 (26.23)</td>
</tr>
<tr>
<td>Yes</td>
<td>501 (33.58)</td>
</tr>
</tbody>
</table>

**Notes:** Based on the highest annual medical specialist encounters in the 3-year baseline period; Comparator: participants with less-frequent medical specialist encounters (less than 10 encounters). Adj PR=Adjusted Prevalence Ratio presented on a logarithmic scale, controlled for all variables in the figure.
Factors associated with frequent ED presentations (two or more)

Figure 5 shows the factors associated with frequent ED presentations (two or more) (see Supplementary Data Table S3). After controlling for all factors, being aged >85 years, reporting at least one fall in the last 12 months and reporting cardiovascular disease, were significantly more likely to be associated with having two or more ED presentations compared with participants who were with non-frequent visitors (less than two). The factors significantly less likely to be associated with having two or more ED presentations were: being female, having private health insurance, having adequate physical activity, consuming 1-13 alcoholic drinks and reporting good quality of life.

Figure 5: Factors associated with frequent ED presentations, participants aged over 75 years in CES
Figure 5 cont’d: Factors associated with frequent ED presentations, participants aged over 75 years in CES

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequent ED presentations (2 or more), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate physical activity</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>539 (23.65)</td>
</tr>
<tr>
<td>Yes</td>
<td>443 (15.39)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>461 (21.28)</td>
</tr>
<tr>
<td>1-13 drinks</td>
<td>353 (16.49)</td>
</tr>
<tr>
<td>14+ drinks</td>
<td>131 (18.37)</td>
</tr>
<tr>
<td>BMI category</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>161 (21.13)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>383 (19.77)</td>
</tr>
<tr>
<td>Overweight</td>
<td>318 (17.84)</td>
</tr>
<tr>
<td>Obese</td>
<td>120 (17.75)</td>
</tr>
<tr>
<td>Being treated for high blood pressure</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>615 (18.71)</td>
</tr>
<tr>
<td>Yes</td>
<td>267 (19.62)</td>
</tr>
<tr>
<td>Being treated for high cholesterol</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>793 (19.37)</td>
</tr>
<tr>
<td>Yes</td>
<td>189 (17.75)</td>
</tr>
<tr>
<td>Self reported good quality of life</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>256 (30.62)</td>
</tr>
<tr>
<td>Yes</td>
<td>612 (16.00)</td>
</tr>
<tr>
<td>Reported at least one fall in 12 months</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>544 (16.07)</td>
</tr>
<tr>
<td>Yes</td>
<td>362 (25.95)</td>
</tr>
<tr>
<td>Self-reported osteoarthritis</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>812 (18.82)</td>
</tr>
<tr>
<td>Yes</td>
<td>170 (21.98)</td>
</tr>
<tr>
<td>Self-reported cardiovascular disease</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>548 (15.58)</td>
</tr>
<tr>
<td>Yes</td>
<td>434 (26.46)</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>827 (18.23)</td>
</tr>
<tr>
<td>Yes</td>
<td>155 (24.92)</td>
</tr>
<tr>
<td>Self-reported cancer</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>721 (18.51)</td>
</tr>
<tr>
<td>Yes</td>
<td>261 (20.87)</td>
</tr>
</tbody>
</table>

**Notes:** Based on the highest ED presentations in the 3-year baseline period; . Comparator: participants with less frequent ED presentations (less than two). Adj PR=Adjusted Prevalence Ratio presented on a logarithmic scale, controlled for all variables in the figure.
Factors associated with frequent hospitalisations (two or more)

Figure 6 shows the factors associated with frequent hospitalisations (two or more) (see Supplementary Data Table S4). After controlling for all factors, being aged >80 years, being an ex-smoker, reporting at least one fall in the last 12 months, cardiovascular disease, diabetes or cancer, were significantly more likely to be associated with having frequent (two or more) hospitalisations compared to participants who had less than two hospitalisations. The factors significantly less likely to be associated with having two or more hospitalisations were: being female, speaking a language other than English at home, having a health concession card, being married or having a partner, having adequate physical activity, consuming 1-13 alcoholic drinks per week and reporting good quality of life.

Figure 6: Factors associated with frequent hospitalisations, participants aged over 75 years in CES
Figure 6 cont’d: Factors associated with frequent hospitalisations, participants aged over 75 years, CES-P&CH

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequent hospitalisation (2 or more), n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate physical activity</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>714 (26.95)</td>
</tr>
<tr>
<td>Yes</td>
<td>574 (17.23)</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>561 (23.05)</td>
</tr>
<tr>
<td>1-13 drinks</td>
<td>487 (20.00)</td>
</tr>
<tr>
<td>14+ drinks</td>
<td>181 (21.37)</td>
</tr>
<tr>
<td>BMI category</td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>180 (21.69)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>478 (21.08)</td>
</tr>
<tr>
<td>Overweight</td>
<td>442 (21.56)</td>
</tr>
<tr>
<td>Obese</td>
<td>178 (22.65)</td>
</tr>
<tr>
<td>Being treated for high BP</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>808 (21.14)</td>
</tr>
<tr>
<td>Yes</td>
<td>460 (22.24)</td>
</tr>
<tr>
<td>Being treated for high cholesterol</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1029 (21.56)</td>
</tr>
<tr>
<td>Yes</td>
<td>260 (21.43)</td>
</tr>
<tr>
<td>Self-reported good quality of life</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>321 (32.13)</td>
</tr>
<tr>
<td>Yes</td>
<td>642 (19.09)</td>
</tr>
<tr>
<td>Reported at least one fall in 12 mont</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>759 (19.32)</td>
</tr>
<tr>
<td>Yes</td>
<td>429 (20.67)</td>
</tr>
<tr>
<td>Self-reported osteoporosis</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1080 (21.22)</td>
</tr>
<tr>
<td>Yes</td>
<td>208 (23.34)</td>
</tr>
<tr>
<td>Self-reported cardiovascular disease</td>
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</tr>
<tr>
<td>No</td>
<td>735 (17.94)</td>
</tr>
<tr>
<td>Yes</td>
<td>558 (23.18)</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td></td>
</tr>
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<td>No</td>
<td>1082 (20.58)</td>
</tr>
<tr>
<td>Yes</td>
<td>206 (28.53)</td>
</tr>
<tr>
<td>Self-reported cancer</td>
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</tr>
<tr>
<td>No</td>
<td>903 (20.12)</td>
</tr>
<tr>
<td>Yes</td>
<td>385 (26.80)</td>
</tr>
</tbody>
</table>

Notes: Based on the highest annual hospitalisations in the 3-year baseline period. Comparator: participants with less frequent overnight hospitalisations (less than two). Adj PR=Adjusted Prevalence Ratio presented on a logarithmic scale, controlled for all variables in the figure.

Discussion

The independent socio-demographic characteristics associated with frequent service use differ according to the type of service frequently accessed (Table 3). Those who frequently attended GPs and medical specialists were more likely to have private health insurance, while those who attended ED frequently were less likely to have private health insurance. Being female was less likely to be associated with frequent presentations at ED and hospitalisations, but was more likely among those who had frequent encounters with medical specialists. Participants who had frequent GP encounters were more likely to have a health care concession card, but this was less likely among those who had two or more hospitalisations. Those who were older were more likely to present at ED or have an overnight hospitalisation, but those 90 years and older were less likely to frequently attend medical specialists.
Independent health risk factors and conditions appeared to have a stronger association with frequent use across the different types of health services. Those who were ex-smokers attended GPs and medical specialists more frequently and were more frequently hospitalised. Those who had adequate physical activity were less likely to have frequent medical specialist encounters, ED presentations and hospitalisations, while those who had low-moderate consumption of alcohol were less likely to frequently present at EDs or be hospitalised. Participants who reported good quality of life, were less likely to be frequent attenders at any of the service types.

Participants with heart disease (self-reported) were more likely to be frequent attenders across all the services. While those with any of the conditions investigated (heart disease, diabetes, cancer, osteoporosis and falls) were more likely to attend medical specialists. Those who had a fall in the previous 12 months were also more likely to be frequent attenders at EDs. Participants who reported diabetes and cancer were also more likely to be hospitalised.

**Table 3: Factors associated with frequent health service users, participants aged over 75 years in CES**

<table>
<thead>
<tr>
<th>Factors</th>
<th>GP encounters</th>
<th>Medical specialist encounters</th>
<th>ED presentations</th>
<th>Hospitalisations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21+</td>
<td>10+</td>
<td>≥ 2</td>
<td>≥ 2</td>
</tr>
<tr>
<td>Age</td>
<td>+ (81-85)</td>
<td>- (&gt;90)</td>
<td>+ (&gt;85)</td>
<td>+ (&gt;80)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>- Female</td>
<td>- Female</td>
</tr>
<tr>
<td>Highest educational qualification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaks a language other than English at home</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td>-</td>
<td>($20,000-39,999; $70,000+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work status</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Private health insurance</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health care concession card</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently married</td>
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<tr>
<td>Smoking status</td>
<td>+ (ex-smoker)</td>
<td>+ (ex-smoker)</td>
<td>+ (ex-smoker)</td>
<td></td>
</tr>
<tr>
<td>Adequate physical activity</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Adequate fruit and vegetable intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>- (any)</td>
<td>- (low-moderate)</td>
<td>- (low-moderate)</td>
<td></td>
</tr>
<tr>
<td>BMI category</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated for high BP</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated for high cholesterol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-reported good quality of life</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reported at least one fall in 12 months</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Self-reported osteoporosis</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-reported heart disease</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Self-reported cancer</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

**Notes:** + = more likely to be associated with health service use; - less likely to be associated with health service use; blank cells = no association. Based on the highest annual hospitalisations in the 3-year baseline period.
Q2. Association between frequent health service use and mortality

Research question 2
What is the effect of frequent health service use on mortality?

Statistical analyses

The statistical analysis undertaken was time to event analysis and included information captured at baseline: either in the baseline 45 and Up Study survey or within the baseline service period (+/− 1 year from date of recruitment to the 45 and Up Study) and deaths in the seven-year period starting from the end of the baseline service period (+ 1 year from date of recruitment). Hazard ratios (HRs) were estimated using Cox proportional hazards regression model to measure the effect of the health service use on mortality, controlling for all socio-demographic, health risk factors, health status and health care utilisation factors identified as being significant.

Results

The seven-year mortality rate of those who were frequent service users compared to non-frequent users is provided in Table 4. Participants who presented to ED two or more times were almost twice as likely to die; while those who had 21 or more GP encounters or ten or more specialist encounters, were almost 50% more likely to die than those with less frequent presentations or encounters. Those who had two or more hospitalisations had a 67% higher risk of dying than those who attended once or didn’t attend at all.

Table 4: Effect of frequent service use on seven-year mortality among the participants aged over 75 years in CES

<table>
<thead>
<tr>
<th>Highest number of services in any year of the 3-year baseline period</th>
<th>N</th>
<th>Death &lt;=7 years of recruitment (+ 1 year)</th>
<th>Mortality per 1000 patient years</th>
<th>Crude HR (95% CI)</th>
<th>Adj. HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP encounters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-13</td>
<td>2726</td>
<td>825</td>
<td>42.5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>14-20</td>
<td>1609</td>
<td>551</td>
<td>45.1</td>
<td>1.16 (1.05, 1.30)</td>
<td>1.17 (1.03, 1.32)</td>
</tr>
<tr>
<td>21 or more (frequent)</td>
<td>1645</td>
<td>727</td>
<td>62.3</td>
<td>1.64 (1.49, 1.81)</td>
<td>1.47 (1.30, 1.64)</td>
</tr>
<tr>
<td>Specialist encounters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than 10</td>
<td>4302</td>
<td>1398</td>
<td>46.1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 or more (frequent)</td>
<td>1678</td>
<td>705</td>
<td>58.6</td>
<td>1.41 (1.29, 1.54)</td>
<td>1.47 (1.32, 1.63)</td>
</tr>
<tr>
<td>ED presentations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than 2</td>
<td>4176</td>
<td>1260</td>
<td>42.3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 or more (frequent)</td>
<td>982</td>
<td>553</td>
<td>93.0</td>
<td>2.38 (2.16, 2.64)</td>
<td>1.95 (1.73, 2.19)</td>
</tr>
<tr>
<td>Hospitalisations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than 2</td>
<td>4692</td>
<td>1435</td>
<td>42.8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2 or more (frequent)</td>
<td>1288</td>
<td>668</td>
<td>83.8</td>
<td>2.09 (1.91, 2.29)</td>
<td>1.67 (1.50, 1.86)</td>
</tr>
</tbody>
</table>

Notes: Crude HR = hazard ratio; Adj. HR Model controlled for all socio-demographic, health risk factor, health status and health care utilisation factors which were statistically significant P<0.05).

Discussion

Our analysis found that participants who were frequent users of any of the services investigated had a substantially increased risk of dying during the seven-year follow-up. This increased risk of death for participants over 75 years who frequently use services may be associated with their increased morbidity and disease complexity above what was included in our models. Two studies investigated outcomes including mortality of frequent users of ED services, finding increased mortality rates for high services users (Halsagi et al., 2001 and Moe et al., 2016). Hansagi et al. (2001) found that the standardised mortality ratio increased with increasing frequency of ED visits. A systematic review of frequent ED users by Moe et al. (2016) also reported that frequent ED users experience higher mortality compared with non-frequent users. This research highlights the need to investigate frequent service use to understand and, if possible, mitigate the underlying cause.
Q3. Frequency of health service attendance over time

Research question 3

Has frequent use of health services changed over time?

Are frequent service users common across services and has this changed over time?

Statistical analyses

i. Descriptive analyses were conducted to estimate the number and proportion of the study population in each year between 2006 and 2017 who were over 75 years of age

ii. For each study participant, we calculated their annual service use for each of the health services in each year of interest

iii. The analyses measured the health service use within each calendar year from 2006 to 2017. The population at risk (PAR) was defined as the study population for each year. Participants were deemed to have accessed an individual measure — population experiencing event (PEE) — if they had at least one service encounter within a calendar year. Crude rates were calculated as (PEE/PAR) 100. Age-adjusted rates were calculated using direct standardisation based on the age and sex structure of the NSW population in 2006.

Results

The trends in frequent use and less frequent use of the health services of interest for participants aged over 75 years are described in Figures 7-10. Proportionally more participants had encounters at the four health services between 2006 and 2017.

Trends in attendance at GP encounters

As shown in Figure 7, during the 12-year period the proportion of participants aged over 75 years who had frequent GP encounters (21 or more/year) significantly increased from 15.2% (95% CI:14.2, 16.2) to 19.8% (95% CI:18.8, 20.9) (see Supplementary Data Table S5). Those who had less frequent encounters (14-20 encounters) also increased by 10.6%.

Figure 7: Trends in general practice encounters for participants aged over 75 years in CES, 2006-2017
Trends in attendance at medical specialist encounters

As shown in Figure 8, between 2006 and 2017 the proportion of participants aged over 75 years who had frequent medical specialist encounters (ten or more) significantly increased from 13.5% (95% CI: 12.5, 14.5) to 18.8% (95% CI: 17.8, 19.9) (see Supplementary Data Table S6).

Figure 8: Trends in annual attendance at medical specialist encounters, aged over 75 years in CES, 2006-2017

![Frequency of Specialist use](chart)

Note: Standardised to 2006 population by age and sex.

Trends in presentations to ED

As shown in Figure 9, during the 12-year period between 2006 and 2017, the proportion of participants aged over 75 years who had frequent ED presentations (two or more) significantly increased from 7.5 (95% CI: 6.7, 8.3) to 12.4 (95% CI: 11.6, 13.3) (see Supplementary Data Table S7).

Figure 9: Trends in ED presentations for participants aged over 75 years in CES, 2006-2017

![Frequency of ED use](chart)

Note: Standardised to 2006 population by age and sex.
Trends in overnight hospitalisations

As shown in Figure 10, between 2006 and 2017 the proportion of participants aged over 75 years who had frequent overnight hospitalisations (two or more) significantly increased from 8.3% (95% CI: 7.6, 9.1) to 10.7% (95% CI: 9.9, 11.5) (see Supplementary Data Table S8).

Figure 10: Trends in overnight hospitalisations for participants aged over 75 years in CES, 2006-2017

![](image)

**Note:** Standardised to 2006 population by age and sex.

Are frequent service users common across services and has this changed over time?

Figure 11 presents the percentage of participants aged over 75 years of age who were frequent and non-frequent users across the four services of interest in 2008 and 2017 (see Supplementary Data Table S9). In 2008 only 1.3% of the participants were frequent users of all the services (GP, Specialist, ED and hospital) and only 2.4% were frequent users of all of the services in 2017. In 2008 two thirds of participants (66.0%) were non-frequent users across all the services investigated and 60% were non-frequent users across all of the services in 2017. Most frequent users only used one service (9.3% for GP and 7.4% for medical specialists in 2008, and 11.1% for GPs and 7.5% for medical specialists in 2017). The most common frequent user combination was GP and specialist (3.3% in 2008 and 3.2% in 2017) followed by ED and hospital (2.2% in 2008 and 2.5% in 2017).
Discussion

Even though, the data was standardised to account for differences in the age and gender of the population over time, this analysis shows that there was a significant increase in frequent users for all health services for participants over 75 years of age. Frequent users were not common across services, with most participants only being frequent users of one service type; only 1.3% of the participants were frequent users of all the services (GP, Specialist, ED and hospital) in 2008 and only 2.4% were frequent users of all of the services in 2017.

The increasing trends in frequent ED and hospitalisation users is also reported in other Australian and international studies. Two Australian studies found increasing rates of elderly ED frequent users (Dinh et al., 2016; Kirby et al., 2012). These increases in ED use may be explained in part by the increasing complexity of older patients presenting to the ED (Aboagye-Sarfo et al., 2015; Kennelly et al., 2014). Compared with younger patients, older patients are often more likely to be sicker and require more urgent care, be transported to ED by ambulance, stay longer in the ED, be admitted to hospital and have higher rates of adverse outcomes following discharge (Dinh et al., 2016; Lowthian et al., 2013; Leonard et al., 2014; Aminzadeh et al., 2002). This increase in the morbidity and disease complexity of older people is also likely to contribute to an increase in their encounters with primary care and medical specialists.
References


Kirby SE, Dennis SM, Jayasinghe UW, et al. (2010) Patient related factors in frequent readmissions: the influence of condition, access to services and patient choice. BMC Health Serv Res. 10, 216.


### Appendix A: Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>Adj PR</td>
<td>Adjusted prevalence ratio</td>
</tr>
<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
</tr>
<tr>
<td>APDC</td>
<td>Admitted Patient Data Collection</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>CES</td>
<td>Central and Eastern Sydney</td>
</tr>
<tr>
<td>CES-P&amp;CH</td>
<td>Central and Eastern Sydney Primary and Community Health Cohort/Linkage Resource</td>
</tr>
<tr>
<td>CPHCE</td>
<td>Centre for Primary Health Care and Equity</td>
</tr>
<tr>
<td>CHeReL</td>
<td>Centre for Health Record Linkage</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>ED</td>
<td>Emergency Department</td>
</tr>
<tr>
<td>EDDC</td>
<td>Emergency Department Data Collection</td>
</tr>
<tr>
<td>GP</td>
<td>General Practice</td>
</tr>
<tr>
<td>GPMP</td>
<td>General Practice Management Plan</td>
</tr>
<tr>
<td>HR</td>
<td>Hazard ratio</td>
</tr>
<tr>
<td>MBS</td>
<td>Medicare Benefits Schedule</td>
</tr>
<tr>
<td>NHPA</td>
<td>National Health Performance Authority</td>
</tr>
<tr>
<td>PBS</td>
<td>Pharmaceutical Benefits Scheme</td>
</tr>
<tr>
<td>PR</td>
<td>Prevalence ratio</td>
</tr>
<tr>
<td>TCA</td>
<td>Team Care Arrangement</td>
</tr>
</tbody>
</table>
Appendix B: Detailed Methods

Data source

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 (45 and Up study collaborators, 2008). CES-P&CH was established to identify a community-dwelling population in Central and Eastern Sydney (CES) to be used to answer policy relevant research questions (Comino et al., 2016; Centre for Primary Health Care and Equity, 2021).

The 45 and Up Study comprises more than 267,153 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 Services Australia (formerly the Australian Government Department of Human Services) Medicare enrolment database, with oversampling in people aged 80 and over and people from rural and remote areas. Potential participants 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 their health and other records. Recruitment occurred between 2006 and 2009, with 78% of the sample being recruited in 2008. The baseline questionnaire collected information on a range of participant characteristics. The response rate was 18%. Baseline data 45 and Up Study data (Wave 1) were collected between 2006 and 2009, with a pilot in 2005. The first follow-up data were collected between March and October 2010 through the Social, Economic and Environmental Factors (SEEF) Project (Stamatakis et al., 2014). The next follow-up data (Wave 2) were collected from September 2012 to December 2015 (surveying SEEF cohort members last). The current wave of data collection (Wave 3) was collected 2018 to 2020 (SAX Institute, 2020).

![Figure B1: CES-P&CH data sources](image)

There were 30,645 participants recruited within the CES area at baseline. The CES-P&CH includes 45 and Up Study questionnaire data linked to Medicare Benefits Schedule (MBS) and Pharmaceutical Benefits Scheme (PBS) data for the period 2006-2017 by the Sax Institute using a unique identifier and deterministic methods. It also includes data (Figure B1) from the Admitted Patient Data Collection (APDC), Emergency Department Data Collection (EDDC) and Cancer Registry and Death Registry linked by the NSW Centre for Health Record Linkage (CHERel) using probabilistic techniques (CHERel, 2020). Most datasets are to 2018 except for the Cancer Registry data.
Study population

Two study populations were extracted from the CES-P&CH and included in the analysis:

(i) To identify independent factors associated with frequent health service use and mortality, the study population consisted of participants who resided in CES and were over 75 years of age at recruitment in the 45 and UP study. Participants were excluded if the individual had multiple dates of death or died during the three-year baseline service period.

(ii) To assess the trends in frequent use and the overlap of frequent service use, we included all participants who resided in CES, and were over 75 years of age in each year of interest. Participants were excluded if the individual had multiple dates of death or died during the year of interest.

There were 6,327 participants who resided in the CES area and were over 75 years of age when first registered in the 45 and Up Study. Figure B2 presents the eligible participants in the years between 2006 and 2017.

Figure B2: Number of participants aged over 75 years by calendar year, CES-P&CH, 2006-2017

![Graph showing the number of eligible participants by year]

Table B1: Characteristics, variables, data sources and descriptions

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data source</th>
<th>Question</th>
<th>Categorisation for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Age group                                | 45 And Up Study Baseline  | Self-reported age at baseline                 | 76-80 years  
                                            |                           |                                               | 81-85  
                                            |                           |                                               | 86-90  
                                            |                           |                                               | >90  
| Gender                                   | 45 And Up Study Baseline  | Self-reported sex                             | Male  
                                            |                           |                                               | Female  
| Highest qualification                    | 45 And Up Study Baseline  | Self-reported highest level of educational qualification – categorised as | 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  
| Speaks a language other than English at home | 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  

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data source</th>
<th>Question</th>
<th>Categorisation for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household income</td>
<td>45 And Up Study Baseline</td>
<td>Self-reported household income category</td>
<td>&lt;$20,000&lt;br&gt;$20,000-$39,999&lt;br&gt;$40,000-$69,999&lt;br&gt;$70,000 or more&lt;br&gt;Won’t disclose</td>
</tr>
<tr>
<td>Work status</td>
<td>45 And Up Study Baseline</td>
<td>Working status at baseline</td>
<td>Not working&lt;br&gt;Working part-time/full-time</td>
</tr>
<tr>
<td>Private insurance</td>
<td>45 And Up Study Baseline</td>
<td>Private insurance status</td>
<td>Yes: Has private health insurance&lt;br&gt;No: No private health insurance</td>
</tr>
<tr>
<td>Health care card</td>
<td>45 And Up Study Baseline</td>
<td>Healthcare card status</td>
<td>Yes: Has a healthcare card&lt;br&gt;No: No healthcare card</td>
</tr>
<tr>
<td>Currently married/partnered</td>
<td>45 And Up Study Baseline</td>
<td>Current marital status: or not</td>
<td>Yes: currently married/partnered&lt;br&gt;No: Not currently married/partnered</td>
</tr>
</tbody>
</table>

**Health characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Data source</th>
<th>Question</th>
<th>Categorisation for analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking status</td>
<td>45 And Up Study Baseline</td>
<td>Smoking status at baseline</td>
<td>Yes: Currently smoking&lt;br&gt;No: Non-smoker or ex-smoker</td>
</tr>
<tr>
<td>Adequate physical activity</td>
<td>45 And Up Study Baseline</td>
<td>Based on the amount of moderate and vigorous exercise reported: see AIHW definition</td>
<td>Yes: Adequate physical activity&lt;br&gt;No: Inadequate physical activity</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>45 And Up Study Baseline</td>
<td>Based on self-reported number of standard drinks each week, categorised as</td>
<td>zero&lt;br&gt;low (1-14 drinks per week)&lt;br&gt;high (&gt;14 drinks per week)</td>
</tr>
<tr>
<td>BMI</td>
<td>45 And Up Study Baseline</td>
<td>Calculation based on 2 questions: How tall are you without shoes? How much do you weigh?</td>
<td>Underweight: &lt;18.5&lt;br&gt;Normal weight: 18.6-24.9&lt;br&gt;Overweight: 25.0-29.9&lt;br&gt;Obese: ≥30</td>
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<tr>
<td>Treatment for high blood pressure</td>
<td>45 And Up Study Baseline</td>
<td>Self-reported as currently taking treatment for high blood pressure (yes or no)</td>
<td>Yes: Treated for high blood pressure&lt;br&gt;No: Not treated for high blood pressure</td>
</tr>
<tr>
<td>Treatment for high cholesterol</td>
<td>45 And Up Study Baseline</td>
<td>Self-reported as currently taking treatment for high cholesterol (yes or no)</td>
<td>Yes: Treated for high cholesterol&lt;br&gt;No: Not treated for high cholesterol</td>
</tr>
<tr>
<td>Self-reported good quality of life</td>
<td>45 And Up Study Baseline</td>
<td>Based on self-rated quality of life question – classified as yes if responded as good; very good or excellent</td>
<td>Yes: Excellent, very good or good quality of life&lt;br&gt;No: Fair or poor quality of life</td>
</tr>
<tr>
<td>Reported at least one fall in 12 months prior</td>
<td>45 And Up Study Baseline</td>
<td>Self-reported falls in last 12 months</td>
<td>Yes: 1 or more falls in last 12 months&lt;br&gt;No: No falls in last 12 months</td>
</tr>
<tr>
<td>Self-reported osteoporosis</td>
<td>45 And Up Study Baseline</td>
<td>Has a doctor EVER told you that you have osteoporosis?</td>
<td>Yes: Told have osteoporosis&lt;br&gt;No: Not told they had osteoporosis</td>
</tr>
<tr>
<td>Self-reported heart disease</td>
<td>45 And Up Study Baseline</td>
<td>Has a doctor EVER told you that you have heart disease?</td>
<td>Yes: Told have heart disease&lt;br&gt;No: Not told they had heart disease</td>
</tr>
<tr>
<td>Self-reported diabetes diagnosis</td>
<td>45 And Up Study Baseline</td>
<td>Has a doctor EVER told you that you have diabetes</td>
<td>Yes: Told have diabetes&lt;br&gt;No: Not told they had diabetes</td>
</tr>
<tr>
<td>Self-reported cancer</td>
<td>45 And Up Study Baseline</td>
<td>Has a doctor EVER told you that you have skin cancer, melanoma, breast cancer, prostate cancer or other cancer?</td>
<td>Yes: Told have skin cancer, melanoma, breast cancer, prostate cancer or other cancer&lt;br&gt;No: Not told they had cancer</td>
</tr>
</tbody>
</table>
### Table B2: Groupings and item codes for services subsidised by MBS

<table>
<thead>
<tr>
<th>MBS Group</th>
<th>Name of Group</th>
<th>Item numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GP encounters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A1</td>
<td>GP encounters to which no other item applies</td>
<td>1, 2, 3, 4, 13, 20, 23, 24, 25, 33, 35, 36, 37, 38, 40, 43, 44, 47, 48, 50, 51</td>
</tr>
<tr>
<td>Group A2</td>
<td>Other non-referred presentations to which no other item applies</td>
<td>52, 53, 54, 57, 58, 59, 60, 65, 81, 83, 84, 86, 87, 89, 90, 91, 92, 93, 95, 96, 97, 98 (non-GP)</td>
</tr>
<tr>
<td>Group A5</td>
<td>Prolonged presentations to which no other item applies</td>
<td>160, 161, 162, 163, 164</td>
</tr>
<tr>
<td>Group A7</td>
<td>Acupuncture and non-specialist practitioner items</td>
<td>173, 193, 195, 197, 199</td>
</tr>
<tr>
<td>Group A11</td>
<td>Emergency after-hours attendances</td>
<td>602, 603, 696, 697, 698</td>
</tr>
<tr>
<td>Group A14</td>
<td>Health assessments</td>
<td>700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711-715, 716-19</td>
</tr>
<tr>
<td>Group A15</td>
<td>GP care plans</td>
<td>Preparation of a General Practice Management Plan (GPMP) (721), Team Care arrangement (TCA) (723), Review of a GPMP or TCA (725, 727, 729, 731, 732)</td>
</tr>
<tr>
<td>Group A17</td>
<td>Medication management review</td>
<td>900, 903</td>
</tr>
<tr>
<td>Group A18</td>
<td>GP attendance associated with Practice Incentive Program (PIP)</td>
<td>2497, 2501, 2503, 2504, 2506, 2507, 2509, 2517, 2518, 2521, 2522, 2525, 2526, 2546, 2547, 2552, 2553, 2558, 2559</td>
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<tr>
<td>Group A19</td>
<td>Other non-referred attendances associated with PIP payments to which no other item applies</td>
<td>2598, 2600, 2603, 2606, 2610, 2613, 2616, 2620, 2622, 2624, 2631, 2633, 2635, 2664, 2666, 2668, 2673, 2675, 2677</td>
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<tr>
<td>Group A20</td>
<td>GP mental health care</td>
<td>2700, 2701, 2702, 2710, 2712, 2713, 2715, 2717, 2721, 2723, 2725, 2727, 2729, 2731</td>
</tr>
<tr>
<td>Group A22</td>
<td>GP after-hours attendances to which no other item applies</td>
<td>5000, 5003, 5007, 5010, 5020, 5023, 5026, 5028, 5040, 5043, 5046, 5049, 5060, 5063, 5064, 5067</td>
</tr>
<tr>
<td>Group A23</td>
<td>Other non-referred after-hours attendances to which no other item applies</td>
<td>5200, 5203, 5207, 5208, 5220, 5222, 5223, 5227, 5228, 5240, 5243, 5247, 5248, 5260, 5263, 5265, 5267</td>
</tr>
<tr>
<td><strong>Medical specialist encounters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A3</td>
<td>Specialist encounters to which no other item applies</td>
<td>99, 104, 105, 106, 107, 108, 109, 111, 113</td>
</tr>
<tr>
<td>Group A4</td>
<td>Consultant physician attendances to which no other item applies</td>
<td>110, 112, 114, 116, 117, 119, 120, 122, 128, 131, 132, 133</td>
</tr>
<tr>
<td>Group A24</td>
<td>Pain and palliative medicine</td>
<td>2799, 2801, 2806, 2814, 2820, 2824, 2832, 2840, 3003, 3005, 3010, 3014, 3015, 3018, 3023, 3028</td>
</tr>
<tr>
<td>Group A26</td>
<td>Neurosurgery attendances to which no other item applies</td>
<td>6004, 6007, 6009, 6011, 6013, 6015, 6016</td>
</tr>
<tr>
<td>Group A28</td>
<td>Geriatric medicine</td>
<td>141, 143, 145, 147, 149</td>
</tr>
</tbody>
</table>

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4 Items 735-880 (case-conferences) were excluded as they do not involve a patient attendance
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 and inconsistencies for individuals (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 best evidence and documenting the decisions.

Statistical analyses

The statistical analysis included five components:

(i) **Descriptive analyses** were conducted to examine the proportion of participants aged over 75 years, and the overlap of frequent use across health services.

(ii) **Crude or unadjusted prevalence ratios (PRs)** with 95% confidence intervals, were calculated using univariate Poisson regression model with Poisson family and log link function to examine which demographic, social and health factors were related to frequency of health service use.

   **About Prevalence Ratios**

   \[
   \text{Crude (unadjusted) PR} = \frac{\text{Prevalence of an outcome (e.g. frequency of health service use) among those with the specific exposure or characteristic (e.g. high GP use)}}{\text{Prevalence of an outcome (e.g. frequency of health service use) among those without the specific exposure of characteristic (e.g. high GP use)}}
   \]

(iii) **Adjusted prevalence ratios** (Adj PR) with 95% confidence intervals were calculated using multivariable Poisson regression models with Poisson family and log link function to identify which demographic, social and health characteristics were independently associated with frequent health service use. Thus, taking into account other factors that may influence frequent health service use.

   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.

(iv) **Time to event analysis** including information captured at baseline: either in the baseline 45 and Up Study survey or within the baseline service period (+/- 1 year from date of recruitment to the 45 and Up Study) and deaths in the seven-year period starting from the end of the baseline service period (+ 1 year from date of recruitment). **Cox proportional hazards regression modelling** was used to examine the relationship between the health service use and mortality, controlling for all socio-demographic, health risk factors, health status and health care utilisation factors identified as being significant.

(v) To investigate the frequency of health service use for each calendar year from 2006 to 2017, the population at risk (PAR) was calculated and defined as the study population for each year. Participants were deemed to have accessed an individual measure — population experiencing event (PEE) — if they had at least one service within a calendar year. Crude rates were calculated as (PEE/PAR) 100. Age-adjusted rates were calculated using direct standardisation based on the age and sex structure of the NSW population in 2006.

Statistical significance for all statistical tests was set at \(p<0.05\). SAS9.4 (SAS institute, 2011) was used for data management and R version 3.5.1 for statistical analyses (R Core Team, 2019).
Table B3: Characteristics of the study population reported at recruitment

<table>
<thead>
<tr>
<th>Factors</th>
<th>n</th>
<th>%</th>
<th>Factors</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study participants</td>
<td>6327</td>
<td></td>
<td>BMI category</td>
<td></td>
<td></td>
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<tr>
<td>Age at recruitment</td>
<td></td>
<td></td>
<td>Underweight</td>
<td>962</td>
<td>15.2</td>
</tr>
<tr>
<td>&gt;75-&lt;=80</td>
<td>1895</td>
<td>30.0</td>
<td>Normal weight</td>
<td>2406</td>
<td>38.0</td>
</tr>
<tr>
<td>81-85</td>
<td>3065</td>
<td>48.4</td>
<td>Overweight</td>
<td>2140</td>
<td>33.8</td>
</tr>
<tr>
<td>86-90</td>
<td>1060</td>
<td>16.8</td>
<td>Obese</td>
<td>819</td>
<td>12.9</td>
</tr>
<tr>
<td>&gt;90</td>
<td>307</td>
<td>4.9</td>
<td>Alcohol consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>Underweight</td>
<td>962</td>
<td>15.2</td>
</tr>
<tr>
<td>Male</td>
<td>3325</td>
<td>52.6</td>
<td>Normal weight</td>
<td>2406</td>
<td>38.0</td>
</tr>
<tr>
<td>Female</td>
<td>3002</td>
<td>47.4</td>
<td>Overweight</td>
<td>2140</td>
<td>33.8</td>
</tr>
<tr>
<td>Highest educational qualification</td>
<td></td>
<td></td>
<td>Obese</td>
<td>819</td>
<td>12.9</td>
</tr>
<tr>
<td>Less than high school</td>
<td>2633</td>
<td>43.1</td>
<td>Adequate physical activity</td>
<td>3451</td>
<td>54.5</td>
</tr>
<tr>
<td>Year 12 or equivalent</td>
<td>729</td>
<td>11.9</td>
<td>Alcohol consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade/Diploma</td>
<td>1725</td>
<td>28.2</td>
<td>Zero</td>
<td>2584</td>
<td>42.4</td>
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<tr>
<td>University or higher</td>
<td>1020</td>
<td>16.7</td>
<td>1-13 drinks/week</td>
<td>2611</td>
<td>42.9</td>
</tr>
<tr>
<td>Speaks other than English at home</td>
<td>1221</td>
<td>19.3</td>
<td>14+ drinks/week</td>
<td>896</td>
<td>14.7</td>
</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td>Being treated for high BP</td>
<td>2281</td>
<td>36.1</td>
</tr>
<tr>
<td>&lt;$20,000</td>
<td>2158</td>
<td>34.1</td>
<td>Being treated for high cholesterol</td>
<td>1269</td>
<td>20.1</td>
</tr>
<tr>
<td>$20,000-$39,999</td>
<td>1132</td>
<td>17.9</td>
<td>Self-reported good quality of life</td>
<td>4595</td>
<td>80.4</td>
</tr>
<tr>
<td>40,000-69,999</td>
<td>583</td>
<td>9.2</td>
<td>Reported 1+ falls in 12 months</td>
<td>1736</td>
<td>29.7</td>
</tr>
<tr>
<td>70,000 or more</td>
<td>442</td>
<td>7.0</td>
<td>Self-reported osteoporosis (ever)</td>
<td>949</td>
<td>15.0</td>
</tr>
<tr>
<td>Won’t disclose</td>
<td>2012</td>
<td>31.8</td>
<td>Self-reported cardiovascular disease</td>
<td>2067</td>
<td>32.7</td>
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<tr>
<td>Work status</td>
<td></td>
<td></td>
<td>Self-reported diabetes (ever)</td>
<td>783</td>
<td>12.4</td>
</tr>
<tr>
<td>Not working</td>
<td>5813</td>
<td>93.6</td>
<td>Self-reported cancer (ever)</td>
<td>1605</td>
<td>25.4</td>
</tr>
<tr>
<td>Part-/Full-time working</td>
<td>396</td>
<td>6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has private health insurance</td>
<td>3614</td>
<td>57.1</td>
<td></td>
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</tr>
<tr>
<td>Has a health care concession card</td>
<td>2726</td>
<td>43.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently married</td>
<td>3336</td>
<td>52.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoke</td>
<td>3734</td>
<td>59.0</td>
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<td></td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>2412</td>
<td>38.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>181</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Data includes participants who died during the baseline period.
Choosing the number of attendances to define frequent use

There are no agreed definitions for defining frequent service use. Frequent service use definitions may vary across regions due to the demographics and health of the study population, the availability of care and the health system. For each study participant, we identified their highest annual service use in any year of the three-year baseline period for each of the health services, and we considered the literature on frequent use by the elderly population in the different health services to guide our decisions in defining frequent use. See Figure B3.

The National Health Performance Authority (NHPA) reviewed general practice attendance by all Australians in 2012, defining ‘frequent’ users as 12-19 attendances (8.7% of the population) and ‘very frequent’ GP attendance as 20 or more attendances (3.8% of the population) (NHPA, 2015). A systematic review of frequent use of primary care services among patients aged 65 years and over found that definitions of frequent GP attendances in the ten European studies analysed, ranged from 10% to 33% of the populations studied (Welzel et al., 2017). For this study, we chose the cut off point for frequent GP attendance as 21 or more encounters in a 12-month period or the top 15% of the populations.

Two studies investigated medical specialist attendance in older adults, and both chose six or more episodes of care to define frequent use. In one study, this represented the top 10% of older patients (Dinkel et al., 2016) and in the other survey-based study, it represented 50% of the population (Hajek et al., 2018). We chose the cut-off point of ten or more encounters in a 12-month period which equated to 15% of the population.

A systematic review of ED attendance by elderly patients found that the definitions of frequent ED attendance varied from one or more presentations in six months to five or more in 12 months (Dufour et al., 2019). After examining the data, we have chosen the cut-off point of top 9% to define frequent ED attendances, which equates to two or more presentations in a 12-month period.

The definition of frequent hospitalisations for older patients varies from two or more to four or more in 12 months (Amini et al., 2019; Condelius et al., 2008; Longman et al., 2012; Morrissey et al., 2003). Following review of the data, we have chosen the cut-off point of the top 9% to define frequent hospitalisations (i.e. two or more hospitalisations in a 12-month period).

**Figure B3: Average annual health service use in the 3-year baseline survey period, participants aged over 75 years in CES**