Royal Commission
into Aged Care Quality and Safety

THE COST OF RESIDENTIAL AGED CARE

TECHNICAL SUPPLEMENTARY REPORT 1: COMPOSITE INDEX FOR QUALITY OF CARE IN AUSTRALIAN RESIDENTIAL AGED CARE FACILITIES

RESEARCH PAPER 9

AUGUST 2020

The Royal Commission into Aged Care Quality and Safety was established by Letters Patent on 8 October 2018. Replacement Letters Patent were issued on 6 December 2018, and amended on 13 September 2019 and 25 June 2020.

The Honourable Tony Pagone QC and Ms Lynelle Briggs AO have been appointed as Royal Commissioners. They are required to provide a final report by 26 February 2021.

The Royal Commission releases consultation, research and background papers. This research paper has been prepared by the University of Queensland for the information of Commissioners and the public. The views expressed in this paper are not necessarily the views of the Commissioners.

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THE UNIVERSITY OF QUEENSLAND
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Technical Supplementary Report 1: Composite index for quality of care in Australian residential aged care facilities

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Abbreviations

AIC	Akaike information criteria
BIC	Bayes information criteria
CER	Consumer experience report
CI	Confidence interval
CMS	Centers for Medicare & Medicaid Services
LCA	Latent class analysis
MM	Modified Monash category
MMM	Modified Monash Model
PCA	Principal component analysis
Q1	Quality level 1
Q2	Quality level 2
Q3	Quality level 3
RAC	Residential aged care
RACF	Residential aged care facility
ROSA	Registry of Senior Australians
TSR1	Technical Supplementary Report 1
TSR2	Technical Supplementary Report 2
USA	United States of America

1. Introduction

1.1 Context of the report

The University of Queensland was engaged by the Royal Commission into Aged Care Quality and Safety (the Royal Commission) to conduct an analysis to understand the efficient cost associated with providing residential aged care at different levels of quality. To help achieve this aim, a composite index for quality was developed for use in the efficiency analysis.

The Cost of Residential Aged Care report presents the final results of frontier estimation and efficiency costs with respect to different quality levels. The report is accompanied by two **technical supplementary reports**:

- ***Technical Supplementary Report 1 (TSR1): Composite index for quality of care in Australian residential aged care facilities.*** This report describes the data on quality used in the analysis, exploratory analyses and the methods to construct the composite quality index. It has two appendices:
    - *TSR1 Appendix A: Literature review on quality in residential aged care facilities*
    - *TSR1 Appendix B: Latent class analysis to construct the quality index at the provider level* [1]
- ***Technical Supplementary Report 2 (TSR2): Cost frontier analysis of Australian residential aged care facilities.*** The report outlines the step-by-step approach to identify the cost functions that best represent the cost structure of the RAC industry in Australia. The main results and the sensitivity analyses conducted to ensure the robustness are described. It has three appendices:
    - *TSR2 Appendix A: Data diagnostics: Identifying and analysing outliers in cost and output data*
    - *TSR2 Appendix B: Robustness check of estimated inefficiency: Semi-parametric least squares stochastic frontier analysis*
    - *TSR2 Appendix C: Additional results from the stochastic frontier analysis*

In *Technical Supplementary Report 1*, a composite index for quality of care in Australian residential aged care (RAC) facilities was constructed. The composite quality index in this project was constructed for several reasons. First, individual indicators in isolation do not reflect the full picture of the quality of care provided to residents living in residential aged care facilities, whereas a composite index provides a broad based picture. Second, as all quality indicators are subject to measurement error and some are imperfect measures of quality, it was considered more robust and objective to look at all indicators together. Third, as there are often very strong correlations between quality measures (e.g. complaints/issues and sanctions), it is essential in statistical models to reduce the multicollinearity to achieve more reliable estimates.

The composite quality index was constructed for the sole purpose of informing the efficiency estimates in this project. A pragmatic approach was undertaken to account for data limitations (e.g. the nature of the quality indicator, measurement errors, and incomplete data for all RAC facilities), project time constraints, and the overarching goal of understanding how much it costs to provide care at different levels of quality, and how much it would have costed to lift the quality of care from lower to higher quality.

The methods presented here are exploratory and preliminary. Additional statistical analyses should be performed, different aggregation and construction methods should be explored, and models within each method should be carefully examined to improve its usefulness for policy- and decision-makers. This research seeks to contribute to the effort of better understanding how best to design a funding system that

[1] This analysis uses the same methodology as the facility-level analysis to create a composite quality index at the provider level.

focuses on providing the best quality of care for residents living in RAC facilities, in the most cost efficient way.

2. Process to construct the composite quality index

2.1 Theoretical framework

Quality of care is a multidimensional and complex concept (Donabedian, 1988, 1966; Ovretveit, 1992; Wilcock, 1996). The dominant conceptual framework for assessing the quality of care is the Donabedian model (Donabedian, 2003, 1988). The model comprises three domains that represent the type of information that can be used to inform the quality of care in RAC facilities: structure, process and outcome (Donabedian, 2003).

- Structure: refers to the settings, administrative systems and qualifications of providers, upon which all care services in the facility are delivered.
- Process: refers to the components of care delivered from two ends: health professionals activities (diagnosis, treatment, nursing care, patient education) and the residents' choice of care activities.
- Outcome: relates to health recovery, functional restoration and/or the survival of the residents in the facility.

As Donabedian indicates, these three dimensions are interlinked and a comprehensive assessment of the quality of care should be assessed based on a combination of all three dimensions, rather than relying on a single dimension (Donabedian, 2003). This framework was used to guide the variable selection and statistical analyses of the quality-related variables.

2.2 Variable selection

All available quality indicators for RAC facilities in Australia were provided by the Royal Commission under its legal authority. These include clinical care indicators, consumer experience and the number of complaints and issues, sanctions, accreditation and compliance, and hospital bed days. A list and detailed description of all the quality-related variables are provided in Section 3 below.

A variable selection process was undertaken involving two steps:

Step 1: Examination of data

The quality-related data were examined using descriptive statistics to summarise the data and visualise the data distributions. Each variable was assessed for completeness, outliers and quality. A preliminary set of quality-related variables were then selected that maximised the coverage for the aged care sector (i.e. the number of facilities with the available data) and data dimensions (i.e. the number of variables included in the set).

Step 2: Consultation with stakeholders and technical and content experts

The proposed preliminary set of selected and excluded quality-related variables were summarised and presented to a panel of technical and content experts in aged care, quality and efficiency. The panel members reviewed the variables for face and content validity. A broad consensus was reached for the selection of the final set of variables for inclusion in the subsequent analysis for the construction of the composite quality indices.

Quality of care in RAC facilities can be considered a latent construct. As such, it is worth noting that structural variables that may impact the quality of care in RAC facilities, such as staffing variables, were excluded on the basis that they are considered input variables and do not represent the underlying construct of quality.

2.3 Correlation analysis

Following the variable selection, multivariate analyses were conducted to investigate the underlying structure among the quality variables. The two main methods used were:

- Principal component analysis (unrotated)
- Principal factor analysis (unrotated and rotated) using likelihood ratio test and retaining factors that have eigenvalues greater than 1.

The multivariate analyses were performed using the quality variables in both their original and transformed forms. The transformed data was created using normalisation methods to address the skewness of the data.

In addition to identifying the underlying latent structures, the multivariate analyses were conducted to inform the finalised list of quality variables and their format (i.e. original or transformed) to be included in the construction of the composite quality index.

3. Data exploration

3.1 Data collection

The Commission provided data on quality indicators that were available in Australia at the time of writing this report. These are described in Table 1.

Table 1. Details of the quality indicators available for analysis

Quality indicators	Data sources/ custodians	Data quality and completeness	Description of the data sources and their role in the analysis	Used (Yes/No) in the subsequent analysis and to construct the composite quality index
Registry of Senior Australians (ROSA) Monitoring Outcome indicators	Registry of Senior Australians (ROSA)	12 indicators: 5 indicators available for all Australian states and territories; 7 indicators available for South Australia only. Five years 2012/13 to 2016/17	Data (facility level) contains 12 clinical outcome indicators, estimated using a variety of data sources (Commonwealth and State Government of South Australia), including crude and casemix-adjusted proportions and rates. Additional covariates, including dementia or osteoporosis, are included in the specifications of some indicators. Detailed information is described in Section 3.2.	Yes (4 out of 12 indicators): high sedative load; antipsychotic use; chronic opioid use; and antibiotic use
Hospital bed days	Facilities reported	All five years 2014/15 to 2018/19.	Number of days in hospital	No
Complaints and issues	Aged Care Quality and Safety Commission	All facilities that had complaints; Five years 2014/15 to 2018/19	Data (facility level) contains complaints count, issues count (one complaint may comprise multiple issues), count for each of the 29 issue types.	Yes (Issue count) No (Complaint count)
Sanctions	Aged Care Quality and Safety Commission	All facilities that had sanctions; Five years 2014/15 to 2018/19	Data (facility level) contains sanction count. Used to check the validity of 5-category classification derived from the composite quality index.	No for the composite quality index, used as a validity check for the categorisation of low-high quality facilities
Accreditation standards	Aged Care Quality and Safety Commission	All facilities that had not met accreditation standards; Five years 2014/15 to 2018/19	Data (facility level) contains compliance with accreditation standards (flags, not met accreditation standards, serious risk).[a]	Yes
Consumer experience report	Aged Care Quality and Safety Commission	Small number of facilities; Three years 2016/17 to 2018/19	Data (facility level) contains the count of consumer rating responses for each of 10 questions regarding their experience.	Yes

ROSA: Registry of Senior Australians
[a] There are 44 expected outcomes across four Accreditation Standards.

During this step, the quality databases were merged with the facility and provider characteristics database. This enabled further examination of data completeness across variables and financial years. A detailed description of each data quality variable is presented below. All the data was provided for the analysis unit of "RAC facility" (i.e. facility level), unless otherwise specified to be at the provider level. There were no

resident-level data. All data were de-identified.

3.2 ROSA Outcome Monitoring indicators

The ROSA Outcome Monitoring indicators are a set of clinical outcomes developed by the Registry of Senior Australians (ROSA) to measure the safety and quality of services received by individuals receiving aged care services in Australia (Inacio et al., 2020). It comprises 12 indicators: premature mortality, falls, fractures, medication-related adverse events, malnutrition or weight loss, delirium and/or dementia, emergency department presentations, pressure injuries and high-risk medicine use, including sedative, antipsychotic, chronic opioid, antibiotic. Sedative load and antipsychotic use indicators were provided for all residents, residents with dementia, and residents without dementia. Premature mortality and emergency department presentations indicators were provided for short-term and long-term residents. Descriptions of these indicators are shown in Table 2.

The ROSA indicators were provided as an *observed* proportion or rate.[2] The ROSA indicators were also provided as *adjusted* proportions and rates, which were adjusted for the different profile of individuals living in each facility.[3] A range of confidence intervals (e.g. 95%, 99.8%) for the ROSA indicators were provided, which had been calculated using the Wilson method for binomial distributions, reflecting the range of values in which the true estimates of each indicator most likely lie. The intervals are influenced by the sample size and variability.

Table 2. ROSA indicators for each financial year (2012/13 to 2016/17)

ROSA indicators (crude, adjusted, 95% CI)	Description	Format of proportion / rate
1. High-risk medicine use: sedative load		
All residents	Proportion of residents potentially experiencing a high sedative load [a]	Continuous
Dementia	Proportion of residents with dementia potentially experiencing a high sedative load [a]	Continuous
Without dementia	Proportion of residents without dementia potentially experiencing a high sedative load [a]	Continuous
2. High-risk medicine use: antipsychotics		
All residents	Proportion of residents dispensed an antipsychotic	Continuous
Dementia	Proportion of residents with dementia dispensed an antipsychotic	Continuous
Without dementia	Proportion of residents without dementia dispensed an antipsychotic	Continuous
3. High-risk medicine use: chronic opioid	Proportion of residents considered chronic opioid users	Continuous
4. High-risk medicine use: antibiotics	Antibiotic use-days per 1000 resident-days of care	Continuous
5. Premature mortality [b]		
Short-term residents	Proportion of short-term residents who had premature deaths	Continuous
Long-term residents	Proportion of long-term residents who had premature deaths	Continuous
6. Fall [b]	Proportion of residents who have experienced ≥1 falls requiring medical attention	Continuous
7. Fracture [b]	Proportion of residents who experience at least one fracture	Continuous
8. Medication-related AEs [b]	Proportion of residents who had a hospitalisation for medication-related events [c]	Continuous
9. Malnutrition/weight loss [b]	Proportion of residents with any hospitalisation with reported weight loss or malnutrition [c]	Continuous
10. Delirium/Dementia [b]	Proportion of residents who had a hospitalisation for delirium or dementia [c]	Continuous

[2] Observed proportion is the crude ratio of observed events (as the numerator) and the number of residents in aged care (as the denominator). Observed rates are the ratio of the numerator/1000 resident days.
[3] All quality indicators were adjusted for age, gender, and the number of co-morbidities of the cohorts. Additional covariates, included dementia or osteoporosis for some indictors. This adjustment was performed by the Registry of Senior Australians (ROSA).

ROSA indicators (crude, adjusted, 95% CI)	Description	Format of proportion / rate
11. Emergency room presentations [b]		
Short-term residents	Proportion of short-term residents who had an ED presentation within 30 days of re-entry to aged care from hospital and which did not result in an inpatient stay	Continuous
Long-term residents	Proportion of long-term residents who had an ED presentation within 30 days of re-entry to aged care from hospital and which did not result in an inpatient stay	Continuous
12. Pressure injury [b]	Proportion of residents who had a hospitalisation with a reported pressure injury	Continuous

Residents are long-term residents unless otherwise specified. AE: adverse events; CI: confidence interval; ED: emergency department
[a] Proportion of residents who had at least one potential period of high sedative load (≥3) medication use within a 91-day period within the year, where the sedative load is calculated by summing the sedative rating of each medication dispensed during the same period.
[b] Available for South Australia only
[c] Hospitalisation or emergency department presentation

The ROSA indicators were available for five financial years (2012/13 to 2016/17). Of the 12 ROSA indicators, the four indicators reflecting high-risk medicine use (high sedative load, antipsychotic use, chronic opioid use and antibiotic use) were available for **all** Australian states and territories. However, the remaining eight indicators (premature mortality, falls, fractures, medication-related adverse events, weight loss or malnutrition, delirium and/or dementia, emergency department presentations and pressure injuries) were only collected and available for **one** Australian state (South Australia).

All ROSA indicators were inspected, visually and by using crosstabs, for missing data across facilities. ROSA indicators were excluded based on the following criteria: (i) the indicator comprised more than 20% missing data in any given year, and (ii) the number of observations in the indicator was insufficient for further analysis. Eight indicators were excluded on the basis that the number of observations was insufficient for further analysis, as these indicators were only collected and available for one Australian state.

The four selected ROSA indicators reflect high-risk medicine use (high sedative load, antipsychotic use, chronic opioid use and antibiotic use) and were drawn from Pharmaceutical Benefits Scheme data. Definitions and information on how these four ROSA indicators were calculated by ROSA are provided in the footnote below.[4]

Harmful polypharmacy and potentially inappropriate medicine use (i.e. medicines that should generally be avoided among older adults) is very common in older residents living in RAC facilities and have been linked to medication-related adverse outcomes (Milton et al., 2008; Wilson et al., 2010). To help address this problem, the Australian Productivity Commission in 2011 identified the need for validated indicators that address medication-related quality of care in the aged care setting. Based on high-level evidence and recommendations by established Australian or international reporting programs and initiatives, the ROSA Outcome Monitoring System includes these four indicators that assess dispensing of high-risk medicines (sedative load, antipsychotic use, chronic opioid use, and antibiotic use). Some level of prescribing of these medicines is, of course, appropriate for some residents living in RAC facilities. Whilst the appropriate level of

[4] High sedative load: Estimate of the cumulative effect of taking multiple medications with sedative properties, as indicated by ≥3 primary sedatives and/or medication with sedative properties. Proportion of long-term residents potentially experiencing a high sedative load (SL≥3), calculated as the number of long-term residents who had at least one potential period of high sedative load (SL≥3) medication used within a 91-day period in the one-year period, where sedative load is calculated by summing the sedative rating of each medication dispensed during the same period, divided by the number of long-term residents of aged care.
Antipsychotic use: Proportion of long-term residents dispensed an antipsychotic, calculated as the number of long-term residents dispensed at least one antipsychotic medication during the year divided by the number of long-term residents of aged care.
Chronic opioid use: Proportion of long-term residents considered chronic opioid users, calculated as the number of long-term residents that are chronic opioid users (i.e. receiving any number of opioid medications for ≥90 days continuously, or for 120 non-consecutive days and where the number of days of medication use is determined based on the number of units dispensed and estimated dose per day), divided by the long-term residents of aged care (without history/current diagnosis of cancer; non-palliative care).
Antibiotic use: Antibiotic use-days per 1000 resident-days of care, calculated as the number of days a long-term resident received at least one antibiotic for systemic use divided by the number of days in residential aged care for long-term residents.

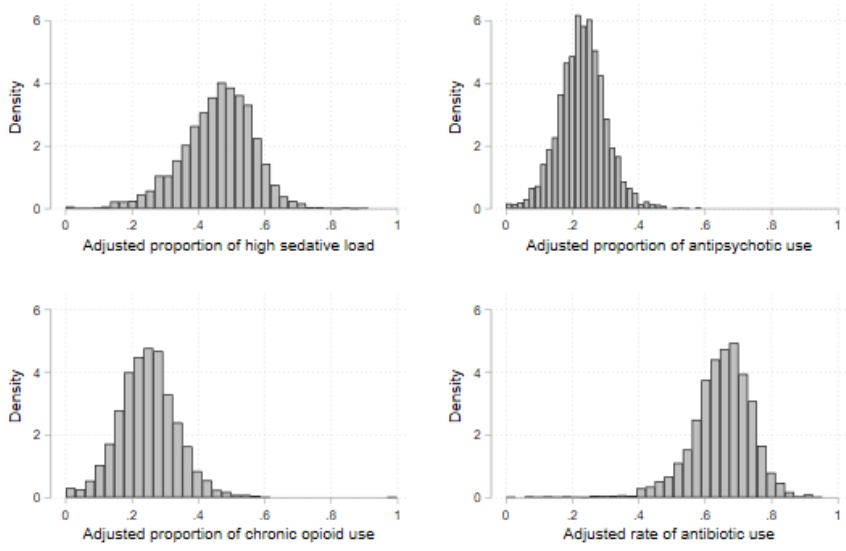
prescribing for these high-risk medicines has not yet been confirmed in Australia, the facilities with a pattern of very high dispensing and use of these medicines have been taken as an indicator of lower quality of care.

The adjusted values and confidence intervals of the selected four ROSA high-risk medicine use indicators were further inspected for descriptive statistics, data distributions and outliers. Data for three financial years (2014/15, 2015/16 and 2016/17) were selected for inclusion in the analysis as it corresponded with the period of the cost parameters in the efficiency model. These indicators were found to have a good level of coverage across these three years.

The adjusted values and their associated 95% and 99.8% confidence intervals for the four selected ROSA high-risk medicine use indicators were considered in the subsequent analyses. Figure 1 shows the histograms and distributions of adjusted proportions and rates of the ROSA high-risk medicine use indicators (high sedative load, antipsychotic use, chronic opioid use and antibiotic use) averaged across financial years (2014/15 to 2016/17).

The four ROSA high-risk medicine use indicators (adjusted proportions and rates for all residents) were transformed from continuous variables into binary variables. Values that fell above the 95% confidence interval (CI) in a given financial year were assigned a value of 1, representing lower quality. All other values were assigned a value of 0.

Each binary variable was then combined into an index variable (count) across the three financial years (2014/15 to 2016/17). The index values ranged from 0 (lower quality) to 3 (higher quality). Facilities were assigned either an index of 0 (quality index fell above the 95% CI in all 3 years), 1 (quality index fell above the 95% CI in any 2 years), 2 (quality index fell above the 95% CI in any 1 year), and 3 (quality index fell on the 95% CI or below in all 3 years). This transformation to a count index variable was preferred over using an average, or the most recent year, as it better reflects the consistency of the facilities high-risk medicine usage over time. The counts for each of the four ROSA high-risk medicine use indicators used in the latent class approach are presented in Table 3.



Abbreviation: ROSA: Registry of Senior Australians

Figure 1. Histograms of ROSA high-risk medicine use indicators averaged across financial years (2014/15 to 2016/17), adjusted proportions and rates

Table 3. Distribution of facilities by ROSA indicators: index count variables used in the analysis

		ROSA high-risk medicine use indicators			
Index variable	**Description (financial years 2014/15 to 2016/17)**	**High sedative use**	**Antipsychotic use**	**Chronic opioid use**	**Antibiotic use**
0	Above 95% CI in all 3 years	91 (3%)	28 (1%)	73 (3%)	77 (3%)
1	Above 95% CI in any 2 years	170 (6%)	84 (3%)	143 (5%)	206 (7%)
2	Above 95% CI in any 1 year	340 (12%)	186 (7%)	290 (10%)	494 (18%)
3	95% CI or below in all 3 years	2,165 (78%)	2,468 (89%)	2,262 (82%)	1,991 (72%)
	Total number of facilities	**2,766**	**2,766**	**2,768**	**2,768**

CI = confidence interval; ROSA: Registry of Senior Australians

3.3 Hospital bed days

Hospitalisations of residents from RAC facilities are common. As many of these hospitalisations are deemed to be inappropriate or avoidable, hospitalisations may reflect the level and quality of personal and clinical care provided in RAC facilities. *Hospital bed days,* defined as the total number of days residents spent in hospital over a given period, was collected by the RAC facilities and was available for five financial years (2014/15 to 2018/19). The description and format of the hospital bed days are provided in Table 4.

Table 4. Hospital bed days per financial year (2014/15 to 2018/19)

Variable	Description	Format
Hospital bed days	Total number of days that all residents in the facility spent in hospital in a given financial year	Count

It is expected that facilities with a large number of residents will have a higher number of hospital bed days than facilities with a smaller number of residents. To account for facility occupancy, the total number of hospital bed days was divided by the number of occupied bed days to give the *hospital bed days per occupied bed day*.

The distributions of *hospital bed days per occupied bed day* for facilities across five financial years (2014/15 to 2018/19) were explored. Mean adjustment was undertaken to address the very low percentage values, calculated as the hospital bed days per occupied bed day for each facility divided by the mean of this variable across all facilities. Facilities with mean-adjusted rates of hospital bed days per occupied bed day above 1 indicates the facility had a rate above the national average rate (lower quality), equal to 1 indicates the facility had a rate equal to the national average rate, and below 1 indicates the facility had a rate below the national average rate (higher quality).

Data for the latest 2-year period (financial years 2017/18 and 2018/19) were examined as it represented the most recent hospitalisation data available. The distribution of the mean-adjusted rate of hospital bed days per occupied bed day across financial years (2017/18 and 2018/19) is presented in Figure 2 below. It is important to note that this variable was used in the pre-testing phase of the latent class analysis; however, it was not used in the final construction of the composite quality index, using the latent class analysis approach.

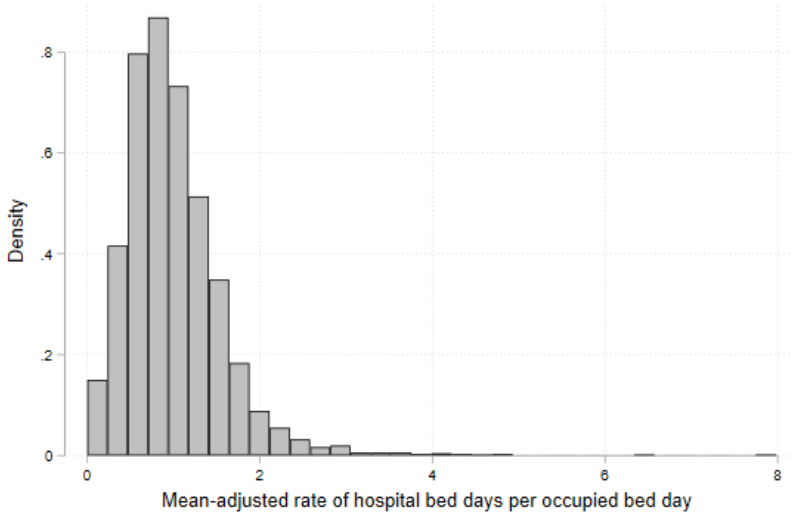


Figure 2. Histogram of mean-adjusted rate of hospital bed days per occupied bed day across financial years (2017/18 and 2018/19)

3.4 Issues and complaints

Concerns about the quality of care provided to a resident in a RAC facility can be brought to the attention of the provider by the resident, family members, staff or others. If they do not feel comfortable talking to the provider (or they have tried but it did not work) complaints can be made to the Aged Care Quality and Safety Commission. The number of official complaints and issues about RAC facilities in Australia lodged across a 5-year period (financial year 2014/15 to 2018/19) were available for analysis. The description and format of the *number of complaints and issues* are provided in Table 5.

Table 5. Number of complaints and issues per financial year (2014/15 to 2018/19)

Variable	Description	Format
Complaints	Total number of complaints about a RAC facility made to the Aged Care Quality and Safety Commission in a given financial year	Count
Issues	Total number of issues about a RAC facility made to the Aged Care Quality and Safety Commission in a given financial year	Count

RAC: residential aged care

Each complaint contains one or more issues. As complaints and issues are highly correlated, only one variable was included in the analysis. As there was a greater or equal number of issues than complaints in the data, the number of issues was selected for inclusion in the subsequent analysis. A higher number of issues indicates a lower level of quality of the RAC facility.

It is expected that facilities with a large number of residents will have a higher number of complaints and issues than facilities with a smaller number of residents. To account for facility size, the total number of issues was adjusted for size by dividing by the number of residential aged care facility (RACF) places to give the *number of issues per RACF place*.

The distributions of the *size-adjusted number of issues* for facilities across five financial years (2014/15 to 2018/19) were explored. Adjustment was undertaken to address the large number of zero values (i.e. no issues), calculated as the size-adjusted number of issues for each facility divided by the mean of this variable across all facilities. Facilities with mean-adjusted rates of the number of issues (after adjustment for facility size) above 1 indicates the facility had a rate above the national average rate (lower quality), equal to

1 indicates the facility had a rate equal to the national average rate, and below 1 indicates the facility had a rate below the national average rate (higher quality).

Data for three financial years (2016/17 to 2018/19) were selected for inclusion in the analysis as it represented the most recent issues data available. The mean-adjusted rates of the number of issues (size-adjusted) averaged across the three financial years (2016/17 and 2018/19) were used in the latent class approach. The distribution of the mean-adjusted rate of issues per RACF place across financial years (2016/17 and 2018/19) is presented in Figure 3 below. The mean-adjusted distribution is positively skewed (zero-inflated).

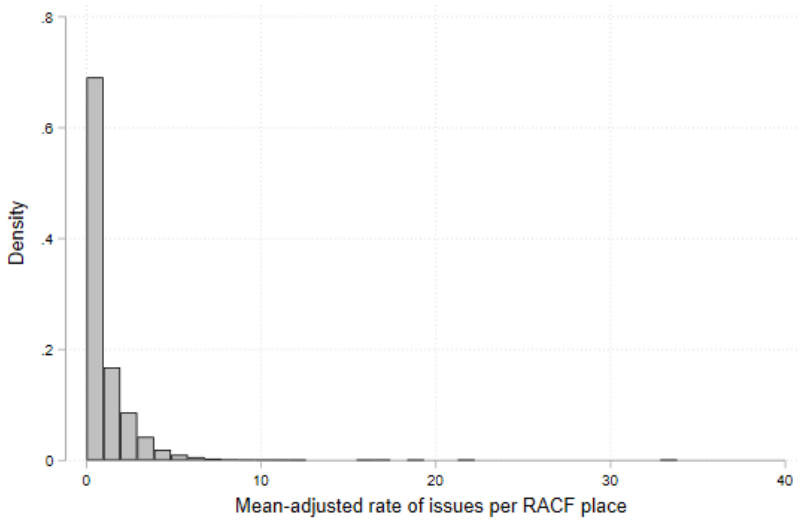


Figure 3. Histogram of mean-adjusted rate of issues per residential aged care facility (RACF) place across financial years (2016/17 and 2018/19)

The latent class approach used to construct the composite quality index requires the underlying distribution of the data to be pre-specified (e.g. normal, poisson, logit, probit). Distributions of issues were thus explored. As none of the standard distributions fit the distribution of the mean-adjusted rates of issues, the latent class model was unable to converge (find a solution) and the variable required further transformation before analysis. The variable was transformed to an index, where 0 reflects no issues across the 3-year period (higher quality), 1 reflects the number of issues per RACF place within the 25–75th percentile (medium quality), and 2 reflects the number of issues per RACF place higher than the 75th percentile (lower quality). This transformed variable follows a distribution that can be used in the latent class analysis.

3.5 Sanctions

The Department of Health may place a sanction on a RAC facility if there is an immediate and severe risk to the safety, health or well-being of someone receiving aged care services or if the provider does not have the appropriate systems in place. Sanctions may also be imposed when a facility has received a notice of non-compliance but has not addressed the issues within an agreed time period. The number of sanctions imposed on RAC facilities was administered by Aged Care Quality and Safety Commission. The description and format of the *number of sanctions* are provided in Table 6.

Table 6. Number of sanctions per financial year (2014/15 to 2018/19)

Variable	Description	Format
Number of sanctions	Total number of sanctions placed on a RAC facility by the Department of Health in a given financial year	Count

RAC: residential aged care

As shown in Table 7 below, the number of sanctions imposed on RAC facilities has increased over the last few years. It is unclear whether this is due to a decline in the quality of RAC facilities or whether the threshold for unacceptable practices of care has been lowered due to recent public scrutiny. The increase in sanctions in the 2018/19 financial year is likely to be associated with the introduction of audits without notice to providers to replace notified site audits from July 2018, which means that aged care providers were no longer able to prepare and plan for scheduled audits.

Table 7. Sanctions by financial year

Sanctions indicator	Number of facilities across financial years				
	2014/15	2015/16	2016/17	2017/18	2018/19
Number of sanctions					
1	2	2	11	19	45
2	0	0	0	3	4
Total [a]	2	2	11	22	49

[a] This data reflects all recorded sanctions imposed on residential aged care facilities for the whole residential care sector across the 5-year period (administered by the Aged Care Quality and Safety Commission).

As expected, a small number of facilities had one or two sanctions. The number of sanctions was summed over the most recent two years of available data (financial years 2017/18 and 2018/19). This was done for the following reasons: (i) to account for the low frequency of the count data in any given year, (ii) to maximise the number of facilities with the data due to the inconsistent timing of the assessments and visits, (iii) to capture the facilities that had sanctions imposed over consecutive time periods, and (iv) to reflect the most recent time period that captures the shift to unannounced visits which better represents the quality of care and services. This count variable was used in the exploratory analysis.

3.6 Accreditation standards (expected outcomes not met)

The Aged Care Quality and Safety Commission expects aged care service providers in Australia to comply with a set of standards. Before 1 July 2019, there are four Accreditation Standards and 44 expected outcomes across the four Accreditation Standards.[5] A description of the Accreditation Standards and expected outcomes data collected by the Aged Care Quality and Safety Commission for five financial years (2014/15 to 2018/19) is provided in Table 8.

RAC facilities must comply with all 44 expected outcomes of the accreditation standards at all times. If the facility was assessed as failing to comply with an expected outcome, then such outcome was considered to be not met. The data was provided in a count format of the number of expected outcomes that were not met by the facility during a given financial year.

The number of RAC facilities with one or more expected outcomes not met has increased over the years from 62–86 facilities across a 3-year period (2014/15 to 2016/17), to 228 and 457 facilities annually in financial years 2017/18 and 2018/19, respectively. Similar to the pattern of sanctions over this same time period, it is unclear whether the increase in the number of facilities with expected outcomes not met is due to a decline in the quality of facilities or change in the threshold for unacceptable care practices. The increase in the number of facilities with at least one expected outcome not met in recent years is likely to be due in part to the shift to unannounced (without notice to providers) visits, replacing announced (with notice to providers) visits meaning that aged care providers were no longer able to prepare and plan for the assessments and audits.

[5] From 1 July 2019, the Aged Care Quality and Safety Commission (Commission) began assessing and monitoring quality of care and services against the new Aged Care Quality Standards (Quality Standards). However, data for these new Quality Standards were unavailable for analysis at the time of writing this report.

Table 8. Description of Accreditation Standards and expected outcomes not met for financial year (2014/15 to 2018/19)

Accreditation Standards [a]	Principle / intention	Number of expected outcomes	Format (Expected outcomes not met)
Standard One: Management systems, staffing and organisational development	Within the philosophy and level of care offered in the residential care service, management systems are responsive to the needs of care recipients, the representatives, staff and stakeholders, and the changing environment in which the service operates. Intention of standard: This standard is intended to enhance the quality of performance under all Accreditation Standards, and should not be regarded as an end in itself. It provides opportunities for improvement in all aspects of service delivery and is pivotal to the achievement of overall quality.	9	Count
Standard Two: Health and personal care	Care recipients' physical and mental health will be promoted and achieved at the optimum level in partnership between each care recipient (or his or her representative) and the health team.	17	Count
Standard Three: Care recipient lifestyle	Care recipients retain their personal, civic, legal and consumer rights, and are assisted to achieve active control of their own lives within the residential care service and in the community.	10	Count
Standard Four: Physical environment and safe systems	Care recipients live in a safe and comfortable environment that ensures the quality of life and welfare of care recipients, staff and visitors.	8	Count
Total		44	Count

Details of the expected outcomes for each of the four Accreditations Standards is provided in the footnote below.[6]

As expected, a small number of facilities had one or more expected outcomes not met. The number of expected outcomes not met was summed over the most recent two years of available data (financial years 2017/18 and 2018/19). This was done for the following reasons: (i) to account for the low frequency of the count data in any given year, (ii) to maximise the number of facilities with the data due to the inconsistent timing of the assessments and visits, (iii) to capture the facilities that failed to meet the expected outcomes over consecutive time periods, and (iv) to reflect the most recent time period that captures the shift to unannounced visits which better represent the quality of care and services.

The distribution of the total number of expected outcomes not met across financial years is presented in Figure 4 below. The distribution is positively skewed (zero-inflated). This count variable was used in the latent class approach.

[6] *Standard One (expected outcomes):* Continuous improvement; regulatory compliance; education and staff; comments and complaints; planning and leadership; human resource management; inventory and equipment; information systems; and external services.
Standard Two (expected outcomes): Continuous improvement; regulatory compliance; education and staff development; clinical care; specialised nursing care needs; other health and related services; medication management; pain management; palliative care; nutrition and hydration; skin care; continence management; behavioural management; mobility, dexterity and rehabilitation; oral and dental care; sensory loss; and sleep.
Standard Three (expected outcomes): Continuous improvement; regulatory compliance; education and staff development; emotional support; independence; privacy and dignity; leisure interests and activities; cultural and spiritual life; choice and decision-making; and care recipient security of tenure and responsibilities.
Standard Four (expected outcomes): Continuous improvement; regulatory compliance; education and staff development; living environment; occupational health and safety; fire, security and other emergencies; infection control; and catering, cleaning and laundry services.

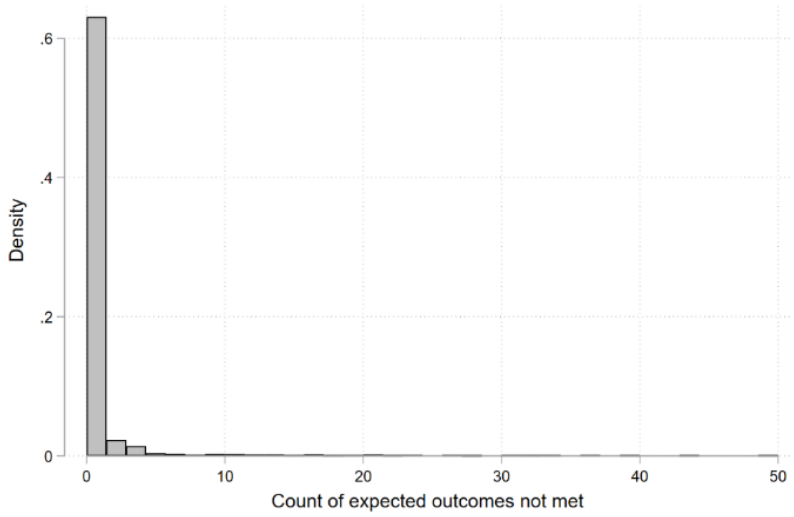


Figure 4. Histogram of the total number of expected outcomes not met (accreditation standards) (financial years, 2017/18 and 2018/19)

3.7 Consumer experience report (CER) data

The experiences of the quality of care and services provided to residents living in RAC facilities were captured through a consumer experience report (CER) survey collected by the Aged Care Quality and Safety Commission. The consumer experience report consists of ten questions with response options of 1 (never), 2 (some of the time), 3 (most of the time) and 4 (always) (Table 9). Higher scores indicate higher quality and lower scores indicate lower quality. The consumer experience data was provided in count format reflecting the number of respondents who had selected each response option for a period of three financial years (2016/17 to 2018/19).

Table 9. Description of the consumer experience report questions and response options

Consumer experience questions *(variable name)*	**Never (1)**	**Some of the time (2)**	**Most of the time (3)**	**Always (4)**
1. Do staff treat you with respect? *(respect)*			Format (count)	
2. Do you feel safe here? *(safety)*			Format (count)	
3. Do staff meet your healthcare needs? *(care need)*			Format (count)	
4. Do staff follow up when you raise things with them? *(follow up)*			Format (count)	
5. Do the staff explain things to you? *(explain)*			Format (count)	
6. Do you like the food here? *(food)*			Format (count)	
7. If I'm feeling a bit sad or worried, there are staff here who I can talk to. *(caring)*			Format (count)	
8. The staff know what they are doing. *(competent)*			Format (count)	
9. This place is well run. *(operation)*			Format (count)	
10. I am encouraged to do as much as possible for myself. *(independent)*			Format (count)	

A consumer experience report summary score was constructed for each RAC facility for each question. The methodology used to construct the consumer experience report summary score is outlined in Table 10 below. The score for each response was multiplied by the number of respondents in each response option. The values were summed and then divided by the total number of respondents. The consumer experience report summary score is a score out of 40, with a higher score indicating higher quality of care and services experienced by residents living in RAC facilities.

Table 10. Method used to construct the consumer experience report summary score per facility

Ref	Step	Never	Some of the time	Most of the time	Always	Total [a]
A	Scores for each response option for Question 1	1	2	3	4	
B	Number of respondents per response option for Question 1[a]	0	2	6	12	20
C	Score multiplied by respondents (A x B). Sum total.	0	4	18	48	70
D	Mean item score (total divided by number of respondents)					3.5
E	Repeat for remaining 9 questions. Sum mean item scores for 10 items. Consumer experience report summary score per facility (maximum 40).					36.67

Ref: reference
[a] Excludes respondents that did not provide a response to the question.

Table 11 shows the number of facilities and descriptive statistics for the average consumer experience report summary score for the 3-year period of available data (2016/17 to 2018/19). As the consumer experience report survey was not conducted annually, data were pooled from across all three available years to maximise the number of facilities with consumer experience data. The average consumer experience report summary score from 2,218 facilities for financial years 2016/17 to 2018/19 were included in the latent class approach. The distributions of the scores are shown in Figure 5.

Table 11. Average consumer experience report summary score per year

		Consumer experience report summary score			
Financial year	Number of facilities [a]	Mean	SD	Min.	Max.
2016/17	82	33.95	1.77	29.11	37.77
2017/18	1,071	34.96	1.51	29.44	39.00
2018/19	1,124	34.93	1.51	28.36	39.00
All	2,218	34.92	1.51	29.11	39.00

Max: maximum; Min: minimum; SD: standard deviation
[a] A total of 59 facilities had >1 consumer experience report surveys administered in a given year. Scores for these facilities were averaged for the relevant year.

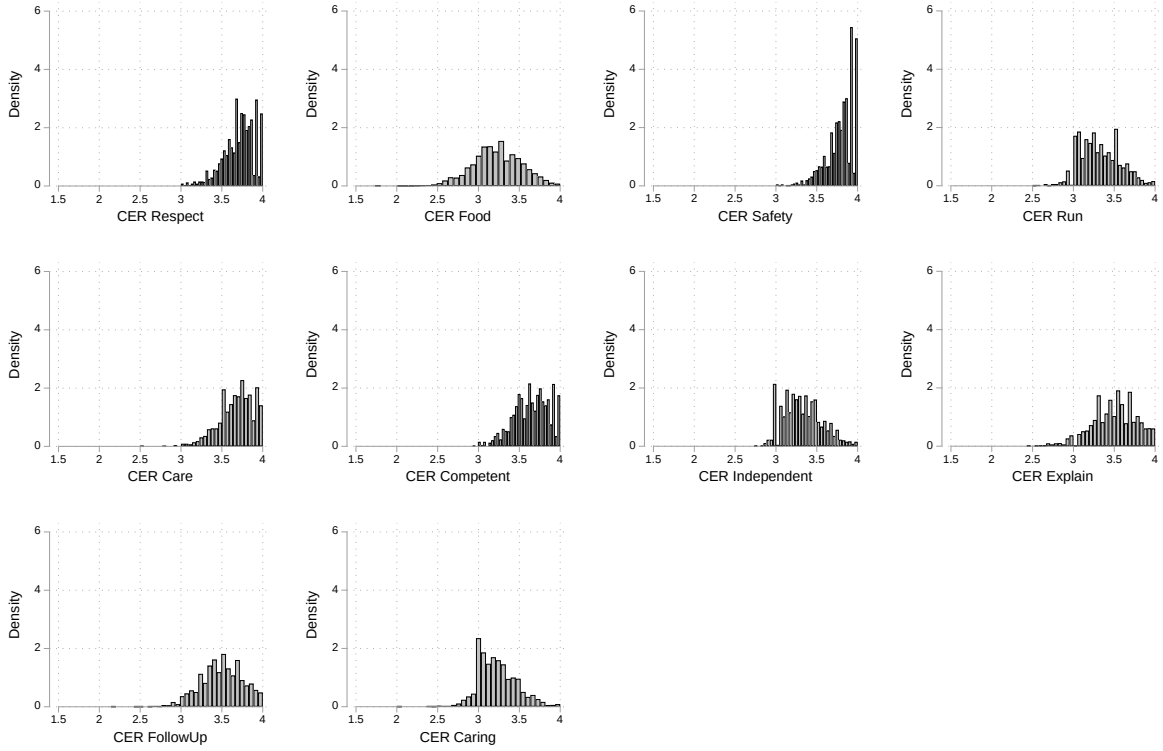


Figure 5. Histogram of the average consumer experience report (CER) summary score for each question across financials year (2016/17 to 2018/19)

3.8 Descriptive statistics by facility characteristics

3.8.1 Quality indicators by provider type

The number of facilities with available data on quality indicators by service provider type is presented in Table 12. There are three types of service providers in the data: not-for-profit, for-profit and government. Across the 5-year period, not-for-profit providers accounted for over half (57%) of the RAC market, followed by for-profit (34%) and government (9%) providers. Most of the selected quality indicators had good coverage for each of the three service provider types. Firstly, *issues (complaints)* and *sanctions* data were provided for all facilities across the three service providers types, covering the whole sector.[7] One-third of government, half of not-for-profit, and two-thirds of for-profit operated facilities had *issues (complaints)* recorded against the facilities. The *ROSA high-risk medicine use indicators* and number of *expected outcomes not met (accreditation standards)* were available for most not-for-profit (95–97%) and government (97–99%) operated facilities, and for the majority of for-profit (91–93%) facilities for the three and five years of available data, respectively. *Consumer experience report* data were available for all three provider types, covering approximately 40% of facilities in the latest 2-year period and less than 5% of facilities in financial year 2016/17.

[7] About 50–70% of facilities across five years received issues (complaints) and only a handful of facilities had sanctions imposed.

Table 12. Number of facilities with available data on quality indicators by service provider type

	2014/15	2015/16	2016/17	2017/18	2018/19	Total
Whole sector sample	***2,811***	***2,813***	***2,801***	***2,782***	***2,762***	***13,969***
Provider types						
Government	***255***	***250***	***248***	***245***	***242***	***1,240***
ROSA						
Antibiotic use	255	247	242	-	-	744
Antipsychotic use	253	246	240	-	-	739
Chronic opioid use	255	246	242	-	-	743
High sedative load	252	244	240	-	-	736
Issues [a]	68	70	77	63	116	394
Sanctions [b]	0	0	1	1	1	3
Consumer experience report	-	-	10	96	105	211
Expected outcomes not met [c]	257	250	243	240	208	1,198
For-profit	***939***	***959***	***953***	***950***	***936***	***4,737***
ROSA						
Antibiotic use	848	869	874	-	-	2,591
Antipsychotic use	848	869	874	-	-	2,591
Chronic opioid use	848	869	874	-	-	2,591
High sedative load	848	869	874	-	-	*2,591*
Issues [a]	554	584	606	673	746	3,163
Sanctions [b]	0	2	4	10	25	41
Consumer experience report	-	-	38	348	383	769
Expected outcomes not met [c]	850	872	885	914	879	4,400
Not-for-profit	***1,617***	***1,604***	***1,600***	***1,587***	***1,584***	***7,992***
ROSA						
Antibiotic use	1,578	1,563	1,555	-	-	4,696
Antipsychotic use	1,578	1,563	1,555	-	-	4,696
Chronic opioid use	1,577	1,563	1,555	-	-	4,695
High sedative load	1,577	1,563	1,554	-	-	4,694
Issues [a]	727	741	776	833	988	4,065
Sanctions [b]	2	0	5	8	22	37
Consumer experience report	-	-	34	627	636	1,297
Expected outcomes not met [c]	1,562	1,553	1,548	1,550	1,394	7,607
Missing provider types data						
ROSA						
Antibiotic use	16	8	11	-	-	35
Antipsychotic use	16	8	11	-	-	35
Chronic opioid use	16	8	11	-	-	35
High sedative load	16	8	11	-	-	35
Issues [a]	10	16	15	36	22	99
Sanctions [b]	0	0	1	3	1	5
Consumer experience report	-	-	0	0	0	0
Expected outcomes not met [c]	15	7	7	10	6	45

ROSA: Registry of Senior Australians
Data was provided only for the facilities (for the whole sector) across the 5-year period that had (a) official complaints (and issues) recorded, (b) sanctions imposed, and/or (c) failed to comply with to comply with any of the 44 expected outcomes across the four Accreditation Standards. Note, some of the facilities with issues (complaints) were not listed in the Department of Health characteristics dataset.

3.8.2 Quality indicators by geographical classification

The number of facilities with available data on quality indicators by remoteness is presented in Table 13. Geographical classification was measured using the Modified Monash Model (MMM) which measures the remoteness and population size on a scale with categories from metropolitan (MM 1) to very remote communities (MM 7). Across the 5-year period, the majority of facilities (62%) operated in metropolitan areas (MM 1), while 16% of facilities operated in regional centres and large rural towns (MM2–3), 20% operated in medium and small rural towns (MM 4–5) and only 2% (45–50 facilities every year) operated in remote and very remote regions of Australia (MM 6–7).

Most of the selected quality indicators had good coverage across the geographical regions of Australia. Firstly, *issues (complaints)* and *sanctions* data were provided for all facilities across all geographical regions, covering the whole sector. Over the 5-year period, less than 1% of facilities in each region had sanctions imposed. Of the 85 facilities with *sanctions* imposed over the 5-year period, 65 (76%) occurred in metropolitan (MM 1), 11 (13%) occurred in regional and large rural (MM 2–3), 9 (11%) occurred in medium and small rural (MM 4–5), and none occurred in remote and very remote (MM 6–7) facilities. Sixty percent of metropolitan (MM 1), 56% of regional and large rural (MM 2–3), 40% of medium and small rural (MM 4–5) and 34% of remote and very remote (MM 6-7) facilities had *issues (complaints)* recorded against the facilities. The *ROSA high-risk medicine use indicators* and *number of expected outcomes not met* were available for 94% of more of facilities in all MMMs for the three and five years of available data. Consumer experience report data were available for all regions, covering 32–41% of facilities in the latest 2-year period and less than 5% of facilities in financial year 2016/17.

Table 13. Number of facilities with available data on quality indicators by Modified Monash Model (MMM) Remoteness Classifications

	2014/15	2015/16	2016/17	2017/18	2018/19	Total
Whole sector sample	**2,811**	**2,813**	**2,801**	**2,782**	**2,762**	**13,969**
MM 1 (Metropolitan)	**1,752**	**1,751**	**1,748**	**1,741**	**1,728**	**8,720**
ROSA						
Antibiotic use	1,670	1,657	1,663	-	-	4,990
Antipsychotic use	1,669	1,657	1,663	-	-	4,989
Chronic opioid use	1,670	1,657	1,663	-	-	4,990
High sedative load	1,669	1,657	1,663	-	-	4,989
Issues [a]	940	961	1,012	1,104	1,253	5,270
Sanctions [b]	2	2	7	21	33	65
Consumer experience report	0	0	48	644	723	1,415
Expected outcomes not met [c]	1,656	1,652	1,658	1,685	1,583	8,234
MM 2–3 (Regional; large rural)	**456**	**457**	**454**	**448**	**445**	**2260**
ROSA						
Antibiotic use	431	431	428	-	-	1,290
Antipsychotic use	431	431	427	-	-	1,289
Chronic opioid use	431	431	428	-	-	1,290
High sedative load	430	430	427	-	-	1,287
Issues [a]	218	236	233	265	324	1,276
Sanctions [b]	0	0	3	0	8	11
Consumer experience report	0	0	12	185	166	363
Expected outcomes not met [c]	431	434	434	438	407	2,144

	2014/15	2015/16	2016/17	2017/18	2018/19	Total
MM 4–5 (Medium and small rural)	**550**	**549**	**547**	**544**	**541**	**2731**
ROSA						
Antibiotic use	545	544	541	-	-	1,630
Antipsychotic use	544	543	540	-	-	1,627
Chronic opioid use	544	544	541	-	-	1,629
High sedative load	543	543	540	-	-	1,626
Issues [a]	189	194	211	222	271	1,087
Sanctions [b]	0	0	1	0	8	9
Consumer experience report	0	0	20	224	222	466
Expected outcomes not met [c]	545	542	541	540	456	2,624
MM 6–7 (Remote and very remote)	**53**	**56**	**52**	**49**	**48**	**258**
ROSA						
Antibiotic use	51	55	50	-	-	156
Antipsychotic use	51	55	50	-	-	156
Chronic opioid use	51	54	50	-	-	155
High sedative load	51	54	49	-	-	154
Issues [a]	12	20	18	14	24	88
Sanctions [b]	0	0	0	0	0	0
Consumer experience report	0	0	2	18	13	33
Expected outcomes not met [c]	52	54	50	51	41	248
Missing remoteness data						
ROSA	0	0	0	0	0	0
Issues [a]	0	0	0	0	0	0
Sanctions [b]	0	0	0	1	0	1
Consumer experience report	0	0	0	0	0	0
Expected outcomes not met [c]	0	0	0	0	0	0

MM: Modified Monash category; ROSA: Registry of Senior Australians
Data was provided only for the facilities (for the whole sector) across the 5-year period that had (a) official complaints (and issues) recorded, (b) sanctions imposed, and/or (c) failed to comply with to comply with any of the 44 expected outcomes across the four Accreditation Standards. Note, some of the facilities with issues (complaints) were not listed in the Department of Health characteristics dataset.

4. Multivariate analysis

Following the data exploration, the quality of the data was thoroughly examined before constructing the composite quality index. This is because the validity and reliability of the main efficiency analyses may be influenced by the quality of the data (e.g. outliers in the data may potentially bias the estimates).

Multivariate analyses were conducted (i) to identify the underlying latent structures among the quality variables, (ii) to examine the correlations between individual quality variables, (iii) to investigate how each variable contributes to the quality of care in RAC facilities. This informed the finalised list of quality variables and their format (i.e. original or transformed) to be included in the construction of the composite quality index.

The two main methods used in the multivariate analyses were:

- Principal component analysis (unrotated), and
- Principal factor analysis (unrotated and rotated) using likelihood ratio test and retaining factors that have eigenvalues greater than 1.

In total, 21 variables were included in the multivariate analyses presented below. The multivariate analyses were performed using the quality variables in both their original and transformed forms. The consumer experience report survey questions were reversed-coded in the principal factor analysis. This was undertaken to align with the direction of the other variables for easier interpretation. Higher scores on all of the quality variables indicate lower quality and lower scores indicate higher quality.

The principal component analysis and principal factor analysis were performed. The eigenvalues were then extracted to investigate the number of constructs (factors) underlying the quality indicator items. The scree plots for the principal component analysis and principal factor analysis are presented in Figure 6. Components (factors) with eigenvalues greater than one are suggested to be retained. The scree plot for the principal component analysis suggests five components were underlying the data. However, the fifth component might add relatively little information above the other four components. The principal factor analysis suggested a four-factor model.

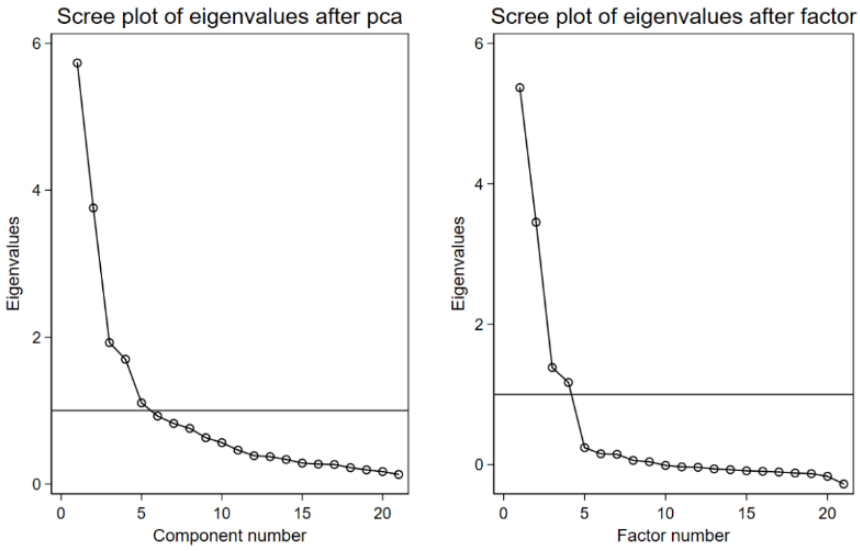


Figure 6. Scree plot of eigenvalues after principal component analysis (PCA) and principal factor analysis

Principal factor analysis (unrotated and rotated) was conducted to investigate the magnitude of the correlations between each quality variable and each factor (known as factor loadings). The purpose of factor

rotation was to improve the interpretability of the factor solution. The factor analysis was undertaken using the likelihood ratio test based on the eigenvalues, total variance, and the meaningfulness of the factors. The factor loadings (pattern matrix) and unique variances from the rotated principal factor analysis of the 21 quality variables are shown in Table 14.

Table 14. Rotated factor loadings (pattern matrix) and unique variances from the principal factor analysis

No.	Variable	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
1.	ROSA – Adjusted proportion of high sedative load				**0.73**	0.44
2.	ROSA – Adjusted proportion of antipsychotic use				**0.51**	0.73
3.	ROSA – Adjusted proportion of chronic opioid use				**0.54**	0.70
4.	ROSA – Adjusted rate of antibiotic use				**0.29**	0.91
5.	CER – Respect (reverse scored)	**0.78**				0.37
6.	CER – Food (reverse scored)	**0.57**		0.26		0.60
7.	CER – Safety (reverse scored)	**0.69**				0.48
8.	CER – Care (reverse scored)	**0.81**				0.29
9.	CER – Explain (reverse scored)	**0.83**		0.24		0.26
10.	CER – Follow Up (reverse scored)	**0.85**				0.23
11.	CER – Caring (reverse scored)	0.35		**0.70**		0.38
12.	CER – Competent (reverse scored)			**-0.78**		0.38
13.	CER – Run (reverse scored)	0.39		**0.77**		0.25
14.	CER – Independent (reverse scored)	0.26		**0.82**		0.27
15.	Accreditation Standard 1: Expected outcomes not met		**0.90**			0.17
16.	Accreditation Standard 2: Expected outcomes not met		**0.91**			0.17
17.	Accreditation Standard 3: Expected outcomes not met		**0.89**			0.21
18.	Accreditation Standard 4: Expected outcomes not met		**0.83**			0.31
19.	Mean-adjusted rate of issues per RACF place		**0.24**			0.92
20.	Sanctions		**0.65**			0.58
21.	Mean-adjusted rate of hospital days per OBD					0.95

CER: consumer experience report; OBD: occupied bed days; RACF: residential aged care facility; ROSA: Registry of Senior Australians

The pattern matrix shows that all four *ROSA high-risk medicine use* variables (adjusted proportions of high sedative load, antipsychotic use, chronic opioid use, and adjusted rate of antibiotic use) loaded onto one independent factor. These indicators could be described as reflecting a *clinical outcome dimension* of quality of care in the RAC facilities.

The *consumer experience report (CER)* variables loaded onto two factors (Questions 1–6; Statements 7–10), indicating that the format of the items may have accounted for the two factors. The CER variable that measures staff competence was the only negatively loaded variable, suggesting that the residents' perception of staff competence was not indicative of the quality of care delivered to, or experienced by the residents. As such, the composite quality index was constructed with and without this item, for sensitivity analysis purposes (Section 5).[8] The CER variables could be described as reflecting *consumer experience dimensions.*

Six variables, including the *expected outcomes not met* for each of the four Accreditation Standards,[9] *issues* and *sanctions* all loaded on the same factor. The high factor loadings for the *expected outcomes not met* and *sanctions* indicate that failing to meet accreditation standards is highly correlated with or underlying sanctions imposed on facilities. The factor loading of the *issues* item is also positively loaded on this factor;

[8] Due to the negative loading, the inclusion of the consumer experience report staff competence item was subtracted in the composite quality index rather than being summed with the other quality variables that had positive loadings.
[9] The four Accreditation Standards: management system, health and personal care, care recipient lifestyle, and physical environment and safe systems.

however, the loading is much lower and has a high level of uniqueness, suggesting that this variable could stand alone as a separate factor. As such, the *expected outcome not met* and *sanctions* items could be described as reflecting an *accreditation dimension*, whereas the *issues* item could be described as reflecting the quality of care perceived by the residents, their families and staff. The construction of the composite quality index in Section 5.2 was tested with and without the issues item.

Hospital bed days did not load onto any of the factors, suggesting that this quality variable could stand alone as a separate factor. As hospitalisations may reflect the level and quality of personal and clinical care provided in RAC facilities, hospital bed days was tested in further analyses (see Section 5.1).

Based on the data exploration (Section 3) and multivariate analyses (Section 4), the set of quality variables to be included in the construction of the composite quality index was finalised, using the following selection criteria: (i) correlations with other items, (ii) loadings in the principal component analysis and factor analysis, and (iii) data completeness across all facilities and time.

The final list of included variables is summarised in Table 15 below. For each of the variables, additional rescaling or transformation was conducted where appropriate in subsequent analyses (see Section 5).

5. Construction of the composite quality index

A composite quality index was constructed using a latent class analysis (LCA) approach (Section 5.1 below). To check the validity and robustness of the composite quality index, an alternative weighted-based aggregation approach was conducted (Section 5.2 below). The results of the two approaches were then compared to check the result validity (Section 5.3). The relation between the main result of quality measure (LCA classification) and facility characteristics were also explored (Section 5.1.4).

5.1 Latent class analysis (LCA) approach

The latent class model is based on the concept that a number of distinct groups or types of individuals exist in the population of interest. In this case, it was posited that a number of distinct quality classes exist and that each individual RAC facility belongs to a separate identifiable class. Each latent variable is categorical and comprised of a set of latent classes. A number of observed indicators measure the latent classes.

Latent class analysis (LCA) is closely related to factor analysis. The key difference is in the distribution imposed on the latent variable. In LCA, the latent variable is categorical with a multinominal distribution whereas, in factor analysis, the latent variable is continuous and normally distributed. LCA is usually performed using categorical variables. Analysis using continuous variables is more generally known as latent profile analysis. However, in this analysis we used a **flexible generalised structural equation modelling approach** that allows both categorical and continuous variables to be modelled in the same model. In this report, the term LCA is used to refer to the analysis performed in Stata MP 16.1 using the *gsem* command.

Not all facilities had sufficient data for all quality indicators, especially for the consumer experience report data. Due to the nature of the available quality indicators data, a set of annual composite quality indices for the whole 5-year period was unable to be developed. Instead, a set of 5-year composite quality indices were developed, which involved pooling the data to maximise the number of facilities.[10]

[10] For the consumer experience report data, the data were pooled (averaged) across the 3 years of available data (financial years 2016/17 to 2018/19), which resulted in 2,217 complete-case observations (facilities per year), covering about 80% of the sector.

Table 15. Variables included in the construction of the composite quality index

Original variable (original format)	Donabedian framework	Financial years	Construction of the composite quality index	
			LCA approach	Weight-based approach
ROSA high-risk medicine use (continuous)				
High sedative load (adjusted proportion) Antipsychotic use (adjusted proportion) Chronic opioid use (adjusted proportion) Antibiotics use (adjusted rate)	Outcome	3 years; 2014/15 to 2016/17	• *Original (continuous):* Adjusted proportions/ rates for all residents across 3 years • *Transformed (binary combined into* index count variable across 3 years) ranging from 0 (>95% CI 3 years) to 3 (≤95% CI 3 years)	• *Original (continuous):* Adjusted proportions and rates for all residents across 3 years
Consumer experience report (count of responses across 4 levels) [a]				
Respect (Q1) Food (Q2) Safety (Q3) Care (Q4) Explain (Q5) Follow up (Q6) Caring (Q7) Competent (Q8) Operational (Q9) Independent (Q10)	Outcome, process	3 years: 2016/17 to 2018/19	• *Transformed (one continuous): Mean item scores summed across 10 items over 3 years*	• *Transformed (ten items, continuous): Mean item scores for each of the 10 items over 3 years* [b]
Accreditation Standards (count)				
Expected outcomes not met (Standard 1) Expected outcomes not met (Standard 2) Expected outcomes not met (Standard 3) Expected outcomes not met (Standard 4)	Structure, process	2 years: 2017/18; 2018/19	• *Original (count):* Number of expected outcomes not met summed over 2 years	• *Original (count):* Number of expected outcomes not met summed over 2 years
Number of issues (count)	Outcome, Structure	3 years; 2016/18 to 2018/19	• *Transformed (continuous):* Facility size-adjusted and mean-adjusted rate of issues per RACF place averaged over 3 years. Transformed (*index*).	• *Transformed (continuous):* Facility size-adjusted rate of issues per RACF place averaged over 3 years [c]
Number of sanctions (count)	Structure	2 years: 2017/18; 2018/19	• *Original (count):* Number of sanctions summed over two years (used to assign the quality providers prior to LCA).	• *Original (count):* Facilities with sanctions in two years were used as a validation check in quality grouping.
Hospital bed days (count)	Outcome	2 years: 2017/18; 2018/19	• *Transformed (continuous):* Mean-adjusted rates of hospital bed days per occupied bed day averaged across 2 years. Excluded [d]	• *Transformed (continuous):* Mean-adjusted rates of hospital bed days per occupied bed day averaged across 2 years. Excluded [d]

CER: consumer experience report; CI: confidence interval; LCA: latent class analysis; RACF: residential aged care facility; ROSA: Registry of Senior Australians

[a] Consumer experience report (Q1–10) had four response options ranging from never to always. However, the data dictionary provided by the Royal Commission stated that Q7–10 were meant to have five response options ranging from strongly disagree to strongly agree.

[b] Due to the negative loading, the inclusion of the consumer experience report competent variable was subtracted in the composite quality index rather than being summed with the other quality indicators that had positive loadings.

[c] Mean-adjusted and (non-mean adjusted) did not impact the model.

[d] Hospital bed days variable was explored in both approaches. It was inconsistent with being a good quality indicator (see Section 5.1).

5.1.1 Method

Figure 7 shows the conceptual structure of the model, based on the results of the factor analysis. Each quality indicator consists of two parts, a combination of the influence of the latent quality level and an error component.

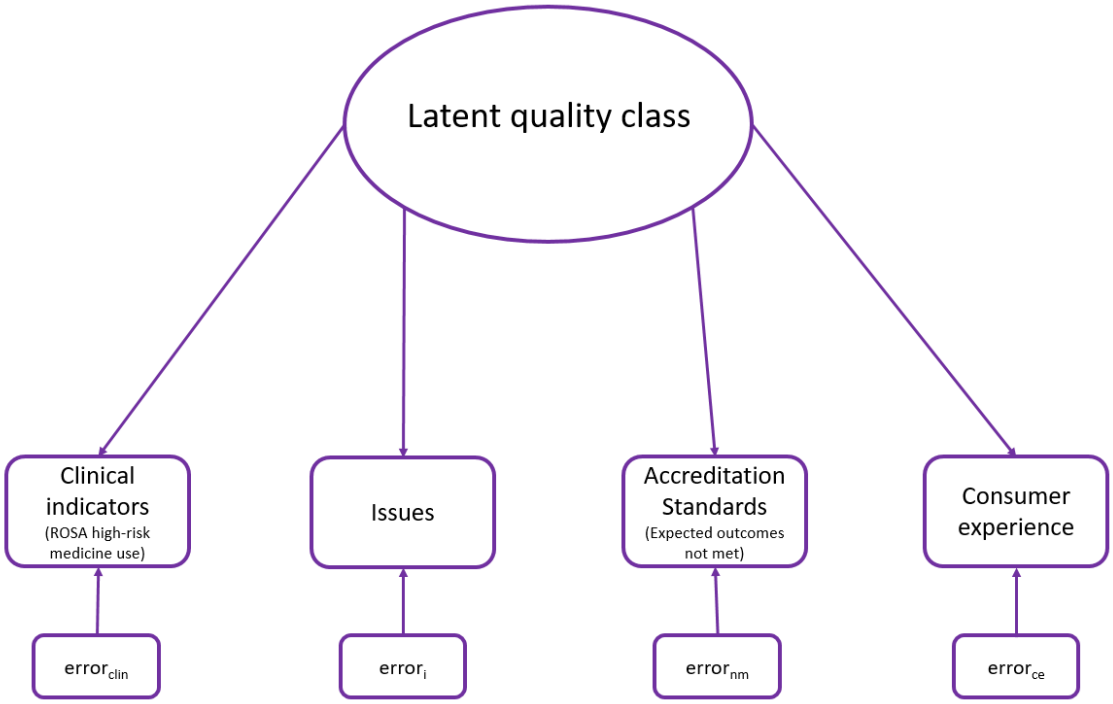


Figure 7. Conceptual diagram of the latent class model

5.1.2 Pre-testing

Before applying the latent class, facilities that had **zeros** on ALL four ROSA high-risk medicine use indicators, issues (complaints), sanctions and expected outcomes not met (accreditation standards) were assigned as the highest-quality providers according to the available quality indicators. This represented approximately 10% of all facilities. These facilities were excluded from the latent class analysis. After the construction of the composite quality index and grouping of the remaining RAC facilities, this highest-quality group of providers was added back to the sample. They represented quality level 1 (Q1).

Several models were tested starting with the ROSA high-risk medicine use variables only and sequentially adding the expected outcomes not met, issues, hospital bed days and the consumer experience report variables. Sanctions were not entered as they were highly correlated with the expected outcomes not met, loaded onto the same factor and had a much smaller count. It was decided that all facilities that had a sanction imposed during the period should be removed from the sample used for the LCA, and later on added to the lowest-quality group. At each stage, the model was assessed for fit and ability to discriminate between classes. Small standard errors of estimates indicate that the model can discriminate well on that indicator whereas higher standard errors indicate classification issues. A model was preferred when the model fit statistics (AIC, BIC) showed a better fit, the identified margins between classes were statistically significant (low standard errors) and no latent class had fewer than 5% of the facilities.

During model testing, all added variables were consistent with *a priori* expectations of direction of movement, except for hospital bed days. The inclusion of hospital bed days in the models worsened the model fit and led to very low numbers in the lower quality classes. The number of hospital bed days appeared to be slightly higher when other variables showed very high quality and lower when variables demonstrated very low quality. Given this, it was decided to remove this variable as it was not representing quality consistently.

The final model then contained seven quality variables. These were: the four *ROSA high-risk medicine use*, *expected outcomes not met*, *number of issues*, and *consumer experience report* variables. The ROSA high-risk medicine use variables were tested in two ways to determine the best fitting model, as a continuous measure and as a binary measure, where 1 represented over the 95% confidence interval (CI) for that variable.

These models were then tested from 2 to 5 classes to determine the best fit for the underlying latent class. While the model fit (AIC, BIC) was slightly better than four classes (Table 16), upon inspection, the extra class was derived from further splitting the lowest quality class (that only contained around 4% of observations) into two more classes with 2–3% and 1% of observations, respectively. This did not add any value to the analysis and it was therefore decided to use the four-class model.

Table 16. Model fit for two-class, three-class, four-class, and five-class models

Model	N	LL (model)	df	AIC	BIC
2 class	2,545	-10117.37	20	20274.73	20391.57
3 class	2,545	-9739.091	28	19534.18	19697.76
4 class	2,545	-9369.471	36	18810.94	19021.25
5 class	2,545	-9245.781	44	18579.56	18836.6

AIC: Akaike information criteria; BIC: Bayes information criteria; df: degree of freedom; LL: log likelihood; N: number of observations

Two main models were then tested. The ROSA high-risk medicine use variables were entered into the model in two different ways. Firstly, by using a binomial variable derived from the 95% CI, where 1 represented outside the upper bound of the confidence interval. Secondly, by using the provided continuous measure proportion. All other variables remained the same.

The two modelled distributions can be described as follows:

$$P(Y = y|L = c) = f((NM, I) < -poisson), f((Ro, Rs, Rap, Rab) < -logit), f\ (CER < -gaussian)$$

$$P(Y = y|L = c) = f((NM, I) < -poisson), f\ ((Ro, Rs, Rap, Rab, CER) < -gaussian)$$

5.1.3 Results

The final model consisted of four classes, using the ROSA high-risk medicine use variables as continuous variables. The use of the continuous variables allowed the identification of a group of facilities with lower high-risk medicine use which were not obvious from using the binary outcome. The latent class marginal means are given in Table 17.

It is clear that two classes (Class 1 and 2) are identified as having lower quality according to the expected outcomes not met. Classes 1 and 2 have average expected outcomes not met of 21.7 and 4.1, respectively. These classes also have a higher than average number of issues and slightly lower consumer experience report scores. The other two classes, Classes 3 and 4, have very low numbers of expected outcomes not met, with most facilities in these two classes having either 0 or 1 expected outcomes not met. Class 4 has a low use of high-risk medicines with all four ROSA high-risk medicine use variables averaging under the mean value of 1 including the confidence intervals.

Table 17. Latent class analysis marginal means (n=2,545 facilities)

	Margin	Std. Err.	z	P>|z|	95% CI
Class 1 (lower quality)					
Number of expected outcomes not met	21.709	0.714	30.400	0.000	(20.309, 23.109)
Issues (percentile)	1.591	0.130	12.260	0.000	(1.337, 1.846)
ROSA Antibiotic use (adjusted rate)	0.999	0.015	67.050	0.000	(0.970, 1.028)
ROSA Antipsychotic use (adjusted proportion)	1.015	0.030	33.400	0.000	(0.956, 1.075)
ROSA Chronic opioid use (adjusted proportion)	0.941	0.034	27.310	0.000	(0.873, 1.008)
ROSA High sedative load (adjusted proportion)	0.903	0.021	43.610	0.000	(0.862, 0.943)
CER summary score	34.384	0.164	209.210	0.000	(34.062, 34.706)
Class 2 (lower quality)					
Number of expected outcomes not met	4.128	0.383	10.790	0.000	(3.378, 4.878)
Issues (percentile)	1.361	0.082	16.570	0.000	(1.200, 1.522)
ROSA Antibiotic use (adjusted rate)	1.024	0.010	97.990	0.000	(1.004, 1.045)
ROSA Antipsychotic use (adjusted proportion)	1.026	0.022	46.930	0.000	(0.984, 1.069)
ROSA Chronic opioid use (adjusted proportion)	1.011	0.025	41.060	0.000	(0.963, 1.059)
ROSA High sedative load (adjusted proportion)	0.999	0.015	64.510	0.000	(0.968, 1.029)
CER summary score	34.105	0.127	267.660	0.000	(33.855, 34.355)
Class 3 (medium quality)					
Number of expected outcomes not met	0.153	0.016	9.440	0.000	(0.121, 0.185)
Issues (percentile)	1.096	0.024	44.920	0.000	(1.048, 1.144)
ROSA Antibiotic use (adjusted rate)	1.025	0.003	300.970	0.000	(1.019, 1.032)
ROSA Antipsychotic use (adjusted proportion)	1.057	0.008	134.080	0.000	(1.042, 1.073)
ROSA Chronic opioid use (adjusted proportion)	1.083	0.009	115.480	0.000	(1.065, 1.102)
ROSA High sedative load (adjusted proportion)	1.078	0.007	156.080	0.000	(1.064, 1.091)
CER summary score	34.890	0.041	851.530	0.000	(34.810, 34.971)
Class 4 (medium quality)					
Number of expected outcomes not met	0.285	0.045	6.390	0.000	(0.197, 0.372)
Issues (percentile)	1.098	0.069	15.870	0.000	(0.962, 1.234)
ROSA Antibiotic use (adjusted rate)	0.889	0.019	47.550	0.000	(0.853, 0.926)
ROSA Antipsychotic use (adjusted proportion)	0.742	0.025	29.600	0.000	(0.693, 0.791)
ROSA Chronic opioid use (adjusted proportion)	0.631	0.030	20.790	0.000	(0.571, 0.690)
ROSA High sedative load (adjusted proportion)	0.647	0.022	28.740	0.000	(0.603, 0.691)
CER summary score	35.470	0.122	289.820	0.000	(35.231, 35.710)

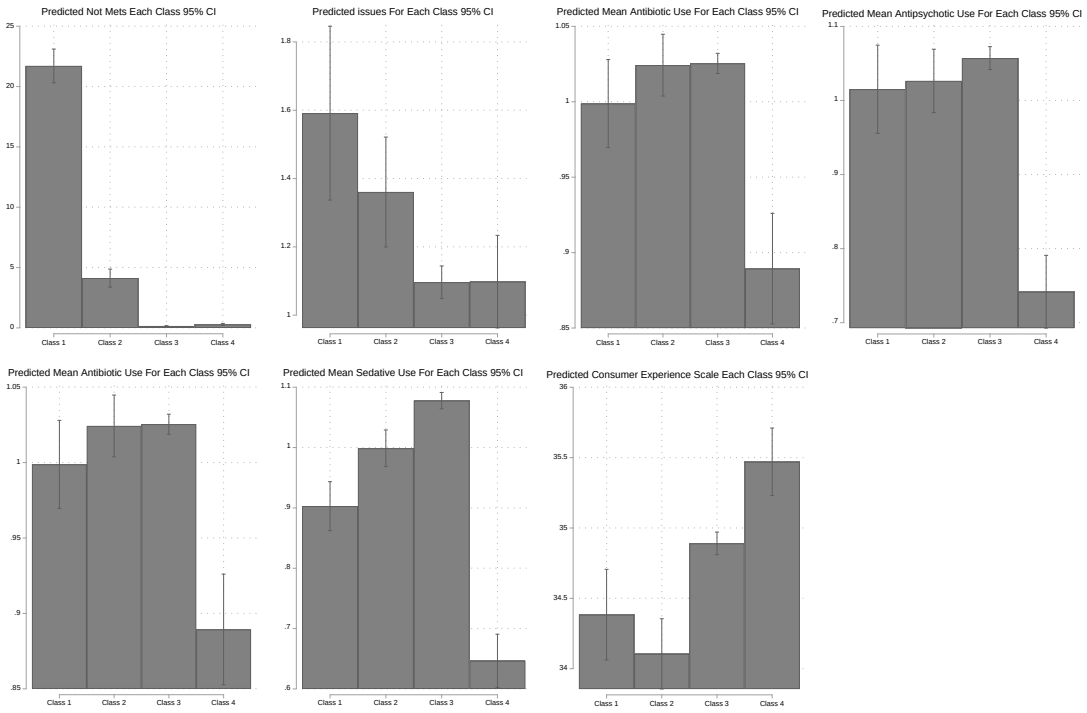
CER: consumer experience report; CI: confidence interval; ROSA: Registry of Senior Australians; Std. Err.: standard error

The difference between the four classes is summarised in Table 18 below. The four classes can be evaluated using the margins plots in Figure 8 below, using the class descriptions to guide interpretation.

Table 18. Latest class analysis level interpretation

Level	LCA class	Quality	Description of quality levels
Level 1	N/A (pre-selected before LCA analysis)	Highest quality	Four ROSA high-risk medicine use variables = 0 Number of issues = 0 Expected outcomes not met (accreditation standards) = 0 Number of sanctions = 0 CER score = 35.49 (standard deviation 1.44)
Level 2	Class 4		Four ROSA high-risk medicine use variables = lower Expected outcomes not met (accreditation standards) = lower Number of issues = lower CER score = comparable to CER score of Level 1
Level 3	Class 3		Four ROSA high-risk medicine use variables = lower Expected outcomes not met (accreditation standards) = lower Number of issues = lower CER score = moderately high
Level 4	Class 2		Expected outcomes not met (accreditation standards) = average Number of issues = high CER score = lower
Level 5	Class 1	Lowest quality	Expected outcomes not met (accreditation standards) = high Number of issues = high CER score = lower *All facilities with a sanction during the study period*

CER: consumer experience report; CI: confidence interval; LCA: latent class analysis; ROSA: Registry of Senior Australians



Abbreviation: CI: confidence interval

Figure 8. Margin plots of the latent class analysis, four-class model

Following the selection of the model, the classes were selected based on the highest predicted probability class for each facility. The probability of membership in a particular class (c) conditional on the responses given to the indicators (y) is obtained using Bayes' theorem.

$$P(L = c|Y = y) = \frac{P(Y = y|L = c)\,P(L = c)}{P(Y = y)}$$

In general, with each observed response pattern, there is a non-zero probability of belonging to a particular class so there is classification uncertainty. The average highest predicted probability for the LCA was high with a mean of 0.928 (standard deviation = 0.120; 95% CI: 0.924, 0.933). The range of values is demonstrated in Figure 9. The clustering towards 1 indicates a low probability that misclassification occurred in the model.

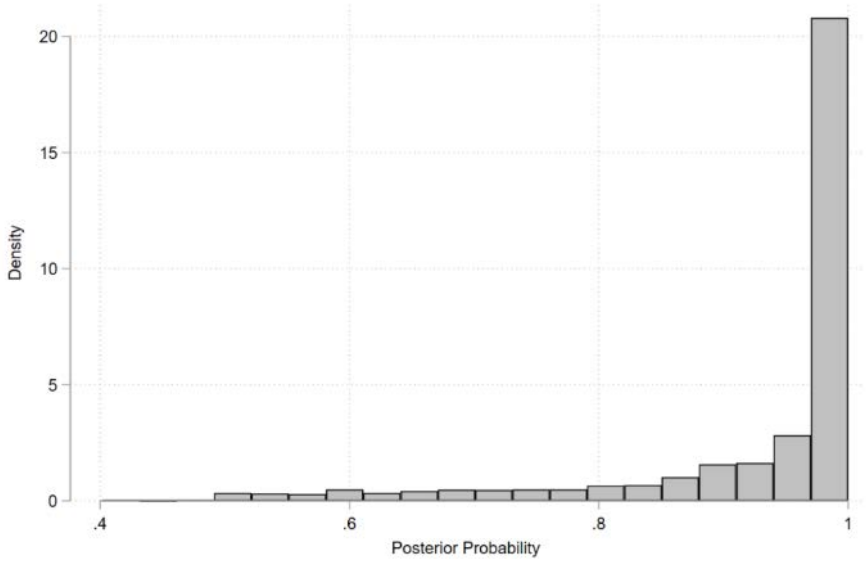


Figure 9. Predicted probability for the latent class analysis

Table 19 presents the final selected model categories. Level one represents facilities chosen *a priori* as higher quality as they did not score on any of the count quality variables.

Table 19. Final selected model categories

Level	LCA level	Frequency	Percentage
1	N/A	302	10.6%
2	4	240	8.4%
3	3	1,992	70.0%
4	2	217	7.6%
5	1	96	3.4%
Total number of facilities		**2,847**	**100%**

LCA: latent class analysis

5.1.4 Descriptive statistics of latent class analysis (LCA) composite quality index and facility characteristics

The analysis captured five levels (1 pre-specified and 4 latent classes); however, several of these levels share similar features. Levels 4 and 5 (two lowest-quality classes) were similar in every indicator apart from a difference in expected outcomes not met. However, both of these classes displayed a much higher count of expected outcomes not met than the other three levels. It was therefore considered logical to merge these two levels together. Similarly, it was difficult to interpret a true difference between Levels 2 and 3 (two middle-quality classes) which were similar on all measures apart from high-risk medicine use. For the subsequent frontier estimation analysis it was decided that three quality levels with clearly distinguishable features should be retained: Higher quality (Q1) – (Level 1); Medium quality (Q2) – (Levels 2 and 3); Lower quality (Q3) – (Levels 4 and 5).

Higher quality facilities (Q1): These facilities had an extremely low number of expected outcomes not met, low number of issues (complaints) and inappropriate high-risk medicine use, and high consumer experience report scores.

Medium quality facilities (Q2): These facilities had average to higher use of high-risk medicines. This aligns with the Australian government's focus on addressing medication-related quality of care in RAC facilities. These facilities had a relatively low number of expected outcomes not met and issues (complaints), and moderate consumer experience report scores.

Lower quality facilities (Q3): These facilities had a high number of expected outcomes not met. These facilities also had a relatively higher number of issues (complaints), and lower report scores.

Note that these results were consistent with the provider-level analysis in *Appendix B* of this report.

The number and proportion of facilities in each level of quality by service provider type are presented in Table 20. Facilities operated by government service providers had the highest proportion of facilities in the higher quality Q1 level (24%), followed by the facilities operated by non-for-profit providers (13%). Meanwhile, the for-profit facilities had a very low proportion (4%) of facilities in Q1 level. The government service providers had the lowest proportion of facilities operating at the lowest quality Q3 level (8%), closely followed by the not-for-profit facilities (10%). The for-profit providers, again, were found to have the poorest quality as indicated by the highest proportion of facilities in the lowest quality Q3 level.

Table 20. Number and proportion of facilities by quality levels and service provider type

Service provider type, n (%)	Quality levels			
	Q1	Q2	Q3	Total
Not-for-profit	207 (13%)	1,273 (78%)	162 (10%)	1,642 (100%)
For-profit	35 (4%)	793 (82%)	132 (14%)	960 (100%)
Government	60 (24%)	166 (68%)	19 (8%)	245 (100%)
Total	302 (11%)	2,232 (78%)	313 (11%)	2,847 (100%)

Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

The number and proportion of facilities in each level of quality by the size of the residential age care facility is shown in Table 21. Over 40% of the very small-sized facilities (15 places or fewer) were categorised as the highest quality level Q1. As the facilities became larger in size, the proportion of facilities in the higher quality Q1 level decreased. None of the very small-sized facilities (15 places or fewer) were in the lower quality Q3 level. None of the largest-sized facilities (over 200 places) were in the higher quality Q1 level. For lower quality Q3 facilities, the proportion of facilities increases as the size of the facility became larger, indicating a relationship between quality and size.

Table 21. Number and proportion of facilities by quality levels and facility size

	Quality levels			
Facility size	**Q1**	**Q2**	**Q3**	**Total**
1–15 places	33 (41%)	47 (59%)	0 (0%)	80 (100%)
16–30 places	66 (26%)	177 (68%)	15 (6%)	258 (100%)
31–60 places	129 (17%)	569 (75%)	57 (8%)	755 (100%)
61–120 places	63 (5%)	1,018 (83%)	150 (12%)	1,231 (100%)
121–200	11 (2%)	394 (81%)	84 (17%)	489 (100%)
Over 200 places	0 (0%)	27 (79%)	7 (21%)	34 (100%)
Total	302 (11%)	2,232 (78%)	313 (11%)	2,847 (100%)

Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

The number and proportion of facilities by quality levels and remoteness are shown in Table 22. Based on the Modified Monash Model (MMM) classification system, the majority of facilities (62%) operated in metropolitan areas (MM 1), while only 2% of facilities operated in remote and very remote regions of Australia (MM 6–7). The proportion of higher-quality facilities increased with the level of remoteness. Facilities located in remote and very remote areas had the highest proportion in Q1 (27%) and the lowest proportion in Q3 (5%).

Table 22. Number and proportion of facilities by quality levels and remoteness

Remoteness (MMM classification) [a]	Quality levels			
	Q1	**Q2**	**Q3**	**Total**
Metropolitan (MM1)	142 (8%)	1,435 (81%)	199 (11%)	1,776 (100%)
Regional (MM2)	17 (7%)	183 (80%)	28 (12%)	228 (100%)
Large rural (MM3)	20 (9%)	186 (79%)	28 (12%)	234 (100%)
Medium rural (MM4)	22 (12%)	148 (79%)	18 (10%)	188 (100%)
Small rural (MM5)	86 (24%)	242 (66%)	37 (10%)	365 (100%)
Remote (MM6)	10 (27%)	25 (68%)	2 (5%)	37 (100%)
Very remote (MM7)	5 (27%)	13 (68%)	1 (5%)	19 (100%)
Total	302 (11%)	2,232 (78%)	313 (11%)	2,847 (100%)

MMM: Modified Monash Model classification system; Q1: quality level 1; Q2: quality level 2; Q3: quality level 3
[a] The Modified Monash Model (MMM) measures the remoteness and population size on a scale of Modified Monash (MM) category MM 1 to MM 7 with MM 1 is a major city and MM 7 is very remote.

Number and proportion of facilities by facility size and remoteness are presented in Table 23. The majority facilities (70%) were operating with between 31 and 120 places. Twelve percent of facilities operated with less than 30 places, while 17% of facilities operated between 121 to 200 places. A very small proportion of facilities operated with more than 200 places (1%).

The majority of facilities (70–79%) in metropolitan to medium rural areas (MM 1–4) operated with between 31 and 120 places. Only 4–11% of facilities in metropolitan to medium rural areas (MM 1–4) were very small (less than 15 people) or small (16 to 30 places) sized facilities. By contrast, the majority of facilities in remote areas (MM 6: 62%) and most facilities in very remote areas (MM 7: 90%) were very small (less than 15 people) and small (16 to 30 places) sized facilities. Most of the very large facilities (78%) with above 121 places were located in metropolitan areas and large cities (MM 1).

Table 23. Number and proportion of facilities by facility size and remoteness

Remoteness (MMM classification) [a]	<15 places	16–30 places	31–60 places	61–120 places	121–200 places	200+ places	Total
Metropolitan (MM1)	6 (0.3%)	70 (3.9%)	446 (25.1%)	844 (47.5%)	379 (21.3%)	31 (1.8%)	1,776 (100%)
Regional (MM2)	3 (1.3%)	13 (5.7%)	47 (20.6%)	116 (50.9%)	47 (20.6%)	2 (0.9%)	228 (100%)
Large rural (MM3)	1 (0.4%)	12 (5.1%)	56 (23.9%)	125 (53.4%)	39 (16.7%)	1 (0.4%)	234 (100%)
Medium rural (MM4)	0 (0%)	20 (10.6%)	73 (38.8%)	75 (39.9%)	20 (10.6%)	0 (0%)	188 (100%)
Small rural (MM5)	51 (14.0%)	122 (33.4%)	123 (33.7%)	65 (17.8%)	4 (1.1%)	0 (0%)	365 (100%)
Remote (MM6)	8 (21.6%)	15 (40.5%)	8 (21.6%)	6 (16.2%)	0 (0%)	0 (0%)	37 (100%)
Very remote (MM7)	11 (57.9%)	6 (31.6%)	2 (10.5%)	0 (0%)	0 (0%)	0 (0%)	19 (100%)
Total	80 (3%)	258 (9%)	755 (27%)	1231 (43%)	489 (17%)	34 (1%)	2,847 (100%)

MMM: Modified Monash Model classification system; Q1: quality level 1; Q2: quality level 2; Q3: quality level 3
[a] The Modified Monash Model (MMM) measures the remoteness and population size on a scale of Modified Monash (MM) category MM 1 to MM 7 with MM 1 is a major city and MM 7 is very remote.

Number and proportion of facilities by quality levels in each state and territory are shown in Table 24. New South Wales and Victoria accounted for more than half of all facilities, followed by Queensland. The states and territories with the highest proportion of facilities in the higher quality Q1 level were located in Western Australia, followed by New South Wales and Victoria. The states and territories with the highest proportion of facilities in the lower quality Q3 level were located in Australian Capital Territory, followed by South Australia and New South Wales.

Table 24. Number and proportion of facilities by quality levels and state/territories

	Quality levels			
State/territory	Q1	Q2	Q3	Total
New South Wales	107 (12%)	683 (74%)	134 (15%)	924 (100%)
Victoria	98 (12%)	654 (82%)	47 (6%)	799 (100%)
Queensland	29 (6%)	417 (85%)	46 (9%)	492 (100%)
South Australia	24 (9%)	181 (70%)	53 (21%)	258 (100%)
Western Australia	33 (13%)	209 (82%)	13 (5%)	255 (100%)
Tasmania	8 (10%)	61 (77%)	10 (13%)	79 (100%)
Australian Capital Territory	2 (7%)	17 (61%)	9 (32%)	28 (100%)
Northern Territory	1 (8%)	10 (84%)	1 (8%)	12 (100%)
Total	302 (11%)	2,232 (78%)	313 (11%)	2,847 (100%)

Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

5.1.5 Regression analysis for associations between quality and facility characteristics

A *post-hoc* additional regression analysis was conducted to examine the relationship between quality and facility characteristics. The regression was not conducted to identify the predictors for the LCA-based composite quality index levels, but rather to investigate the association (if any) between the predicted quality levels, generated from the latent class analysis, and the facility characteristics.

An ordered logistic regression (also known as ordered logit model) is an ordinal regression model that is applied to an ordinal (ordered) response variable. The ordinal response variable is the quality of RAC facilities. The LCA-based composite quality index captured five levels of quality, including Level 1 (highest quality) to Level 5 (lowest quality). Similar to the latent class analysis, the ordered logistic regression requires the data to meet the proportional odds assumption that the relationship between each pair of outcome groups is the same.[11]

The ordered logistic regression for LCA-based composite quality index (5 quality levels) was conducted with all characteristics variables as a *whole model* and *separately* for each of the characteristics. Results of the ordered logistic regression with all the facility characteristics (N=2,813) are presented in Table 25. The model was statistically significant, as evidenced by the likelihood Chi-square statistics of 322.93 (degrees of freedom, df = 12), p=0.0000, indicating that at least one of the regression coefficients for the characteristics is not equal to zero.

In the whole characteristics model, ***facility size*** had a significant association with quality. As quality was coded as Level 1 (highest quality) to Level 5 (lowest quality), the results indicate a significant negative relationship (p=0.000), such that smaller-sized facilities were associated with higher quality (i.e. lower LCA index level). When regressed separately with quality, similar results for the *facility size* were found. These results are in line with the descriptive statistics above, which showed the proportion of higher-quality facilities increased as the facility size becomes smaller.

In the whole characteristics model, ***remoteness*** was not found to be associated with quality. When regressed separately with quality, *remoteness* had a significant positive association with quality, such that more remote areas were associated with higher quality (i.e. lower LCA index level) (coefficient = -0.182, p=0.000). These results are in line with the descriptive statistics above, which showed the proportion of higher-quality facilities increased with the level of remoteness.

Regarding ***provider types***, when compared with *not-for-profit* as the base, the *for-profit* provider had a significant association with quality and increases the likelihood of having a lower quality (i.e. higher LCA index level) compared with their not-for-profit counterparts. The government providers, on the other hand, were not significantly associated with quality when compared with their counterparts. However, when regressed separately with quality, all *provider types* had a significant association (p=0.00) with quality. When compared to not-for-profit providers, for-profit providers decrease the likelihood of having higher quality (i.e. lower LCA index level), (coefficient = 0.656, p=0.000), while government providers increase the likelihood of having a higher-quality level (coefficient = -0.458, p=0.002).

Compared with Australian Capital Territory as the base,[12] all ***states/territories*** had a significant association with quality, except for South Australia and Tasmania. Northern Territory (coefficient = -1.8), New South Wales and Western Australia (coefficients = -1.4), Victoria (coefficient = -1.3), and Queensland (coefficient = -1.1) had a likelihood of having a higher quality level (i.e. lower LCA index level). When regressed separately with quality, similar results for the states/territories were found.

In the whole characteristics model and when regressed separately, the ***number of facilities in the provider*** was not found to be associated with quality. This suggests that the number of facilities within a service provider is not associated with the latent class of quality.

[11] The proportional odds assumption means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable.

[12] Australian Capital Territory as the base (which had the highest proportion of lower-quality facilities and the lowest proportion of higher-quality facilities as shown in Table 24 above.

Table 25. Ordered logistic regression with all facility characteristics (N=2,813)

Ordered logistic regression, LCA index (5 quality levels)				***Number of obs***	***= 2,813***
				LR chi2(12)	***= 322.93***
				Prob > chi2	***= 0.0000***
Log likelihood = -2674.05				***Pseudo R2***	***= 0.0569***
	Coef.	**Std. Err.**	**z**	**P>|z|**	**95% CI**
Facility size	0.654	0.050	13.020	0.000	0.556 0.753
Remoteness	0.026	0.031	0.840	0.403	-0.034 0.086
Provider type (Not-for-profit as base)					
For-profit	0.478	0.096	4.980	0.000	0.290 0.665
Government	0.303	0.169	1.800	0.072	-0.028 0.633
State/territory (Australian Capital Territory as base)					
New South Wales	-1.384	0.416	-3.320	0.001	-2.200 -0.568
Northern Territory	-1.852	0.660	-2.800	0.005	-3.146 -0.558
Queensland	-1.116	0.421	-2.650	0.008	-1.942 -0.291
South Australia	-0.432	0.431	-1.000	0.316	-1.276 0.412
Tasmania	-0.832	0.481	-1.730	0.084	-1.775 0.111
Victoria	-1.292	0.419	-3.080	0.002	-2.113 -0.470
Western Australia	-1.364	0.431	-3.160	0.002	-2.209 -0.518
Number of facilities operated by provider	-0.001	0.002	-0.560	0.574	-0.005 0.003
Cut level 1	-0.904	0.462			-1.809 0.001
Cut level 2	-0.175	0.461			-1.079 0.729
Cut level 3	3.718	0.469			2.799 4.637
Cut level 4	5.018	0.475			4.087 5.949

CI: confidence interval; Coef.: ordered log-odds regression coefficient; LCA: latent class analysis; LR chi2: Likelihood Ratio Chi-squared; obs: observations; Pseudo R2: McFadden's pseudo R-squared; Std. Err.: standard error
The coefficient can be interpreted as for a one unit increase in the predictor, the response variable level (i.e. quality) is expected to change by its respective regression coefficient in the ordered log-odds scale, while the other variables in the model are held constant.

It should be noted that the above findings are possible associations only (not predictors) of RAC characteristics with the quality levels, generated from latent class analysis. Based on the findings above, **facilities with higher quality Q1 level were found to be: smaller-sized; located in remote and very remote areas; operated by the government; and located in Western Australia, New South Wales and Victoria.** Facilities with lower quality Q3 level were found to be: larger-sized; located in metropolitan, regional and large rural areas; operated by for-profit providers; and located in Australian Capital Territory. The size of the services providers (i.e. number of facilities operated by a provider) has no significant association with the level of quality.

5.2 Weight-based approach to construct a composite quality index

The weight-based approach is another possible approach for constructing a composite quality index to measure the quality of RAC facilities. The concept of a composite index constructed based on weights is to capture the multidimensionality and complexity of an issue or phenomenon by aggregating individual performance measures into a summary score (OECD, 2013). Examples of composite quality indices include the Human Development Index, Environmental Performance Index, and Quality of Life Index (OECD, 2013). In health care, the USA has developed the Centers for Medicare & Medicaid Services (CMS) star rating for hospitals as well as nursing homes based on a composite index (Centers for Medicare & Medicaid Services, 2020).

The method used to undertake the weight-based approach is from the OECD handbook on constructing a composite index (OECD, 2008). Technically, the composite index constructed with weights is a mathematical combination (or aggregation) of a set of indicators:

$$I = \sum_{i=1}^{n} w_i x_i$$

where x_i is the normalised variable, and w_i is the weight attached to x_i ($\sum_{i=1}^{n} w_i = 1 \; and \; 0 \leq w_i \leq 1, i = 1, 2, \ldots, n.$) (OECD, 2008).

Conceptually, a composite index is constructed based on various sub-indicators which have no common meaningful unit of measurement and there is no obvious way of weighting these sub-indicators. Constructing a composite index is a process of grouping, (and/or) transforming, normalising, weighting and aggregating various indicators with different units and measurements. Among these steps, normalisation and weighting are the most technically important steps.

The composite quality index using a weight-based approach was constructed in two main steps:
(i) normalisation of all selected and/or transformed variables listed in Table 15, and (ii) aggregating normalised variables with weights.

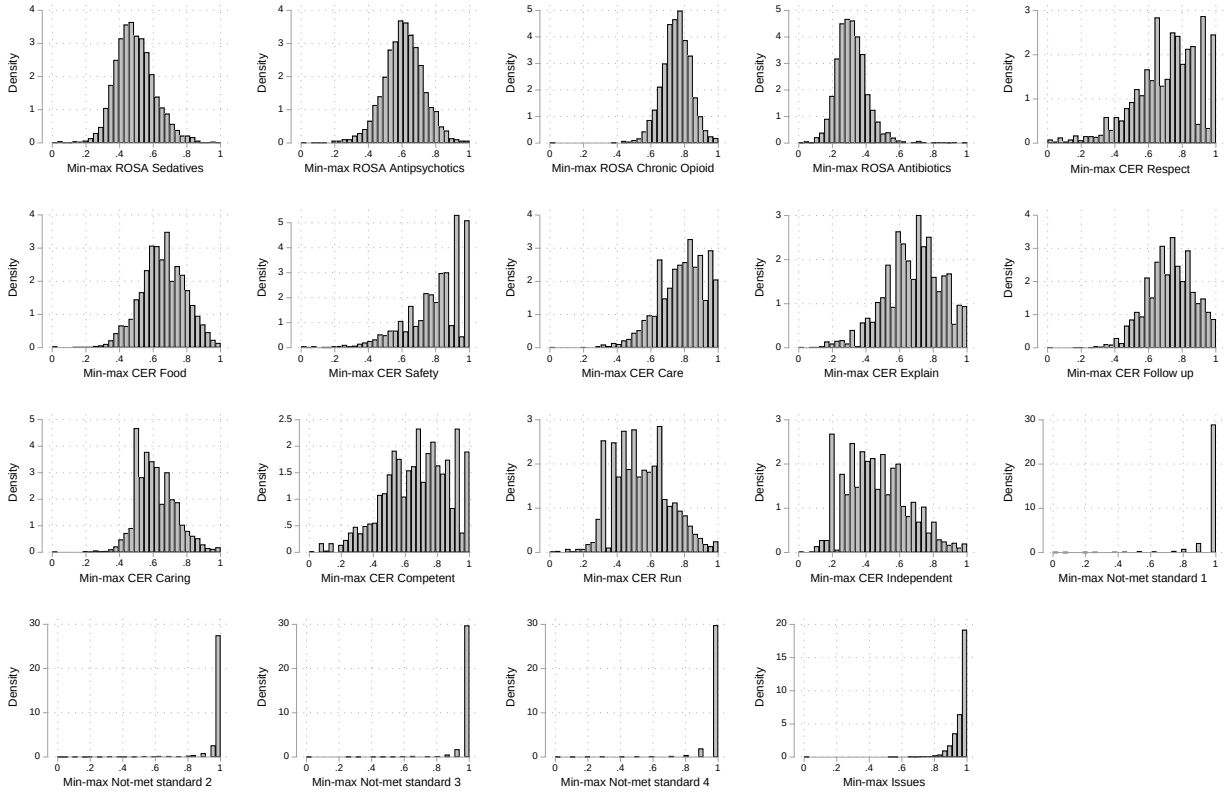
5.2.1 Normalisation

Two commonly-used normalisation methods, min-max and z-score, were used to normalise the selected original or transformed variables. Normalised values have positive polarity (i.e. higher values indicate higher quality).

5.2.1.1 Min-max normalisation

Min-max nominalisation provides an identical range, from 0 to 1, for all variables[13] (see Figure 10). Min-Max normalisation is used by subtracting the minimum from the variable and dividing by the range of the variable value [max-min]. Note that the min-max normalisation can potentially widen the range of the indicator, thus increasing the impact of the variables on the composite index.

[13] All four original ROSA risk-risk medicine use indicators were adjusted proportions or rates and were all continuous variables, ranging from 0 to 1.



Abbreviations: CER: consumer experience report; Min-max: min-max normalisation; ROSA: Registry of Senior Australians

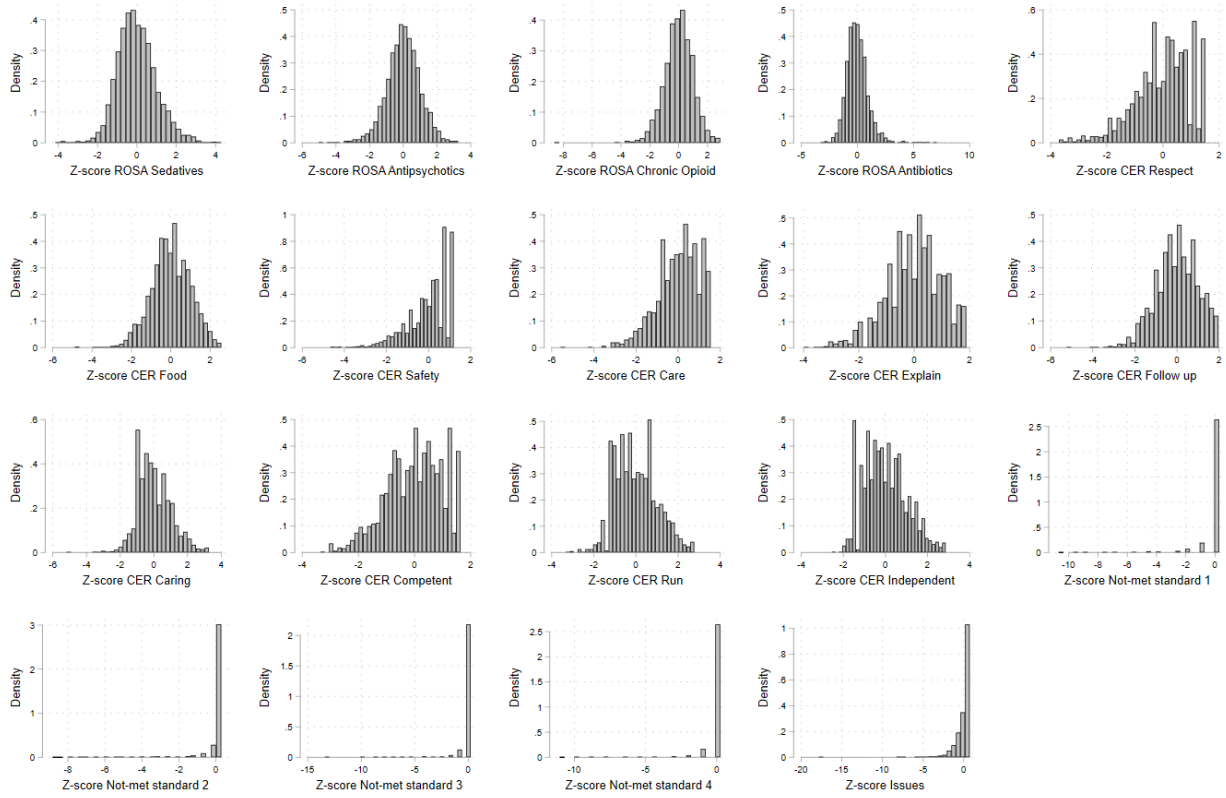
Figure 10. Min-max normalised variables converted to direction of higher value better quality

5.2.1.2 Z-score normalisation

The z-score normalisation for each variable was performed using the formulae:

$$\frac{(Raw\ score - mean)}{Standard\ deviation}$$

The observations with extreme values potentially have a greater effect on the composite index. For example, consumer experience report scores with very high values reflected many residents in the facility consistently responding with the response options at either end of the scale (i.e. ‘always’ and ‘never’). Facilities with many residents answering the 'always' will be likely to have a higher value in the composite quality index (higher quality), whereas facilities with many residents answering 'never' will have lower values in the composite quality index (lower quality). Using the z-score normalisation, all the variables are normalised to a common scale with a mean of zero and a standard deviation of one (see Figure 11).



Abbreviations: CER: consumer experience report; ROSA: Registry of Senior Australians; Z-score: z-score normalisation

Figure 11. Z-score normalised quality variables

5.2.2 Weighting

After normalisation to common units, the variables were weighted and aggregated according to (i) the underlying multidimensional framework (structure, process and outcome) proposed by Donabedian, (ii) the types of such variables (input, output, or process of quality phenomenon), and (iii) the factor analysis. Then, the correlation among the variables was considered, which can be addressed by aligning with the nature of RAC quality phenomenon or at least taken into account. The weights reflect the relative importance of the variables included that can have a significant effect on the composite index. There are a range of weighting techniques, such as statistical approaches including factor analysis and data envelopment analysis, or participatory methods including analytic hierarchy processes.

The current report used two methods for weighting: (i) the arithmetic mean (equal weights among all variables) at both the variable and factor levels, and (ii) principal component analysis. In principal components analysis (specifically factor analysis), individual variables which are collinear are grouped together to form a composite index. This allows the composite index to reflect statistical dimensions rather than the dimensionality in the original data. Each variable is required to have the same unit of measurement. Individual variables that have the strongest association with each factor are grouped together to account for the highest possible variation in the set of variables using the lowest number of factors.

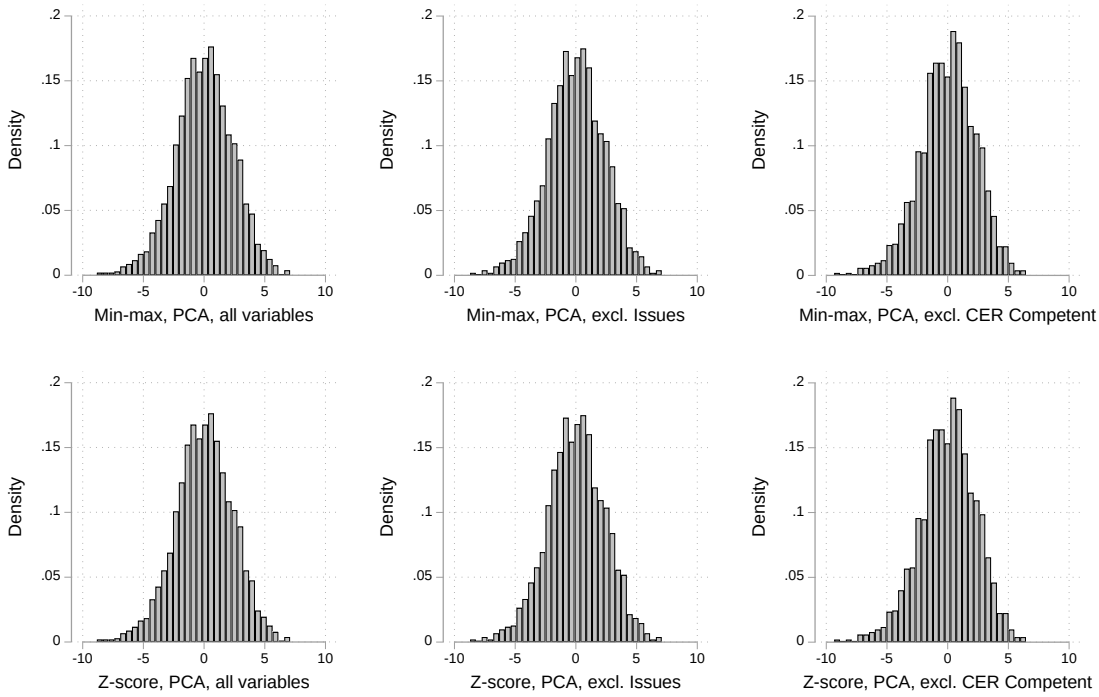
A total of 16 models were tested based on the combination of different normalisation and weighting methods as summarised in Table 26 below.

Table 26. Models used to construct the composite quality index for residential aged care facility quality

Model	Model short description	Normalisation	Weighting	Variables
M1	Min-max, PCA, all variables	Min-max	PCA	All selected variables
M2	Z-score, PCA, all variables	Z-score	PCA	All selected variables
M3	Z-score, PCA, excl. issues	Z-score	PCA	All selected variables, excluding issues
M4	Min-max, PCA, excl. CER competent	Min-max	PCA	All selected variables, excluding CER competent
M5	Min-max, PCA, excl. issues	Min-max	PCA	All selected variables, excluding issues
M6	Z-score, PCA, excl. CER competent	Z-score	PCA	All selected variables, excluding CER competent
M7	Min-max, Item arithmetic mean, all variables	Min-max	Arithmetic mean	All selected variables
M8	Z-score, Item arithmetic mean, all variables	Z-score	Arithmetic mean	All selected variables
M9	Z-score, Item arithmetic mean, excl. Issues	Z-score	Arithmetic mean	All selected variables, excluding issues
M10	Min-max, Item arithmetic mean, excl. Issues	Min-max	Arithmetic mean	All selected variables, excluding issues
M11	Min-max, Item arithmetic mean, excl. CER Competent	Min-max	Arithmetic mean	All selected variables, excluding CER competent
M12	Min-max, Factor arithmetic mean, all variables	Min-max	Arithmetic mean	Items are grouped in four factors: health outcomes, CER (Q1–6), CER (Q7–10), and accreditation (see Table 14). Composite index is aggregated from the arithmetic mean of these four factors.
M13	Z-score, Factor arithmetic mean, all variables	Z-score	Arithmetic mean	Composite index is aggregated from the arithmetic mean of the four factors.
M14	Z-score, Factor arithmetic mean, excl. issues	Z-score	Arithmetic mean	Composite index is aggregated from the arithmetic mean of the four factors. Issues are excluded.
M15	Min-max, Factor arithmetic mean, excl. issues	Min-max	Arithmetic mean	Composite index is aggregated from the arithmetic mean of the four factors. Issues are excluded.
M16	Min-max, Factor arithmetic mean, excl. CER competent	Min-max	Arithmetic mean	Composite index is aggregated from the arithmetic mean of the four factors. CER Competent is excluded.

CER: consumer experience report; excl: excluding; PCA: principal component analysis
All selected variables refers to the 19 indicators listed in Table 15, which includes ROSA high-risk medicine use (4), consumer experience report (10), expected outcomes not met (accreditation standards) (4), and issues (1).

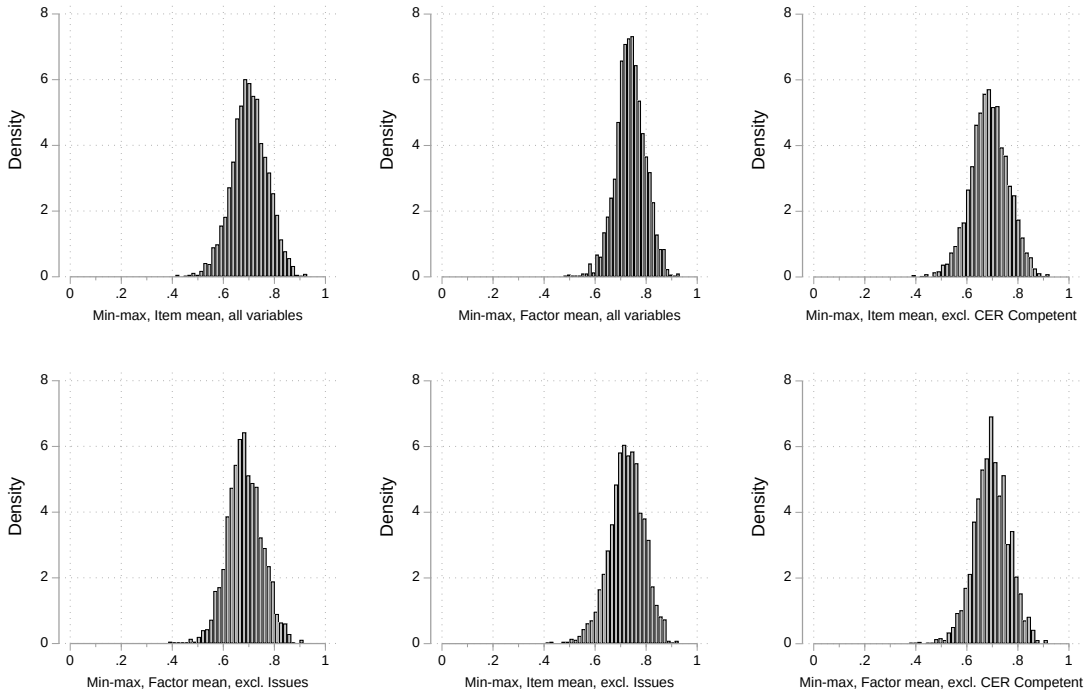
Of the 16 models, six of the models were principal component analysis-weighted (PCA-weighted) and the remaining 10 models were weighted using the arithmetic mean. The composite quality indices generated from the six PCA-weighted models were all very similar in their distribution (Figure 12). The exclusion of *issues* and/or the *consumer experience report competent variable* did not appear to affect the values created using the PCA-weighted method.



Abbreviations: CER: consumer experience report; excl: excluding; Min-max: min-max normalisation, PCA: principal component analysis; Z-score: z-score normalisation

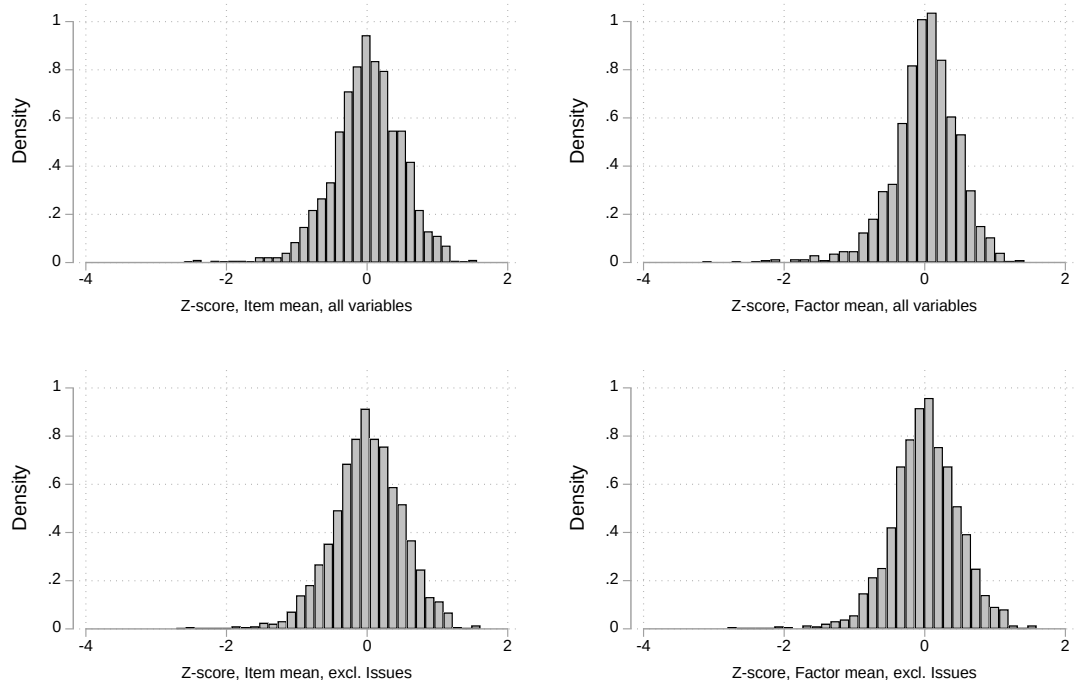
Figure 12. Histograms of composite quality indices constructed with PCA-weighted models (Models 1–6)

Of the ten 10 models weighted using the arithmetic mean models, six models were normalised using min-max (Models 7, 10–12, 15–16) and four models were normalised using z-scores (Models 8–9, 13–14). The similarity between the six min-max and four z-score normalisation models weighted using the arithmetic mean models are shown in Figure 13 and Figure 14, respectively. The distributions of the composite quality indices generated from the arithmetic-mean approach (using the factor mean) (Models 12–16) are more skewed, especially with min-max normalisation method (Model 12, 15–16). Similar to the index values created by PCA-weighted approach, the exclusion of *issues* and/or the *consumer experience report competent variable* did not affect the values created using the arithmetic-mean method.



Abbreviations: CER: consumer experience report; excl: excluding; Min-max: min-max normalisation

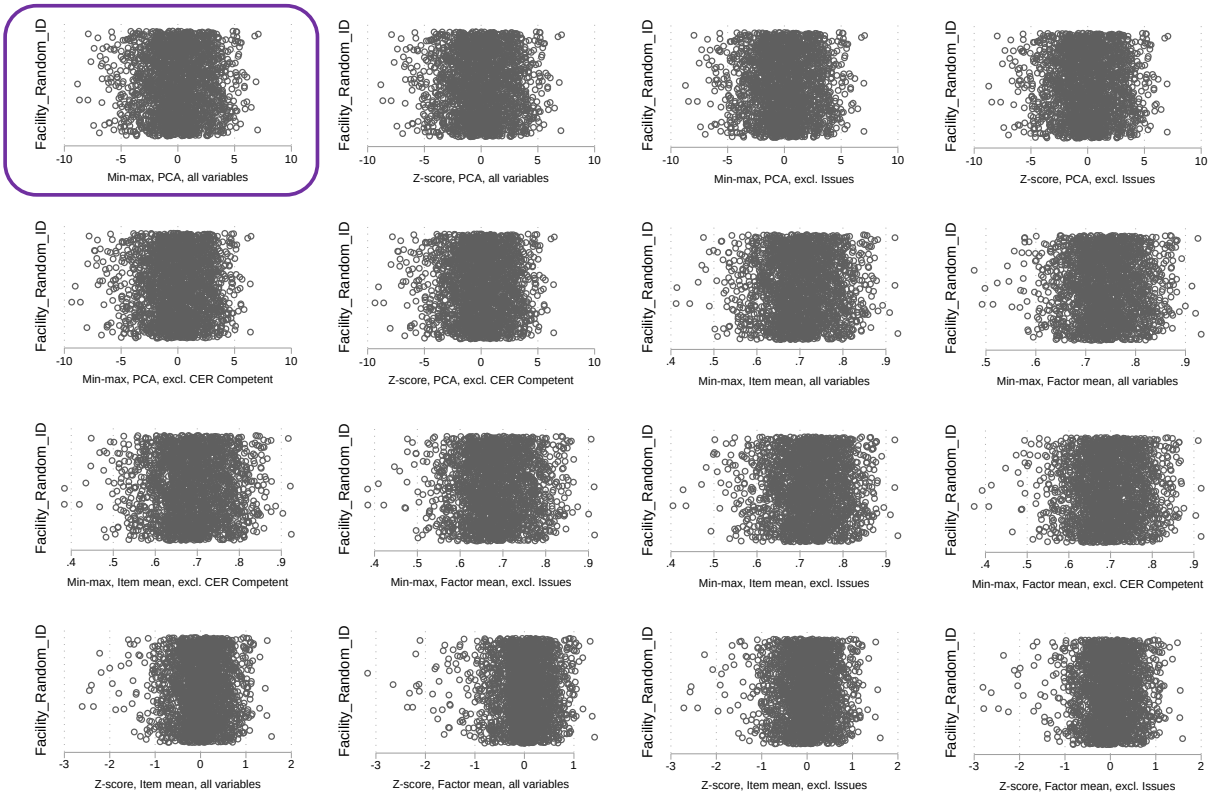
Figure 13. Histograms of composite quality index constructed with min-max normalisation and arithmetic mean aggregation (Models 7, 10–12, 15–16)



Abbreviations: excl: excluding; Z-score: z-score normalisation

Figure 14. Histograms of composite quality index constructed with z-score normalisation and arithmetic mean aggregation (Models 8–9, 13–14)

A comprehensive robustness check was conducted. The scatter plots of all composite quality indices are shown in Figure 15. All the indices created with the z-score normalisation and arithmetic-mean approach had a narrower range of values, compared to other models. Arithmetic-mean models captured a slightly wider range of values compared to PCA-based models. Within PCA-weighting models, the interchange between min-max and z-score normalisation method does not affect the resulting values.



Abbreviations: CER: consumer experience report; excl: excluding; Min-max: min-max normalisation, PCA: principal component analysis; Z-score: z-score normalisation

Figure 15. Scatter plots for composite indicators constructed

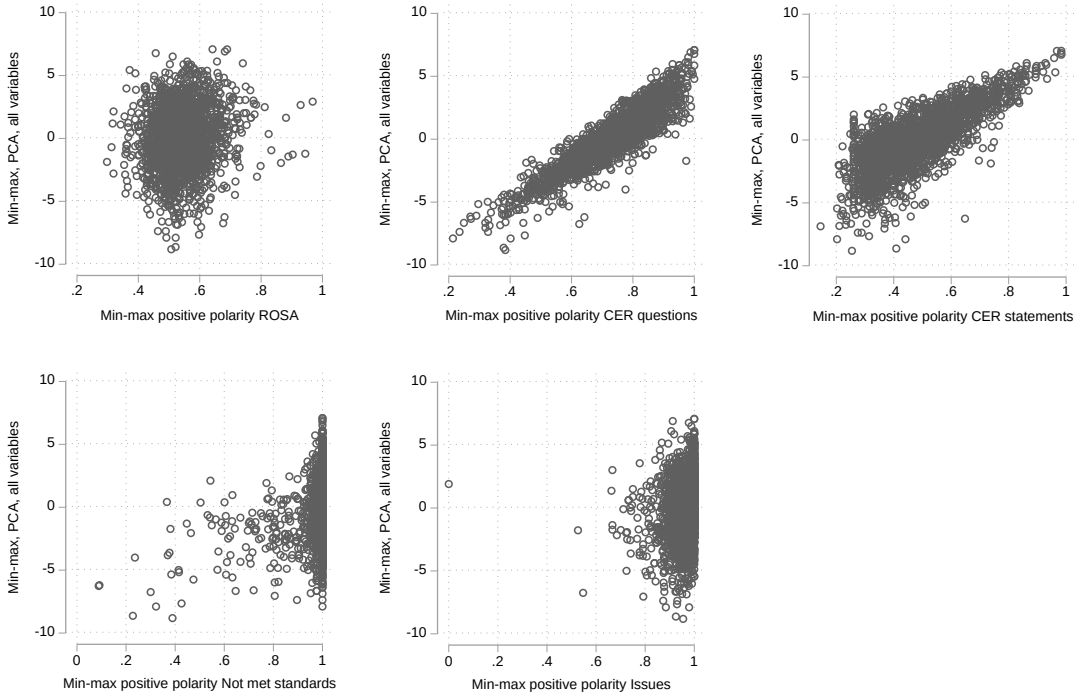
The Spearman's correlations for the 16 composite quality models are displayed in Table 27. There are very high correlations between the composite quality index results generated in the 16 models. With PCA weighting, there was no difference between two normalisation methods (min-max and z-score).

Table 27. Spearman's correlations for the composite quality models (all correlations are significant at p<0.001)

		M1	M7	M12	M15	M5	M10	M4	M11	M16	M2	M3	M8	M9	M13	M14	M6
Min-max, PCA, all variables	M1	1.00															
Min-max, Item arithmetic mean, all variables	M7	0.98	1.00														
Min-max, Factor arithmetic mean, all variables	M12	0.94	0.98	1.00													
Min-max, Factor arithmetic mean, excl. issues	M15	0.96	0.99	0.98	1.00												
Min-max, PCA, excl. issues	M5	1.00	0.98	0.93	0.96	1.00											
Min-max, Item arithmetic mean, excl. Issues	M10	0.98	1.00	0.97	0.99	0.98	1.00										
Min-max, PCA, excl. CER competent	M4	0.99	0.97	0.92	0.94	0.99	0.97	1.00									
Min-max, Item arithmetic mean, excl. CER Competent	M11	0.97	0.99	0.97	0.98	0.97	0.99	0.98	1.00								
Min-max, Factor arithmetic mean, excl. CER competent	M16	0.96	0.99	0.97	0.99	0.96	0.99	0.95	0.99	1.00							
Z-score, PCA, all variables	M2	1.00	0.98	0.94	0.96	1.00	0.98	0.99	0.97	0.96	1.00						
Z-score, PCA, excl. issues	M3	1.00	0.98	0.93	0.96	1.00	0.98	0.99	0.97	0.96	1.00	1.00					
Z-score, Item arithmetic mean, all variables	M8	0.94	0.98	0.98	0.98	0.93	0.98	0.93	0.98	0.98	0.94	0.93	1.00				
Z-score, Item arithmetic mean, excl. Issues	M9	0.94	0.98	0.97	0.99	0.94	0.98	0.94	0.98	0.99	0.94	0.94	0.99	1.00			
Z-score, Factor arithmetic mean, all variables	M13	0.83	0.89	0.95	0.89	0.81	0.87	0.81	0.89	0.89	0.83	0.81	0.94	0.91	1.00		
Z-score, Factor arithmetic mean, excl. issues	M14	0.90	0.96	0.96	0.98	0.90	0.96	0.90	0.96	0.98	0.90	0.90	0.99	0.99	0.91	1.00	
Z-score, PCA, excl. CER competent	M6	0.99	0.97	0.92	0.94	0.99	0.97	1.00	0.98	0.95	0.99	0.99	0.93	0.94	0.81	0.90	1.00

CER: consumer experience report; excl: excluding; Min-max: min-max normalisation, PCA: principal component analysis; Z-score: z-score normalisation

Model 1 (with min-max normalisation for positive polarity, PCA-weighted method, all variables included) was found to be the preferred model and was selected to generate the composite quality index. The PCA-weighted method exploited the data correlation patterns better than the arithmetic-mean approach (i.e. equal weights for all quality variables). Figure 16 shows that the weighting patterns of individual components of Model 1 are valid and reasonable.



Abbreviations: CER: consumer experience report; excl: excluding; Min-max: min-max normalisation, PCA: principal component analysis; ROSA: Registry of Senior Australians; Z-score: z-score normalisation

Figure 16. Weighting pattern of individual components (Model 1)

Based on the composite quality index generated from Model 1 (min-max normalised, PCA-weighted model), all facilities were categorised into quintiles to establish five groups ranging from Level 1 (higher quality) to 5 (lower quality). As the sanctions variable was not used to construct the composite quality index, any facility that had at least one sanction imposed at any time over the latest 2-year period (n=58 facilities)[14] was placed into the lower quality group (Level 5), regardless of the values generated in the composite quality index for those facilities.

The five levels of quality generated using the PCA-weighted approach are provided in Table 28 below. It shows that the top 20 percent of facilities are ranked as Level 1. The middle 60 percent of facilities are ranked at Level 2, 3, and 4, with an equal number (20%) in each level. The bottom 20 percent of facilities are ranked as Level 5, including all facilities with sanctions imposed in financial years 2017/18 to 2018/19.

[14] The 2-year period was across financial years 2017/18 and 2018/19.

Table 28. Frequency of residential aged care facilities grouped into five levels

Quality	PCA-weighted index	Number of facilities	Percentage
Higher quality	Level 1	427	19.97%
↕	Level 2	425	19.88%
	Level 3	418	19.55%
	Level 4	412	19.27%
Lower quality	Level 5	456 [a]	21.33%
	Total	2,138	100%

PCA: principal component analysis
[a] Facilities with sanctions imposed in financial years 2017/18 to 2018/19 were categorised as Level 5.

5.3 Correlation of the composite quality indices from the LCA-based and weight-based approaches

The comparison of the composite quality indices generated using the two approaches, the latent class analysis approach and the weight-based approach, is provided in Table 29.

Table 29. Comparison of the composite quality indices generated using the LCA-based and the weight-based approaches

		LCA-based approach					
		Higher quality ⟷ Lower quality					
PCA-weighted approach	Quality levels	Level 1	Level 2	Level 3	Level 4	Level 5	Total
Higher quality ↕ Lower quality	**Level 1**	75	65	276	10	1	**427**
	Level 2	55	43	311	13	3	**425**
	Level 3	37	27	316	34	4	**418**
	Level 4	37	30	299	34	12	**412**
	Level 5	21	13	268	94	61	**456**
	Total	**225**	**178**	**1,470**	**185**	**80**	**2,138**

LCA: latent class analysis: PCA: principal component analysis

Generally, the two approaches yielded reasonably similar results in the identification of facilities with higher and lower quality. The higher quality was represented as Level 1, and the lower quality was represented as Level 5. Of the facilities categorised as lower quality using the LCA-based approach (i.e. Level 5), 75% (61/81) of these facilities were in the lower-quality level using the weight-based approach (i.e. Level 5). For the facilities categorised as higher quality using the LCA-based approach (i.e. Level 1), the similarity is not as high, with 58% (130/225) of these facilities being in the lower quality level using the weight-based approach (i.e. Level 1). This is due to the nature of the two approaches.

The 21 facilities with highest quality (Level 1) using the LCA-based approach but lowest quality (level 5) using the with PCA-weighted approach have no common pattern in terms of their facility's characteristics such as location (11 facilities in metropolitan areas, six in outer regional areas, three in inner regional areas, 1 in remote areas) or number of peer facilities in the same providers. None of these facilities had sanctions imposed. These facilities had a very high number of expected outcomes not met which represents the underlying trait of the lowest quality level in the LCA-based approach, yet had medium to high quality according to the ROSA high-risk medicine use and consumer experience variables. While the LCA-based approach identified very high expected outcomes not met as the major trait of the lower quality group, the PCA-weighted model generated the covariance (weight) for every variable.

To investigate the relationship of interest between the two composite quality indices, an exploratory data analysis was performed by regressing the LCA-based approach level (ROSA high-risk medicine use variables as a continuous variable) on the PCA-based approach level (min-max normalisation, included both the consumer experience report competent variable and number of issues) (see Table 30).

Table 30. Linear regression between LCA class and PCA-based level index (min-max normalisation)

	PCA-based level index (min-max normalisation)
LCA class	.529 ***
	(0.03)
Constant	1.503***
	(.103)
Observations	2,138
R^2	0.0991
Adjusted R^2	0.0987
RMSE	1.3573

LCA: latent class analysis; PCA: principal component analysis: RMSE: root mean square error
Robust standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

The two composite quality indices have a significant positive association which aligns with their value labelling (i.e. Level 1 indicates higher quality and Level 5 indicates lower quality for both the LCA-based and PCA-weighted approaches). However, the fit of the model is low, only 10% of the variation in the LCA level is explained by the variance in the PCA-based level index. This is not surprising given the two approaches to developing a composite quality index are very different.

6. Summary and conclusion

This report summarises two different approaches that can be used to construct a composite quality index from any number of available quality indicators, these being latent class analysis (LCA) and principal component analysis (PCA).

Both approaches were reasonably consistent in the identification of the facilities with higher and lower quality. For the latent class analysis, a clear group of lower-quality facilities were found that had a high failure to meet accreditation standards (i.e. expected outcomes not met). These facilities also had a relatively higher number of issues and complaints, and lower consumer experience report scores.

Both approaches could not differentiate the medium level of quality for a large majority of facilities and providers. Statistically, the driver of this was the low variability in the available quality indicators (i.e. most distributions were tightly distributed around the mean, despite some skewed very long right tails). This might mean most facilities generally did not deviate much from the sector's accepted average standard of care.

Of the two approaches, the composite quality index generated from the LCA approach was chosen for the efficiency analysis. This approach was able to make use of a larger number of facilities, compared to that of the PCA approach which relied on complete cases (i.e. the PCA-approach requires all the variables to be available for each facility each year).

Quality as a categorical variable is appropriate for use in the efficiency analysis. There are two main reasons for this. First, there is no "natural unit" for quality. The composite quality index was generated from a set of quality indicators; each with its own natural units. The inclusion of a continuous variable without a natural unit makes interpretation difficult (if not meaningless). Second, most of the indicators (except for sanctions and failure to meet accreditation standards) are partial proxies or indicators of quality of care in nursing homes. Their variations might be due both to measurement errors and natural fluctuation in health and operational environment in the facility. A continuous measurement might therefore lead to spurious ranking of facilities and spurious results. This argument is strengthened further by the fact that, except for the top and bottom groups of facilities, it is challenging to clearly distinguish the qualities of facilities in the middle groups.

Limitations

The composite indicator provided in this report could be improved with data for more facilities, a wider range of quality indicators and greater consistency in how they are collected. Not all quality indicators were available for each year, and there was no single year where ALL indicators overlapped. This led us to make a trade-off decision between maximising number of facilities to be included versus the quality indicators used. A design to maximise the use of the data was implemented by combining data from different years to get one composite quality index value for each facility for the whole time period. While this approach is naturally acceptable due to the lagging effect of quality, it meant the efficiency analyses could not be done in a panel setting. In this project, a range of suggested solutions have been tested and applied to maximise the robustness and reliability of the constructed composite quality index (Barclay et al., 2019; OECD, 2008). However, when more complete and better quality data becomes available, the results may be different.

Ideally, an annual composite quality index that combines quality indicators of every three years, to reflect the lagging effect (one past year, one current year and one future year) would be developed. Quality and cost are likely to be correlated across time (intertemporal trade-off). For example, if a facility fails to meet an accreditation standard, additional spending is likely to happen in the subsequent year/s in order to improve quality. Reducing spending in one year may not affect quality immediately but may have an impact in the following year as standards are unable to be kept up over time with reduced resources. It is, therefore, essential to construct the annual composite quality index based on a stronger understanding of intertemporal movements of cost and quality (which requires longer time dimensions for each quality indicator included in the composite quality index).

As of May 2020, only five ROSA clinical outcome indicators (out of 12) covered the whole of Australia. These were derived from the national administration data (Pharmaceutical Benefits Scheme), and only related to high-risk medicine use. The other indicators, comprised of hospital-related indicators, were only available for one Australian state. Research in the literature suggests that pressure ulcers, falls and short stays in the emergency department and admitted patient care are reliable proxy indicators for quality of care in residential aged care facilities. From 1 July 2019, Australian Government-subsidised aged care facilities are mandated to collect and report on three quality indicators: pressure injuries, use of physical restraint, and unplanned weight loss (Department of Health, 2019). More quality indicators will be introduced in the future, including two new quality indicators related to falls and fractures, and medication management (PricewaterhouseCoopers Australia, 2019). The inclusion of these quality indicators, when they become available, is expected to improve the relevance and reliability of the composite quality index.

Second, the accreditation assessment was changed during the period of analysis with the introduction of unannounced visits without notice to providers to replace notified site visits from July 2018, which meant that aged care providers were no longer able to prepare and plan for scheduled visit and audits. There has been a rise in sanctions imposed on facilities over the last few years. As such, the variables might not fully reflect the quality of care in the initial three years of the study period. The arrival of coronavirus (COVID-19) has led to a policy of the re-introduction of announced visits being implemented during the pandemic which will likely have an impact on being able to use this as an indicator in the future.

Third, complaints and issues are collected centrally but the method of collection and what is recorded were not well understood. The project team had some doubt about their reliability, and whether or not this indicator was a true proxy of quality performance is RAC facilities.

Similarly, the consumer experience report survey was collected at the time of the accreditation survey. Facility's staff nominated residents who would be able to complete the survey. This may have led to selection bias towards residents who were reasonably satisfied with the care. This resulted in the exclusion of residents who could not complete the survey (due to limited capacity). However, it should be noted that the consumer experience data reasonably aligned with the expected direction and was quite consistent with the other quality indicators. Therefore, the consumer experience report data was included in the construction of the composite quality index.

In the future it is hoped that a carefully selected and well-tested set of quality indicators be collected nationally and annually, as a part of the accreditation process. The collection of such a set of quality indicators will require a standardised process and regular evaluation. This will ensure the reliability and coverage of the data. When such data becomes available across a period of time, the correlation between the constructed composite quality index can be further tested with other variables in aged care settings. This would allow a robust understanding of the quality levels and trends of the industry.

To derive a continuous measure for potential use in a star indicator system, methods for dealing with missing data rather than case deletion used in this report should be refined. Weights could be derived, either through a data-driven process, or through a stronger understanding of the relative importance of factors. For instance, preference weighting of different quality indicators could be obtained with choice experiments, or other methods such as ranking or multi-criteria decision analysis. The choice of appropriate methodology and implementation is beyond the scope of this project. Future studies on the quality of the aged care sector should test alternative quality indicators, involving stakeholders in a weighting stage, and apply alternative methods of normalisation, weighting and aggregation.

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The project team sincerely thanks the input and commitment from the steering committee on this project. Their time, expertise and valuable feedback during the project was essential to the production of this report.

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