

Corrigendum to: Variation in direct healthcare costs to the health system by residents living in long-term care facilities: a Registry of Senior Australians study

Jyoti Khadka, Julie Ratcliffe, Gillian Caughey, Tracy Air, Steve Wesselingh, Megan Corlis, Keith Evans and Maria Inacio

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The authors propose the following corrections.

There was a misalignment in Table 1 and the last three lines should have read:

Size, N (%)	
<20 residents	4703 (6.3)
≥20 residents	70,439 (93.7)

The Table 1 footnote A should have read as follows:

^ADementia was ascertained from the aged care eligibility, aged care funding and the dispensing of medications for the treatment of dementia.

s.d., standard deviation; IQR, Interquartile range.

In Table 2, the last column should have included footnote A and read as follows:

^AHealthcare costs adjusted for: age, sex, frailty index, state, Rx-Risks, activities of daily living needs, behavioural daily living needs and complex healthcare needs with additional variables (dementia, facility remoteness, types of facilities) where relevant. CI, confidence interval.

The Fig. 2 caption should have read:

Healthcare resource use as a proportion (average) of all healthcare costs in 2016 A\$, overall and by individual and long-term care facility characteristic.

In addition, the line under Fig. 2 should have read:

ED = Emergency department presentations, MBS = Medicare Benefits Schedule, PBS = Pharmaceutical Benefits Scheme (medicines)

In Fig. 3, the note should have read:


Note: the graph showing dispersion around the average cost for each long-term care facility as a function of the facility volume. The solid and dotted lines represent the 95 and 99% confidence.

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Variation in direct healthcare costs to the health system by residents living in long-term care facilities: a Registry of Senior Australians study

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ABSTRACT

Objective. This study aimed to examine the national variation in government-subsidised healthcare costs of residents in long-term care facilities (LTCFs) and costs differences by resident and facility characteristics. **Methods.** A retrospective population-based cohort study was conducted using linked national aged and healthcare data of older people (≥ 65 years) living in 2112 LTCFs in Australia. Individuals' pharmaceutical, out-of-hospital, hospitalisation and emergency presentations direct costs were aggregated from the linked healthcare data. Average annual healthcare costs per resident were estimated using generalised linear models, adjusting for covariates. Cost estimates were compared by resident dementia status and facility characteristics (location, ownership type and size). **Results.** Of the 75,142 residents examined, 70% ($N = 52,142$) were women and 53.4% ($N = 40,137$) were living with dementia. The average annual healthcare cost (all costs in \$A) was \$9233 (95% CI \$9150–\$9295) per resident, with hospitalisation accounting for 47.2% of the healthcare costs. Residents without dementia had higher healthcare costs (\$11,097, 95% CI \$10,995–\$11,200) compared to those with dementia (\$7561, 95% CI \$7502–\$7620). Residents living in for-profit LTCFs had higher adjusted average overall annual healthcare costs (\$11,324, 95% CI \$11,185–\$11,463) compared to those living in not-for-profit (\$11,017, 95% CI \$10,895–\$11,139) and government (\$9731, 95% CI \$9365–\$10,099) facilities. **Conclusions.** The healthcare costs incurred by residents of LTCFs varied by presence of dementia and facility ownership. The variation in costs may be associated with residents' care needs, care models and difference in quality of care across LTCFs. As hospitalisation is the biggest driver of the healthcare costs, strategies to reduce preventable hospitalisations may reduce downstream cost burden to the health system.

Keywords: aged care, costs variation, healthcare costs, longterm care, nursing homes, observational research, older adults, residential aged care.

Introduction

Globally, most countries are experiencing significant growth in the proportion of older people in their populations.¹ This demographic shift is resulting in significantly higher government spending on aged (also referred to as social care) and healthcare services required to meet the growing number of older people and their care needs.² As in many Organisation for Economic Cooperation and Development countries,³ the Australian aged and healthcare sectors are multi-billion dollar industries.⁴ In Australia, both sectors are largely funded by the federal government through taxation revenue.⁴ In 2021–22, the Australian government expenditure on aged care was \$25 billion and healthcare was \$98 billion,⁴ with these costs projected to increase significantly over the next 10 years (projected average annual growth of 3.33%, all costs in \$A).⁵

Aging has a direct effect on healthcare expenditure. Reorienting aged care systems to effectively and efficiently deliver high-quality aged care, may improve health and quality of life outcomes for older people and subsequently alleviate downstream healthcare costs.^{6,7} Older people accessing long-term care facilities (LTCFs) (i.e. where both medical and personal support services are provided to people who are unable to live independently in the community) typically are frail, have complex physical and mental health issues and consequently are also major healthcare service users.^{6–10} For example, older people entering LTCFs in 2015 had a median of 10 medicines dispensed, two-thirds had \geq five comorbid conditions and half had a high frailty index score.¹¹ It is also known that one in five residents have unplanned hospitalisations and emergency presentations within 90 days of entering LTCFs.¹²

The aged care and healthcare sectors are inextricably linked, both in Australia and internationally, and yet at least in Australia these sectors remain largely structurally and financially separated.^{4,13} However, both the healthcare and aged care sectors are jointly responsible for the health and wellbeing of older Australians. Policy and practice in one sector directly impact the other. To our best knowledge, the average costs of healthcare incurred by individuals in LTCFs in Australia, which can inform our understanding of the downstream costs to the health system associated with the experiences older people have in care, has not been evaluated before.

Our study aimed to estimate the government-subsidised healthcare costs incurred by older people living in LTCFs over a 12-month follow-up period and assess the variation in these costs by specific resident and facility characteristics.

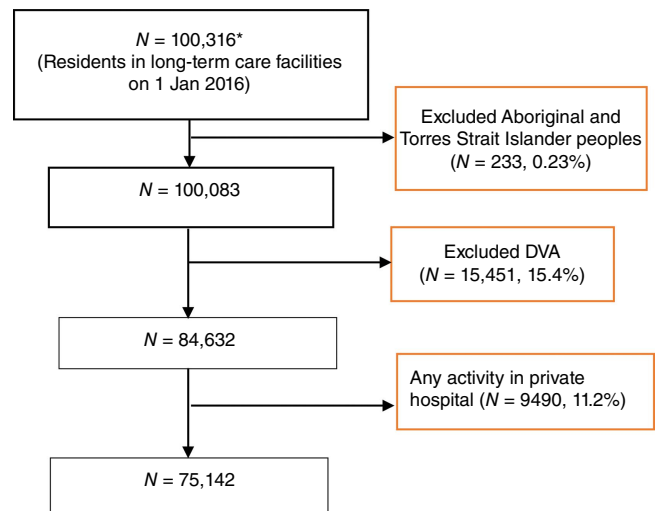
Methods

Study design and data source

A retrospective population-based cohort study was conducted using the National Historical Cohort of the Registry of Senior Australians (ROSA). Details on the ROSA data platform and cohort have been described elsewhere.¹⁴ Briefly, ROSA contains integrated de-identified aged care (Australian Institute of Health and Welfare's National Aged Care Data Clearinghouse, which also contains the National Death Index), health services (Medicare Benefits Schedule, MBS), medicines (Pharmaceutical Benefits Scheme, PBS), state-based hospitalisations (New South Wales, Victoria, South Australia and Queensland) and social welfare support (Data Over Multiple Individual Occurrences) data collections.

Study cohort and setting

People aged 65 years and older and living in LTCFs across three Australian states (New South Wales, Victoria and Queensland) on 1 January 2016 were included. Residents



Note: DVA = Department of Veteran Affairs card holders.

Fig. 1. Flow chart showing cohort selection. *Provides how the cohort has been selected for the analysis for clarity and aids to replicability of the study.

who identified as Aboriginal or Torres Strait Islanders, were Department of Veteran Affairs' card holders or had an activity in private hospitals within the follow-up period were excluded from the study (Fig. 1, for cohort selection). The cohort was followed up for a year (31 December 2016) to assess their direct healthcare costs.

Healthcare costs

Direct costs were measured from the health system perspective and the enumeration period was from 1 January to 31 December 2016 or individuals' date of death if they died during the study period. Costs estimations had four components: hospital admissions, emergency department (ED) presentations, PBS subsidised medicines and MBS subsidised out-of-hospital services. Hospital costs were based on the hospitalisations' National Hospital Cost Data Collection efficient price set for each Australian Refined Diagnostic Related Group code. ED presentations were classified using Urgency Disposition Groups according to type of presentation, triage category and discharge status.¹⁵ Unit costs for the healthcare services were the paid benefits recorded in the MBS. The dates of supply of prescription medicines and out-of-hospital healthcare services from the PBS and MBS, respectively, were used to assign costs to relevant time periods. Only government contribution costs recorded were considered. All costs were reported in 2016 Australian dollars.¹⁶

Covariates

Analyses were stratified by whether individuals were living with dementia and facility characteristics, including rurality (major cities vs outside major cities), ownership (for-profit, not-for-profit and government) and size (<20 residents and

≥ 20 residents). Dementia was ascertained from aged care eligibility assessments, assessments for funding in residential aged care and the dispensing of medications for the treatment of dementia.¹⁷

Individual characteristics considered as covariates in the analysis included age, sex, language spoken at home, country of birth, number of health conditions (Rx-Risk-V pharmaceutical-based comorbidity measure based on a 6-month look back period),¹⁴ frailty index scores¹⁸ and needs assessments for activities of daily living, behaviour and complex health care at entry into care.

Statistical analysis

Characteristics of the cohort were described as means and standard deviations or medians and interquartile ranges (IQR) for continuous variables and frequency distribution and proportion for categorical variables. The International Society of Pharmacoeconomics and Outcomes Research good research practice guidelines were used for cost data analysis.¹⁹ Due to expected asymmetry (right skewed costs data) in healthcare costs distribution, generalised linear models with gamma distribution and log link function were applied adjusting for covariates to estimate the adjusted average direct healthcare cost for each resident. The model estimates were adjusted for age, sex, state, facility location, facility ownership, dementia status, frailty index score, number of Rx-Risk-V health conditions, activity of daily living needs, behavioural daily living needs and complex healthcare needs. Cost estimates were also censored at individuals' deaths using Lin's method.²⁰ In stratified analyses (e.g. by dementia, rurality and ownership types) the same covariates were used for cost adjustment, except for the variables used in the stratification. Adjusted costs were reported as mean and 95% confidence intervals (CI). The proportion of average costs for each cost component was displayed graphically. Funnel plots were used to visualise the relationship between the variation in adjusted average healthcare costs by LTCF studied (only facilities with ≥ 20 residents are shown to reduce risk of re-identification). Descriptive statistics and generalised linear models (GLM) were carried out on STATA v15.1 and funnel plots were created using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Ethics

This study obtained ethics approvals from the University of South Australia Human Research Ethics Committee (Ref: 200489), Australian Institute of Health and Welfare Ethics Committee (Ref: EO2022/4/1376), South Australian Department for Health & Wellbeing Human Research Ethics Committee (Ref: HREC/18/SAH/90) for the inclusion of Victorian and Queensland datasets and New South Wales Population & Health Services Research Ethics Committee (Ref: 2019/ETH12028).

Results

A total of 75,142 (median age 83, IQR 78–88) unique residents living in 2112 LTCFs were studied. Of these, 52,814 (70.3%) were women, 40,137 (53.4%) had a diagnosis of dementia, 48,992 (65.2%) were born in Australia, 52,627 (70%) were living in LTCFs located in major cities and 41,997 (55.9%) were living in not-for-profit LTCFs (Table 1). Of the total, 20,266 (27.0%) died during the year follow-up period (Table 2). Of the LTCFs studied, 1587 (75.1%) had at least 20 or more residents (Table 2).

The adjusted average annual healthcare cost per LTCF resident was \$9233 (95% CI: \$9150–\$9295) in 2016. Residents without dementia incurred higher average healthcare costs (\$11,097, 95% CI: \$10,995–\$11,200) than those with dementia (\$7561, 95% CI: \$7502–\$7620). Residents living in for-profit LTCFs incurred higher healthcare costs (\$11,324, 95% CI: \$11,185–\$11,463) than residents in not-for-profit (\$11,017, 95% CI: \$10,895–\$11,139), while those in government LTCFs had the lowest healthcare costs (\$9731, 95% CI: \$9365–\$10,099). The residents living in LTCFs outside major cities (\$8314, 95% CI: \$8213–\$8414) incurred similar healthcare costs to those in major cities (\$8233, 95% CI: \$8153–\$8314). Residents living in larger LTCFs (≥ 20 residents) incurred higher adjusted annual healthcare costs (\$9324, 95% CI: \$9290–\$9357) in comparison to smaller facilities (< 20 residents) (\$8895, 95% CI: \$8771–\$9019) (Table 2). Supplementary Table S1 shows the GLM estimates of the total healthcare costs as a function of individual and facility variables.

Overall, hospitalisations accounted for the largest proportion of costs (47.2%) followed by MBS (27.2%). ED presentations represented the lowest proportion of healthcare costs (6.0%) (Fig. 2, Supplementary Table S2). Similar healthcare resource cost component breakdown was observed by dementia status, facility ownership, rurality and size (Fig. 2, Supplementary Table S2).

Of the 1587 LTCFs with ≥ 20 residents, residents living in 561 (35.3%) incurred costs below the 95% confidence interval upper limit and 537 (33.8%) below the lower limit (Fig. 3). Similar variation by residents' (Supplementary Fig. S1) and LTCFs characteristics were also observed (Supplementary Figs S2 and S3).

Discussion

Individuals in LTCFs incurred an average of \$9233 in public healthcare costs per resident with an estimated total healthcare cost of \$694 million for the study cohort in 2016. Significant variation in these costs was observed among the over 2100 LTCFs studied across Australia's three largest states, with over one-third above the average annual healthcare costs. While key individual characteristics were considered in our analysis, the variation in healthcare costs observed are likely

Table 1. Study cohort and facility characteristics.

Variables	Total cohort (N = 75,142)
Sex, N (%)	
Women	52,814 (70.3)
Men	22,328 (29.7)
Age (years)	
Mean (s.d.)	82.4 (7.3)
Median (IQR)	83 (78–88)
Range	65–105
Age groups, N (%)	
65–74 years	11,689 (15.6)
75–84 years	32,078 (42.7)
≥85 years	31,375 (41.7)
Frailty index score	
Mean (s.d.)	0.25 (0.06)
Median (IQR)	0.25 (0.21–0.30)
Range	0–0.41
Country of birth, N (%)	
Australia	48,992 (65.2)
Overseas	25,822 (34.7)
Missing	359 (0.4)
Language, N (%)	
English	65,266 (86.9)
Others	9756 (13.1)
Missing	120 (0.2)
Rx-Risk-V co-morbidity category, N (%)	
0–2	13,028 (17.3)
3–4	20,398 (27.1)
5–6	21,521 (28.6)
7+	20,195 (26.9)
Dementia, N (%) ^A	
Yes	40,137 (53.4)
No	35,005 (46.6)
Activities of daily living needs, N (%)	
High	21,339 (28.4)
Medium	22,432 (29.8)
Low	26,760 (35.6)
None	3492 (4.6)
Missing	1119 (1.5)
Behavioural daily living needs, N (%)	
High	27,607 (36.7)
Medium	18,054 (24.0)

(Continued on next column)

Table 1. (Continued)

Variables	Total cohort (N = 75,142)
Low	19,108 (25.4)
None	9254 (12.3)
Missing	1119 (1.4)
Complex health care needs, N (%)	
High	16,928 (22.5)
Medium	18,083 (24.1)
Low	27,693 (36.8)
None	11,319 (15.1)
Missing	1119 (1.5)
Facility characteristics	
Remoteness, N (%)	
Major city	52,627 (70.0)
Outside major city	22,479 (29.9)
Missing	36 (0.1)
States, N (%)	
New South Wales	32,359 (43.0)
Victoria	26,285 (35.0)
Queensland	16,498 (22.0)
Ownership, N (%)	
For-profit	29,544 (39.3)
Government	3601 (4.8)
Not-for-profit	41,997 (55.9)
Size, N (%)	
<20 residents	4703 (6.3)
≥20 residents	70,439 (93.7)

^ANote: dementia was ascertained from the aged care eligibility, aged care funding and the dispensing of medications for the treatment of dementia; s.d., standard deviation; IQR, Interquartile range.

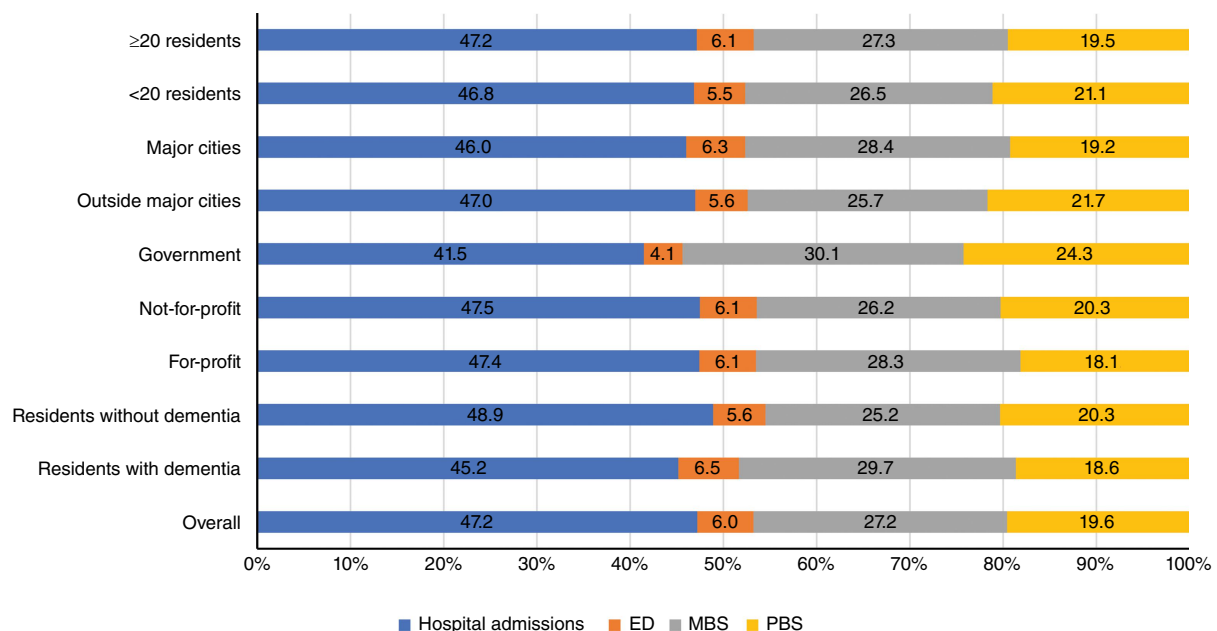
attributed to the varying experiences and care provided to older people in LTCFs including care models (e.g. healthcare integration, types of services provided in facility, reliance on external healthcare) or quality of care provided.

Individuals living in government run LTCFs incurred the lowest average healthcare costs (\$9731) compared to those in not-for-profit (\$11,107) and for-profit (\$11,324) LTCFs. Individuals living in government LTCFs, which in Australia are mostly managed by state health departments, may access healthcare services differently than other ownership types, and are reported to have lower hospitalisations in some cases, which may have led to lower downstream healthcare costs.²¹ Previous research has also highlighted that residents in not-for-profit LTCFs experienced higher comfort and better quality of care than those in for-profit LTCFs,^{22,23} which might have positively influenced residents' health outcomes and again downstream interaction

Table 2. The mortality and adjusted annual average healthcare costs per long-term care facility resident, all facilities, individual and facility characteristics.

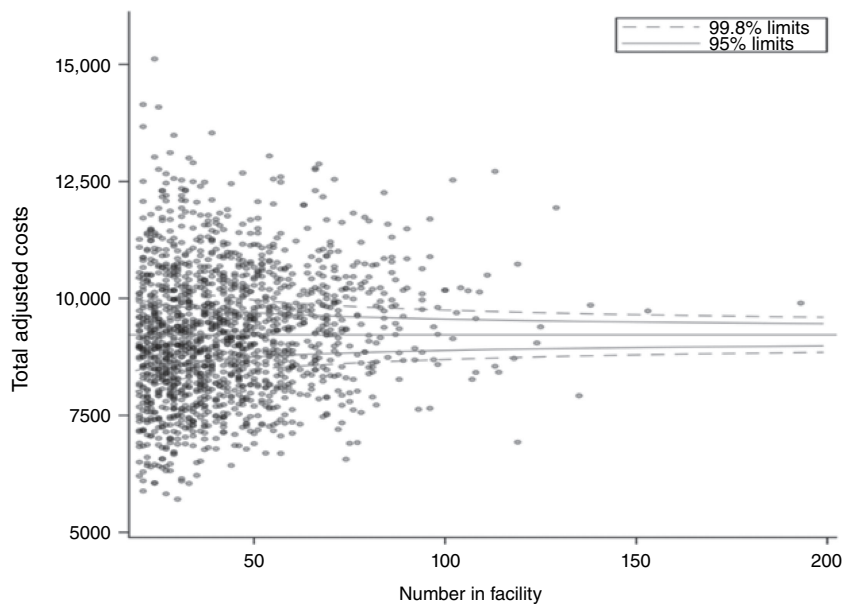
	Number of facilities	Number of residents in the facilities	Number of residents who died, N (%)	Healthcare costs in 2016 in A\$, mean (CI) ^A
All facilities	2112	75,142	20,266 (27.0)	9233 (9150–9295)
Residents dementia status				
With dementia	2054	40,137	11,524 (28.7)	7561 (7502–7620)
Without dementia	2072	35,005	8742 (25.0)	11,097 (10,995–11,200)
Ownership type				
For-profit facilities	703	29,544	8096 (27.4)	11,324 (11,185–11,463)
Not-for-profit facilities	1172	41,997	11,076 (26.4)	11,017 (10,895–11,139)
Government	197	3601	1094 (30.4)	9731 (9365–10,099)
Location				
Outside major cities	792	22,479	6332 (28.2)	8314 (8213–8414)
Major cities	1320	52,627	13,926 (26.5)	8233 (8153–8314)
Size				
<20 residents	525	4703	1296 (27.6)	8895 (8771–9019)
≥20 residents	1587	70,439	18,970 (26.9)	9324 (9290–9357)

Note: healthcare costs adjusted for: age, sex, frailty index, state, Rx-Risks, activities of daily living needs, behavioural daily living needs and complex healthcare needs with additional variables (dementia, facility remoteness, types of facilities) where relevant. CI, confidence interval.



Note: ED = Emergency department presentations, MBS = Medicare Benefits Schedule (out of hospital medical services), PBS = Pharmaceutical Benefits Scheme (medicines)

Fig. 2. Healthcare resource use as a proportion (average) of all healthcare costs in 2016 A\$, overall and by individual and facility characteristics.



Note: the graph showing dispersion around the average cost for each residential aged care facility as a function of the residential aged care facility volume. The solid and dotted lines represent the 95 and 99% confidence

Fig. 3. Funnel plot of annual adjusted healthcare (total) costs per long-term care facility resident in 2016.

with the health system. A prior study has also identified that in comparison to government LTCFs, residents living in for-profit or not-for-profit LTCFs are up to twice as likely to suffer serious injuries that require a hospital visit, hospitalisations for falls or hospitalisations with reported pressure injury, all incidents that would accrue significant costs.²¹ When compared by facility size, our study found that residents living in smaller facilities incurred lower healthcare costs than those in larger facilities. This aligns with prior evidence that suggests smaller facilities tend to deliver higher quality care, resulting in better quality of life²⁴ and residents experiencing fewer hospitalisations when compared to larger facilities, which are the events influencing healthcare costs of individuals.²⁵

As previously reported,^{26,27} the healthcare cost for LTCF residents with dementia were approximately \$3500 less a year than those without dementia. In Australia, LTCF residents with dementia are often placed in a dedicated managed care environment, which may contribute to successfully lowering the hospitalisation rates, and therefore costs, experienced by these individuals.^{26,28} However, while it is possible that residents with dementia have been successfully kept away from hospitals,²⁹ it is also possible that these residents have better physical health compared to others in LTCFs and may not have the same type of intensive clinical needs that others may have required. The possibility that these individuals are not adequately accessing the healthcare services that they need is also likely. There is evidence that suggests residents with dementia are less likely to complain about certain ailments (e.g. pain)³⁰ and access certain healthcare services only.^{31,32}

Innovative care models (e.g. smaller scale LTCFs and clustered domestic models)²⁵ and quality improvement

strategies in LTCFs have shown to be effective in reducing use of health services, including through reducing potentially preventable hospitalisations.^{25,33,34} With major differences in average costs for people aged ≥ 65 years of public hospital stay per day (\sim \$1700 in 2019–20)³⁵ and LTCF resident costs per day (\$243) in Australia,³⁶ government investment in aged care models that support residents' high quality of care and better integration between the aged and healthcare sectors will likely affect the outcomes of individuals and reduce downstream healthcare costs.²⁵ Furthermore, studies have reported that older people, mostly still in the community or on a national waiting list to access aged care at home in Australia, have higher annual average healthcare costs than those living in the LTCFs we are reporting.^{5,37} Given that almost half of the healthcare costs are attributed to hospitalisations in our study, LTCFs are likely offering some benefits to keeping older people out of hospital leading to lower overall health costs than when they are in the community. However, the variation in healthcare costs across the LTCFs reported in this study also suggests that practices and outcomes regarding health care are different among LTCFs and opportunities for improvement are still possible.

The study has several limitations. The study relied on linked administrative and assessment data that were collected for purposes other than research and its incompleteness and the potential for incorrect linkage ($< 1\%$ of records had no linkage records), miscoding or misreporting of events is possible. However, we attempted to minimise these issues by conducting several between datasets logic checks to ensure that anything missing was non-differential between the groups studied. Albeit our results were adjusted for important individual and facility level characteristics,

there are likely residual confounding that can affect our estimates, some of which may be driven by individual and facility characteristics not captured by the data used in this study. Our estimates were also not adjusted for important domains such as care quality and delivery of person-centred care, which are not captured in our linked datasets and have also been identified as drivers of downstream healthcare costs.^{33,34} Furthermore, our study only analysed public healthcare costs and not aged care costs, which are currently between \$73,166 and \$82,316 per resident per year, and the out-of-pocket costs for the residents themselves.²⁶

In conclusion, our study demonstrated a wide variation in annual healthcare costs accrued by LTCF residents, with hospitalisation contributing to almost half of the costs. Understanding sectoral variation and learning from LTCFs where residents are experiencing lower hospitalisations, is a potential strategy to reduce healthcare costs accrued by LTCF residents. This requires cross-sectoral collaboration and efficiency maximisation strategies.

Supplementary material

Supplementary material is available [online](#).

References

- 1 The Lancet Public Health. Ageing: a 21st century public health challenge? *Lancet Public Health* 2017; 2(7): e297. doi:10.1016/S2468-2667(17)30125-1
- 2 Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, et al. The World report on ageing and health: a policy framework for healthy ageing. *Lancet* 2016; 387(10033): 2145–54. doi:10.1016/S0140-6736(15)00516-4
- 3 Lee SH, Chon Y, Kim YY. Comparative Analysis of Long-Term Care in OECD Countries: Focusing on Long-Term Care Financing Type. *Healthcare* 2023; 11(2): 206. doi:10.3390/healthcare11020206
- 4 Commonwealth Government of Australia. Budget 2021-22, Securing Australia's Future, Guaranteeing the essential services. Canberra: The Commonwealth of Australia; 2021.
- 5 Harris A, Sharma A. Estimating the future health and aged care expenditure in Australia with changes in morbidity. *PLoS One* 2018; 13(8): e0201697. doi:10.1371/journal.pone.0201697
- 6 Kalseth J, Halvorsen T. Health and care service utilisation and cost over the life-span: a descriptive analysis of population data. *BMC Health Serv Res* 2020; 20(1): 435. doi:10.1186/s12913-020-05295-2
- 7 Australian Medical Association. Health is the best investment: shifting from a sickcare system to a healthcare system. Brisbane: AMA; 2023.
- 8 Australian Institute of Health and Welfare. Gen aged care data: Interface between the aged care and health system. Canberra; 2020. Available at <https://www.gen-agedcaredata.gov.au/resources/reports-and-publications/2021/june/interfaces-between-the-aged-care-and-health-systems-in-australia>
- 9 Inacio MC, Lang C, Bray SCE, Visvanathan R, Whitehead C, Griffith EC, et al. Health status and healthcare trends of individuals accessing Australian aged care programmes over a decade: the Registry of Senior Australians historical cohort. *Intern Med J* 2021; 51(5): 712–24. doi:10.1111/imj.14871
- 10 Inacio MC, Collier L, Air T, Thapaliya K, Crotty M, Williams H, et al. Primary, allied health, geriatric, pain and palliative healthcare service utilisation by aged care residents, 2012-2017. *Australas J Ageing* 2023; 42(3): 564–76. doi:10.1111/ajag.13199
- 11 Inacio MC, Caughey GE, Wesselingh S. Behalf of the ROSA Research Team & Steering Committee Members. Registry of Senior Australians (ROSA): integrating cross-sectoral information to evaluate quality and safety of care provided to older people. *BMJ Open* 2022; 12(11): e066390. doi:10.1136/bmjopen-2022-066390
- 12 Inacio MC, Jorissen RN, Khadka J, Whitehead C, Maddison J, Bourke A, et al. Predictors of short-term hospitalization and emergency department presentations in aged care. *J Am Geriatr Soc* 2021; 69(11): 3142–56. doi:10.1111/jgs.17317
- 13 Aujla N, Frost H, Guthrie B, Hanratty B, Kaner E, O'Donnell A, et al. A comparative overview of health and social care policy for older people in England and Scotland, United Kingdom (UK). *Health Policy* 2023; 132: 104814. doi:10.1016/j.healthpol.2023.104814
- 14 Inacio MC, Bray SCE, Whitehead C, Corlis M, Visvanathan R, Evans K, et al. Registry of Older South Australians (ROSA): framework and plan. *BMJ Open* 2019; 9(6): e026319. doi:10.1136/bmjopen-2018-026319
- 15 Independent Hospital Pricing Authority. Urgency Related Groups and Urgency Disposition Groups. Independent Hospital Pricing Authority; 2021. Available at <https://www.ihacpa.gov.au/health-care/classification/emergency-care>
- 16 Australian Bureau of Statistics. Inflation Rates. Australian Consumer Price Index: 1948 to 2023. 2023 [12 September 2023]. Available at <https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/latest-release#:~:text=Annual%20CPI%20inflation%20was%203.6,in%20the%20December%202022%20quarter>
- 17 Cations M, Lang CE, Ward SA, Crotty M, Whitehead C, Maddison J, et al. Cohort profile: Dementia in the Registry of Senior Australians. *BMJ Open* 2021; 11(2): e039907. doi:10.1136/bmjopen-2020-039907
- 18 Khadka J, Visvanathan R, Theou O, Moldovan M, Amare AT, Lang C, et al. Development and validation of a frailty index based on Australian Aged Care Assessment Program data. *Med J Aust* 2020; 213(7): 321–6. doi:10.5694/mja2.50720
- 19 Caro JJ, Briggs AH, Siebert U, Kuntz KM. ISPOR-SMDM Modeling Good Research Practices Task Force. Modeling good research practices—overview: a report of the ISPOR-SMDM Modeling Good Research Practices Task Force-1. *Value Health* 2012; 15(6): 796–803. doi:10.1016/j.jval.2012.06.012
- 20 Lin DY. Linear regression analysis of censored medical costs. *Biostatistics* 2000; 1(1): 35–47. doi:10.1093/biostatistics/1.1.35
- 21 Royal Commission into Aged Care Quality and Safety. Final Report: Care, Dignity and Respect. Canberra; 2021. Available at <https://www.royalcommission.gov.au/aged-care/final-report>
- 22 Comondore VR, Devereaux PJ, Zhou Q, Stone SB, Busse JW, Ravindran NC, et al. Quality of care in for-profit and not-for-profit nursing homes: systematic review and meta-analysis. *BMJ* 2009; 339: b2732. doi:10.1136/bmj.b2732
- 23 Frey R, Balmer D, Robinson J, Gott M, Boyd M. The Effect of Residential Aged Care Size, Ownership Model, and Multichain Affiliation on Resident Comfort and Symptom Management at the End of Life. *J Pain Symptom Manag* 2019; 57(3): 545–55. doi:10.1016/j.jpainsymman.2018.11.022
- 24 Shippee TP, Henning-Smith C, Kane RL, Lewis T. Resident- and Facility-Level Predictors of Quality of Life in Long-Term Care. *Gerontologist* 2015; 55(4): 643–55. doi:10.1093/geront/gnt148
- 25 Dyer SM, Liu E, Gnanamanickam ES, Milte R, Easton T, Harrison SL, et al. Clustered domestic residential aged care in Australia: fewer hospitalisations and better quality of life. *Med J Aust* 2018; 208(10): 433–8. doi:10.5694/mja17.00861
- 26 Gnanamanickam ES, Dyer SM, Milte R, Harrison SL, Liu E, Easton T, et al. Direct health and residential care costs of people living with dementia in Australian residential aged care. *Int J Geriatr Psychiatry* 2018; 33(7): 859–66. doi:10.1002/gps.4842
- 27 Moyo P, Zullo AR, McConeghy KW, Bosco E, van Aalst R, Chit A, et al. Risk factors for pneumonia and influenza hospitalizations in long-term care facility residents: a retrospective cohort study. *BMC Geriatr* 2020; 20(1): 47. doi:10.1186/s12877-020-1457-8
- 28 Gimm GW, Kitsantas P. Falls, Depression, and Other Hospitalization Risk Factors for Adults in Residential Care Facilities. *Int J Aging Hum Dev* 2016; 83(1): 44–62. doi:10.1177/0091415016645347
- 29 Shepherd H, Livingston G, Chan J, Sommerlad A. Hospitalisation rates and predictors in people with dementia: a systematic review and meta-analysis. *BMC Med* 2019; 17(1): 130. doi:10.1186/s12916-019-1369-7

- 30 Achterberg WP, Pieper MJ, van Dalen-Kok AH, de Waal MW, Husebo BS, Lautenbacher S, et al. Pain management in patients with dementia. *Clin Interv Aging* 2013; 8: 1471–82. doi:10.2147/CIA.S36739
- 31 Bhattacharyya KK, Molinari V, Peterson L, Fauth EB, Anel R. Do nursing homes with a higher proportion of residents with dementia have greater or fewer complaints? *Aging Ment Health* 2023; 28: 448–56. doi:10.1080/13607863.2023.2277265
- 32 Wehrmann H, Michalowsky B, Lepper S, Mohr W, Raedke A, Hoffmann W. Priorities and Preferences of People Living with Dementia or Cognitive Impairment – A Systematic Review. *Patient Prefer Adherence* 2021; 15: 2793–807. doi:10.2147/PPA.S333923
- 33 Ouslander JG, Perloe M, Givens JH, Kluge L, Rutland T, Lamb G. Reducing potentially avoidable hospitalizations of nursing home residents: results of a pilot quality improvement project. *J Am Med Dir Assoc* 2009; 10(9): 644–52. doi:10.1016/j.jamda.2009.07.001
- 34 Spector WD, Limcangco R, Williams C, Rhodes W, Hurd D. Potentially avoidable hospitalizations for elderly long-stay residents in nursing homes. *Med Care* 2013; 51(8): 673–81. doi:10.1097/MLR.0b013e3182984bff
- 35 Independent Hospital Pricing Authority. National Hospital Cost Data Collection Report, Public sector, Round 245 (Financial Year 2019-20). Sydney; 2021. Available at <https://www.ihacpa.gov.au/resources/national-hospital-cost-data-collection-nhcdc-public-sector-report-2019-20>
- 36 Independent Health and Aged Care Pricing Authority. Pricing Framework for Australian Public Hospital Services and Aged Care. Canberra; 2023. Available at <https://www.ihacpa.gov.au/health-care/pricing/pricing-framework-australian-public-hospital-services> [cited 13 September 2023].
- 37 Edney LC, Haji Ali Afzali H, Visvanathan R, Toson B, Karnon J. An exploration of healthcare use in older people waiting for and receiving Australian community-based aged care services. *Geriatr Gerontol Int* 2023; 23(12): 899–905. doi:10.1111/ggi.14703

Data availability. The data are not publicly available due to privacy and ethical restrictions.

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