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Dietary intake and physical activity levels of children attending Australian childcare services

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AUTHOR DECLARATION

First author JJ led the development of this manuscript. Authors JJ, RW, JW, SLY, MF, AF, TCM, JH and LW contributed to the research design and methodology. Authors CL and JJ conducted the data analyses. All the authors contributed to and approved the final version of the manuscript, and declare that the content of the manuscript has not been published elsewhere.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

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ABSTRACT

Aim: The primary aim of this study was to describe the dietary intake and physical activity levels of children while attending childcare.

Methods: A cross-sectional study was conducted with 18 centre-based childcare services in the Hunter region of New South Wales, Australia. Childcare service characteristics were assessed via telephone interview. Child dietary intake and physical activity levels were assessed during a one-day observation conducted at participating childcare services using previously validated tools.

Results: Children consumed a mean of 0.2 serves of vegetables, 0.7 serves of fruit, 1.4 serves of grain (cereal) foods, 0.1 serves of lean meat and poultry, fish, eggs, nuts and
seeds, and legumes/beans, 0.6 serves of milk, yoghurt, cheese and alternatives, and 0.7 serves of discretionary foods during attendance at childcare. Of all child physical activity counts, 48.6% were classified as ‘sedentary’, and 22.3% classified as ‘very active’. Bivariate analyses indicated that children attending services located in rural areas consumed significantly more serves of vegetables (0.3 serves (SD 0.7) versus 0.1 serves (SD 0.2), $p=0.05$). Multivariate analyses indicated that services with large child enrolments had a significantly greater proportion of child counts classified as ‘very active’ (23.6% of child counts (95% CI 1.6, 29.5) versus 14.9% of child counts (95% CI 9.1, 20.6), $p=0.007$).

**Conclusions:** There is considerable scope to improve the diet and activity behaviours of children during attendance at childcare. Future research is needed to identify effective strategies to best support childcare services in implementing policies and practices to improve such behaviours in children.

**Key words:** Childcare, healthy eating, nutrition, physical activity

**INTRODUCTION**

Poor diet and inadequate physical activity are associated with the development of a variety of chronic health conditions including type 2 diabetes, cardiovascular disease, some types of cancer, and overweight and obesity.\(^1\) Health behaviours developed in childhood track into adulthood and can influence the risk of future illness.\(^2\-^4\) As early
Childhood is a crucial period in the establishment of dietary and physical activity habits, and governments across the globe recommend intervention to support the development of healthy eating and physical activity behaviours in pre-school aged children. Centre-based childcare services represent an attractive setting to promote child healthy eating and physical activity as they provide access to a large proportion of the population for extended periods of time and accreditation processes require services to create environments that are supportive of child health. Research also suggests that there is scope to improve the dietary intake and physical activity levels of children during attendance at childcare. For example, research conducted in the United States using objective measures reports that children engage in moderate-to-vigorous physical activity for just 9% to 15% of their time at childcare, while in Australia it has been reported that children engage in 6% to 7% of time at childcare in moderate-to-vigorous physical activity. Similarly, a number of studies of childcare services conducted both internationally and within Australia, where meals are prepared and provided on-site, report that children are rarely provided with nor consume sufficient serves of vegetables in care as recommended by dietary guidelines, with discretionary foods also provided to children regularly. However, little is known about the dietary intake of children attending services where foods for child consumption are packed by parents and brought from home in a ‘lunchbox’.
Previous studies suggest that children attending services located in lower socio-economic areas may consume fewer vegetables\textsuperscript{18} and participate in less physical activity\textsuperscript{10} than those in higher socio-economic areas. However, research is required examining differences in such behaviours across other service characteristics such as service size or service location (i.e. rural or urban) that have been found to be predictive of child health behaviours in settings such as schools.\textsuperscript{20} Childcare service staff attitudes towards and actual implementation of health promoting policies and practices have also been found to differ by characteristics including service size, geographic location and socio-economic factors.\textsuperscript{21} Identifying differences in the health behaviours of children according to service characteristics would assist health policy makers to identify services that may be in most need of intervention support to improve child health behaviour, and to ensure that interventions in this setting do not exacerbate health inequities.

The primary aim of this study was to describe the dietary intake and physical activity levels of children while attending childcare in a sample of Australian childcare services where foods are brought from home. The secondary aims were to examine differences between child dietary intake and physical activity; and service characteristics including service type, size, socio-economic area and geographical location.

\textbf{METHODS}

A cross-sectional study was undertaken in centre-based childcare services in the Hunter region of New South Wales, Australia. Ethical approval to conduct the study was obtained from the Hunter New England and University of Newcastle Human Research
Ethics Committees. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines.

Centre-based childcare services within the study region that had been randomly selected and were participating in the control group arm of a broader randomised controlled trial formed the study sampling frame. Centre-based childcare services included both pre-schools and long day care services enrolling children aged from 0 to 5 years. In New South Wales, preschools provide centre-based care for between 6 and 8 hours per day and enrol children aged between 3 and 5 years. Long day care services provide centre-based care for 8 or more hours per day and usually enrol children aged from 6 weeks up to 5 years. Both types of services provide specific programmes for children aged 3 to 5 years that include educational and developmental activities to assist children in their preparation for school. Services in the study sample met the eligibility criteria of:

i. not catering exclusively for children requiring specialist care;

ii. requiring parents to pack food in a lunchbox for children to consume while at care;

and

iii. not being fully government funded (representing approximately 3% of services in the study region).

A subsample of 21 of 64 services from the control group arm (33%) was randomly selected using a random number function in Microsoft Excel and invited to participate in this study. A random sub-sample was selected so to reduce the risk of selection bias.
Nominated supervisors (service managers) at the 21 randomly selected services were contacted by a research assistant via telephone and invited to provide consent for their service to participate in the study. Consenting nominated supervisors were contacted by trained telephone interviewers between May and July 2014 to complete a computer assisted telephone interview (CATI) survey which assessed service characteristics. A one-day observation was then conducted to assess child dietary intake and physical activity levels. The observations were conducted between June and August 2014. The observations took place during the service operating period common to both pre-schools and long day care services (9am to 3pm). One of four trained observers attended each service to observe both child dietary intake and physical activity during the one-day observation. All children in the selected room were eligible for observation.

During the CATI, nominated supervisors were asked to report on: service days and hours of operation; type of service (pre-school or long day care service); postcode; number of enrolled and attending children; number of primary contact teaching staff; whether any Aboriginal and/or Torres Strait Islander children were enrolled at their service, and if so the number of children. The items used to assess service characteristics have been used in other surveys of Australian childcare services conducted by the research team. Child dietary intake (serves) for each of the five food groups listed in Australian Guide to Healthy Eating (vegetables; fruit; grain (cereal) foods; lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans; milk, yoghurt, cheese and alternatives) as well
as discretionary foods was assessed using a modified version of the validated Dietary Observation for Child Care protocol. Observers completed a 20-food certification test prior to data collection and correctly described more than 90% of items. Dietary intake was observed in three randomly selected children per service. The observer in each service visually estimated and recorded all types and portions of foods and drinks consumed by children for both the morning snack and lunch meal, along with any amounts remaining after the conclusion of each snack or meal.

Once the observation was complete, a dietitian calculated the number of serves consumed for each food group using a nutrient database and the standard serve size of the food according to the Australian Guide to Healthy Eating. Foods were categorised as discretionary using the Australian Guide to Healthy Eating with reference to the Australian Bureau of Statistics Discretionary Food List where unclear.

Child physical activity levels were assessed during the same one-day observation by the same observer, using a modified version of the validated System for Observing Play and Leisure in Youth (SOPLAY) tool and protocol. SOPLAY is a standardised instrument for assessing physical activity levels in recreational settings using systematic, momentary time sampling of a predetermined area. Prior to data collection observers were assessed using the SOPLAY DVD and correctly counted the number of people engaged in either ‘sedentary’, ‘walking’ or ‘very active’ physical activity, with between 61% and 71% accuracy. Individualised feedback was provided to observers following the assessment, including suggestions for how to improve accuracy prior to the commencement of the observations. The observers assessed the level of the physical
activity of all children occurring during each physical activity occasion (i.e. outdoor free play and structured physical activity) between 9am and 3pm by scanning and counting the number of individual children engaged in ‘sedentary’, ‘walking’ or ‘very active’ physical activity every 10 minutes for the duration of each occasion.

Statistical analyses were performed using the statistical software program SAS (version 9.3). Statistical significance was set at $p<0.05$. Descriptive statistics were used to describe the characteristics of participating childcare services; the number of serves consumed of each food group listed in the Australian Guide to Healthy Eating; the proportion (%) consumed of the daily recommended serves for each food group; and the proportion of children (counts) engaged in ‘sedentary’, ‘walking’ or ‘very active’ physical activity overall and during outdoor free play and structured physical activity.

Differences between child intake of each food group, and the following variables: service type, size, socio-economic area, and geographical location, were tested using linear regression models within a generalised estimating equation (GEE) framework to adjust for clustering within services. Separate linear regression models (unadjusted) were used for each comparison. A screening criterion of $p<0.25$ was used to determine the variables to be included in a series of multivariate models. A backwards stepwise approach was undertaken to determine the final multivariate model for each food group, with the least significant service characteristic removed and the analysis re-run until only significant variables ($p<0.05$) remained. Examination of differences between service characteristics and physical activity was conducted in the same way. However level of physical activity was dichotomised into ‘very active’ physical activity and ‘not-
very active’ physical activity (‘sedentary’ and ‘walking’ combined) given that SOPLAY observations have been shown to provide valid indicators of moderate-to-vigorous physical activity if coding is based on the proportion of children classified as ‘very active’.31

RESULTS

All 21 childcare services met the study eligibility criteria and 19 of the 21 invited services consented to participate in the study (90%). All 19 nominated supervisors completed the CATI survey and their service participated in the one-day observation. One service was excluded from the analyses as they had commenced providing on-site meals to children in the time between providing consent and when the observations were conducted.

The service characteristics of participating childcare services are described in Table 1. Almost all services (n=17, 94.4%) operated for five days per week, for an average of 9.1 hours per day. Six services were pre-schools (33.3%) and 12 were long day care services.

Fifty-four children were observed during the morning snack and lunch periods. Five children were excluded from the analyses as on the day of the observation they went home prior to the lunch meal. The dietary intake of the remaining 49 children during the observations can be seen in Table 2.2. Children consumed a mean of 0.2 serves of vegetables, 0.7 serves of fruit, 1.4 serves of grain (cereal) foods, 0.1 serves of lean meat
and poultry, fish, eggs, nuts and seeds, and legumes/beans, 0.6 serves of milk, yoghurt, cheese and alternatives and 0.7 serves of discretionary foods. Children consumed, on average, 5% of the recommended daily intake of vegetables, 49% of the recommended daily intake of fruit, 36% for grain (cereal) foods, 5% for lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans, and 32% for milk yogurt, cheese and alternatives. No child met the daily dietary recommendations for any food group.

Differences in child dietary intake by service characteristics including service type, size, socio-economic area and geographical location are also shown in Table 2. Children attending services located in rural areas consumed significantly more serves of vegetables compared to those attending services located in urban areas (0.3 serves (SD 0.7) versus 0.1 serves (SD 0.2), p=0.05). There were no significant differences in child dietary intake of any food group by any service characteristic in the multivariate analyses.

A total of 4152 SOPLAY child physical activity counts were completed across all services. Child physical activity levels during the observations can be seen in Table 3. Across all scans most child counts (48.6%) were classified as ‘sedentary’. During outdoor free play time, 19.0% of child counts were classified as ‘very active’, while during structured physical activity sessions, 34.2% of child counts were classified as ‘very active’.

Differences in child physical activity by service characteristics including service type, size, socio-economic area and geographical location can also be seen in Table 3. Services with
large child enrolments (>50 children) had a significantly greater proportion of child
counts classified as ‘very active’ compared to services with small child enrolments
(23.6% of child counts (95% CI 1.6, 29.5) versus 14.9% of child counts (95% CI 9.1, 20.6),
\( p=0.007 \)). Child physical activity also differed with service size in the multivariate
analyses with services with large child enrolments (>50 children) having a significantly
greater proportion of child counts classified as ‘very active’ compared to services with
small child enrolments. As per the bivariate analysis, the multivariate analysis found no
other differences between child physical activity and service characteristics.

DISCUSSION

This study provides valuable data regarding the current dietary intake and physical
activity levels of children attending Australian childcare services, and is one of a small
number describing actual child dietary intake in care from foods brought from home.\(^\text{32}\)
Overall the study found considerable opportunity for improvement in child dietary
intake and physical activity, especially in the consumption of vegetables (particularly in
children attending services located in urban areas) and meat and meat alternatives.
Similarly, the study found smaller services had children who were less likely to be ‘very
active’ compared to larger services. Such findings provide valuable information for
health policy makers and practitioners interested in supporting child health through
public health interventions in this setting.

Best-practice guidelines for the childcare setting recommend that children attending
care for eight hours per day consume half of their daily dietary requirements while at
During the six hour observation period of 9am to 3pm child dietary intake should account for approximately 38% of daily dietary requirements. However, levels for four of the five foods groups did not meet this proportion, with the proportion of vegetables and lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans considerably lower at 5%. Given that the usual dietary intakes of children, including foods provided at home, often do not meet nutrition guidelines, it is unlikely that children would achieve the recommended quantities of these food groups outside of care. While common eating patterns in Australia often include the highest intake of serves of meats and vegetables at the evening meal, it is unlikely that children would obtain the remaining 95% of the recommended serves of these foods in one meal. Further, children also consumed 0.7 serves of discretionary foods during the observation period. Given dietary guidelines recommend that such foods are limited, and if chosen, are only eaten sometimes and in small amounts, it is concerning that children consumed such a high amount of discretionary foods while in care. Such findings are consistent with those of previous international studies that have investigated the dietary quality of foods brought from home in a lunchbox (although not necessarily consumed). One study conducted in the United States, found that more than 80% of the sample did not provide or consume the recommended amount of vegetables, 70% did not pack or consume enough wholegrains, seafood and plant proteins, and 60% to 70% exceeded recommendations for refined grains, sodium and saturated fats. An additional study that undertook audits of Australian children’s lunchboxes also found that 60% of lunchboxes contained more than one serve of ‘extra’ or discretionary foods, with an average of 1.8 serves per lunchbox. Such findings reinforce the need for interventions
in this setting to improve child nutrition, with a particular focus on increasing vegetable 
intake and decreasing intake of discretionary foods. The provision of nutrition 
information to parents, staff monitoring of lunchboxes and enforcement of specific food 
guidelines while in care\textsuperscript{13} have been suggested as potentially effective approaches to 
achieve this objective.

The child physical activity observations indicated that approximately 22\% of child counts 
were classified as ‘very active’ (moderate-to-vigorous physical activity), while almost 
half of all child counts were classified as ‘sedentary’. These results are consistent with 
another childcare-based study that assessed child physical activity using the SOPLAY 
tool. Berg found that children attending four Canadian childcare services were engaged 
in ‘very active’ physical activity during 20\% of child counts, and 51\% of child counts were 
‘sedentary’.\textsuperscript{37} However, previous research conducted internationally and in Australia 
utilising accelerometers to measure physical activity suggests that children engage in 
moderate-to-vigorous physical activity for just 6\% to 15\% of the time spent at 
childcare.\textsuperscript{10-14} There is also evidence to suggest that observational measures of physical 
activity (for example SOPLAY) may over-estimate the amount of time children spent in 
moderate-to-vigorous physical activity.\textsuperscript{38,39} While the SOPLAY tool has been shown to 
provide valid indicators of moderate-to-vigorous physical activity,\textsuperscript{31} the use of 
accelerometers provides a more reliable and robust measure of physical activity and 
sedentary behaviours.
Children attending services located in rural areas consumed significantly more serves of vegetables (0.3 serves (SD 0.7) versus 0.1 serves (SD 0.2), \( p=0.05 \)). This finding is surprising given that populations located in such areas often experience barriers such as cost and availability in accessing fresh produce.\(^4\) However, such differences represent just 15 grams of vegetables.\(^2\) Differences of such magnitude may not be clinically meaningful. The findings also indicated that services with large child enrolments had a significantly greater proportion of child counts classified as ‘very active’. This may be due to such services having more spacious outdoor playgrounds or more portable playground equipment, both of which have been associated with increased child moderate-to-vigorous physical activity.\(^4\) However the current study did not measure these environmental characteristics and therefore cannot determine the possible impact of these on child physical activity. Regardless, the results suggest that smaller services may require additional support in implementing policies and practices to ensure that children are sufficiently active while in care.

The strengths of the study include the random selection of childcare services and children, the use of validated direct observation methods for data collection, and the assessment of actual child intake of foods brought from home. Nonetheless, several study limitations are present. Primarily, the study assessed child dietary intake and physical activity on one day only. Repeated dietary intake and physical activity observations conducted over multiple days may provide a more reliable measure of usual behaviour during attendance at childcare. The study also did not collect any demographic information from children. Such information would have aided in the
interpretation of the dietary intake data, particularly as there may be substantial
differences in intake between 3 year olds and 5 year olds for example, and between girls
and boys. Additionally, the SOPLAY tool itself does not directly assess moderate-to-
vigorous physical activity and future studies could consider using alternate objective
measures of child moderate-to-vigorous physical activity, such as accelerometers.
Further the nature of the data collected via the SOPLAY tool did not allow for comparison
against national physical activity guidelines for children. Future research should consider
assessing the dietary intake and physical activity behaviours of children attending
services that provide on-site meals to children in Australia. The use of visual observation
methods to assess the types and portions of foods and drinks consumed by children,
while based on a validated protocol, may have resulted in inaccurate estimations of child
dietary intake. Future studies should consider utilising more objective assessments of
child dietary intake such as plate waste. Finally, the study was conducted in a small
sample of childcare services from one region of New South Wales, Australia which may
limit the generalisability of the study findings.

There is considerable scope to improve the dietary intake and physical activity
behaviours of children attending centre-based childcare. Childcare services located in
urban areas and with smaller child enrolment numbers may require additional support
to implement initiatives to improve such behaviours in children. Future research is
required in order to identify effective strategies to best support childcare services in
implementing evidence-based policies and practices to improve the healthy eating and
physical activity behaviours of children.
REFERENCES


New South Wales Ministry of Health. Caring for Children Birth to 5 years (Food, Nutrition and Learning Experiences)


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Table 2: Differences in child dietary intake by service type, size, socio-economic area and geographical location

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<th>Class</th>
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<th>FRUIT (Mean (SD) serves)</th>
<th>GRAIN (CEREAL) FOODS (Mean (SD) serves)</th>
<th>LEAN MEAT AND POULTRY, FISH, EGGS, NUTS AND SEEDS, AND LEGUMES/BEANS (Mean (SD) serves)</th>
<th>MILK, YOGHURT, CHEESE AND ALTERNATIVES (Mean (SD) serves)</th>
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n=49 children, mean (SD) serves

Overall serves

Proportion (%) of daily recommendation consumed

a

b
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</table>

\(^a\) As recommended by the Australian Guide to Healthy Eating, children aged 4-8 years should consume the following number of serves of each food group per day: 4.5 serves of vegetables, 1.5 serves of fruit, 14 serves of grain (cereal) foods, 1.5 serves of lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans and 2 serves of milk, yoghurt, cheese and alternatives. Discretionary foods should be limited.

\(^b\) Includes foods high in saturated fat and/or added sugars, added salt or low in fibre, for example sweet biscuits, cakes, processed meats, confectionary, savoury pastries, potato chips.

\(^c\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 15 grams of vegetables.

\(^d\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 105 grams of fruit.

\(^e\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 1.5 slices of bread, 0.75 cup of cooked rice or pasta, or 1 cup of wheat cereal flakes.

\(^f\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 7-8 grams of cooked lean red meat or poultry.

\(^g\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 150ml milk, 24 grams of hard cheese, or 0.5 cup of yoghurt.

\(^h\) According to the standard serve sizes outlined in the Australian Guide to Healthy Eating this equates to approximately 40 grams of processed meat, 2 sweet biscuits, 28 grams of plain cake, or 28 grams of sugar confectionary.

\(^i\) Services were classified as small/large if they enrolled less/more than 50 children.

\(^j\) Service socio-economic area was determined using service postcodes classified as being in the top or bottom 50% of the state according to the Socio-economic Indices for Areas.

\(^k\) Service geographic location was classified as either urban (major city) or rural (inner regional, outer regional or remote) according to the Australian Statistical Geography Standard.
Table 3: Differences in child dietary intake by service type, size, socio-economic area and geographical location

<table>
<thead>
<tr>
<th>n=18 services</th>
<th>4152 SOPLAY CHILD COUNTS</th>
<th>% OF CHILD COUNTS (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sedentary</td>
<td>48.6 (44.9, 52.2)</td>
</tr>
<tr>
<td></td>
<td>Walking</td>
<td>29.1 (26.6, 31.7)</td>
</tr>
<tr>
<td></td>
<td>Very active</td>
<td>22.3 (18.4, 26.2)</td>
</tr>
<tr>
<td></td>
<td>Sedentary</td>
<td>50.7 (47.3, 54.1)</td>
</tr>
<tr>
<td></td>
<td>Walking</td>
<td>30.3 (27.4, 33.2)</td>
</tr>
<tr>
<td></td>
<td>Very active</td>
<td>19.0 (15.5, 22.4)</td>
</tr>
<tr>
<td></td>
<td>Sedentary</td>
<td>40.9 (30.5, 51.3)</td>
</tr>
<tr>
<td></td>
<td>Walking</td>
<td>24.9 (18.0, 31.7)</td>
</tr>
<tr>
<td></td>
<td>Very active</td>
<td>34.2 (24.4, 44.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CLASS</th>
<th>% OF CHILD COUNTS (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-school</td>
<td>24.9 (15.4, 34.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long day care</td>
<td>20.7 (15.4, 25.9)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small (&lt;50 child enrolments)</td>
<td>14.9 (9.1, 20.6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large (&gt;50 child enrolments)</td>
<td>23.6 (17.6, 29.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High (top 50% of the state)</td>
<td>24.7 (16.6, 32.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low (bottom 50% of the state)</td>
<td>21.3 (15.1, 27.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>20.1 (15.4, 24.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>23.9 (15.5, 32.4)</td>
<td></td>
</tr>
</tbody>
</table>

* Services were classified as small/large if they enrolled less/more than 50 children.
* Service socio-economic area was determined using service postcodes classified as being in the top or bottom 50% of the state according to the Socio-economic Indices for Areas.
* Service geographic location was classified as either urban (major city) or rural (inner regional, outer regional or remote) according to the Australian Statistical Geography Standard.