NOVA

University of Newcastle Research Online

nova.newcastle.edu.au

Jones, Jannah; Wyse, Rebecca; Wolfenden, Luke; Wiggers, John; Yoong, Sze L.; Finch, Meghan; Lecathelinais, Christophe; Fielding, Alison; Clinton-McHarg, Tara; Hollis, Jenna & Seward, Kirsty. "Dietary intake and physical activity levels of children attending Australian childcare services" Published in *Nutrition & Dietetics*, Vol. 74, Issue 5, pp. 446-453, (2017).

Available from: <http://dx.doi.org/10.1111/1747-0080.12375>

This is the peer reviewed version of above article, which has been published in final form at <http://dx.doi.org/10.1111/1747-0080.12375>. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions.

Accessed from: <http://hdl.handle.net/1959.13/1352782>

TITLE

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

AUTHORS

Jannah Jones BNutDiet¹⁻⁴, Rebecca Wyse PhD¹⁻⁴, John Wiggers PhD¹⁻⁴, Sze Lin Yoong PhD, APD¹⁻⁴, Meghan Finch MPH¹⁻⁴, Christophe Lecathelinais DESS de Mathématiques Appliquées^{1,3}, Alison Fielding PhD¹⁻³, Tara Clinton-McHarg PhD²⁻⁴, Jenna Hollis PhD, APD¹⁻², Kirsty Seward BNutDiet, APD¹⁻⁴, Luke Wolfenden PhD¹⁻⁴

1. Hunter New England Population Health, Wallsend, New South Wales 2287, Australia
2. School of Medicine and Public Health, University of Newcastle, Callaghan, New South Wales 2308, Australia
3. Hunter Medical Research Institute, Newcastle, New South Wales 2300, Australia
4. Priority Research Centre for Health Behaviour, University of Newcastle, Callaghan, New South Wales 2308, Australia

JJ: jannah.jones@hnehealth.nsw.gov.au

RW: rebecca.wyse@hnehealth.nsw.gov.au

JW: john.wiggers@hnehealth.nsw.gov.au

SLY: serene.yoong@hnehealth.nsw.gov.au

MF: meghan.finch@hnehealth.nsw.gov.au

CL: christophe.lecathelinais@hnehealth.nsw.gov.au

AF: alison.fielding@hnehealth.nsw.gov.au

TCM: tara.clintonmcharg@hnehealth.nsw.gov.au

JH: jenna.hollis@uon.edu.au

KS: kirsty.seward@hnehealth.nsw.gov.au

LW: luke.wolfenden@hnehealth.nsw.gov.au

Corresponding author: Jannah Jones

Hunter New England Population Health

Locked Bag 10

Wallsend, New South Wales 2287

Australia

Tel: +61 2 4924 6601

Fax: +61 2 4924 6215

Email: jannah.jones@hnehealth.nsw.gov.au

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.

FUNDING STATEMENT

The study was funded by the Australian National Preventive Health Agency with in-kind support provided by Hunter New England Population Health. The project also received infrastructure support from the Hunter Medical Research Institute (HMRI). Author LW is

supported by a NHMRC Career Development Fellowship (Grant ID: APP1128348) and Heart Foundation Future Leader Fellowship (Grant ID: 101175).

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the staff involved in collecting the data and participating childcare services.

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

1 childhood is a crucial period in the establishment of dietary and physical activity habits,
2 the World Health Organization and governments across the globe recommend
3 intervention to support the development of healthy eating and physical activity
4 behaviours in pre-school aged children.⁵

5
6 Centre-based childcare services represent an attractive setting to promote child healthy
7 eating and physical activity as they provide access to a large proportion of the population
8 for extended periods of time^{6,7} and accreditation processes require services to create
9 environments that are supportive of child health.^{8,9} Research also suggests that there is
10 scope to improve the dietary intake and physical activity levels of children during
11 attendance at childcare. For example, research conducted in the United States using
12 objective measures reports that children engage in moderate-to-vigorous physical
13 activity for just 9% to 15% of their time at childcare,¹⁰⁻¹² while in Australia it has been
14 reported that children engage in 6% to 7% of time at childcare in moderate-to-vigorous
15 physical activity^{13,14}. Similarly, a number of studies of childcare services conducted both
16 internationally and within Australia, where meals are prepared and provided on-site,
17 report that children are rarely provided with nor consume sufficient serves of vegetables
18 in care as recommended by dietary guidelines, with discretionary foods also provided to
19 children regularly.¹⁵⁻¹⁹ However, little is known about the dietary intake of children
20 attending services where foods for child consumption are packed by parents and
21 brought from home in a 'lunchbox'.

1 Previous studies suggest that children attending services located in lower socio-
2 economic areas may consume fewer vegetables¹⁸ and participate in less physical
3 activity¹⁰ than those in higher socio-economic areas. However, research is required
4 examining differences in such behaviours across other service characteristics such as
5 service size or service location (i.e. rural or urban) that have been found to be predictive
6 of child health behaviours in settings such as schools.²⁰ Childcare service staff attitudes
7 towards and actual implementation of health promoting policies and practices have also
8 been found to differ by characteristics including service size, geographic location and
9 socio-economic factors.²¹ Identifying differences in the health behaviours of children
10 according to service characteristics would assist health policy makers to identify services
11 that may be in most need of intervention support to improve child health behaviour,
12 and to ensure that interventions in this setting do not exacerbate health inequities.

13
14 The primary aim of this study was to describe the dietary intake and physical activity
15 levels of children while attending childcare in a sample of Australian childcare services
16 where foods are brought from home. The secondary aims were to examine differences
17 between child dietary intake and physical activity; and service characteristics including
18 service type, size, socio-economic area and geographical location.

20 **METHODS**

21 A cross-sectional study was undertaken in centre-based childcare services in the Hunter
22 region of New South Wales, Australia. Ethical approval to conduct the study was
23 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.^{22,23} 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.²⁴ 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.

1
2 Nominated supervisors (service managers) at the 21 randomly selected services were
3 contacted by a research assistant via telephone and invited to provide consent for their
4 service to participate in the study. Consenting nominated supervisors were contacted
5 by trained telephone interviewers between May and July 2014 to complete a computer
6 assisted telephone interview (CATI) survey which assessed service characteristics. A one-
7 day observation was then conducted to assess child dietary intake and physical activity
8 levels. The observations were conducted between June and August 2014. The
9 observations took place during the service operating period common to both pre-
10 schools and long day care services (9am to 3pm). One of four trained observers attended
11 each service to observe both child dietary intake and physical activity during the one-
12 day observation. All children in the selected room were eligible for observation.

13
14 During the CATI, nominated supervisors were asked to report on: service days and hours
15 of operation; type of service (pre-school or long day care service); postcode; number of
16 enrolled and attending children; number of primary contact teaching staff; whether any
17 Aboriginal and/or Torres Strait Islander children were enrolled at their service, and if so
18 the number of children. The items used to assess service characteristics have been used
19 in other surveys of Australian childcare services conducted by the research team.^{21,25}

20
21 Child dietary intake (serves) for each of the five food groups listed in Australian Guide
22 to Healthy Eating (vegetables; fruit; grain (cereal) foods; lean meat and poultry, fish,
23 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.²⁶ 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.²⁶

Once the observation was complete, a dietitian calculated the number of serves consumed for each food group using a nutrient database²⁷ and the standard serve size of the food according to the Australian Guide to Healthy Eating.²⁸ 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.²⁹

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.^{30,31} SOPLAY is a standardised instrument for assessing physical activity levels in recreational settings using systematic, momentary time sampling of a predetermined area.³⁰ 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

1 and poultry, fish, eggs, nuts and seeds, and legumes/beans, 0.6 serves of milk, yoghurt,
2 cheese and alternatives and 0.7 serves of discretionary foods. Children consumed, on
3 average, 5% of the recommended daily intake of vegetables, 49% of the recommended
4 daily intake of fruit, 36% for grain (cereal) foods, 5% for lean meat and poultry, fish, eggs,
5 nuts and seeds, and legumes/beans, and 32% for milk yogurt, cheese and alternatives.
6 No child met the daily dietary recommendations for any food group.

7
8 Differences in child dietary intake by service characteristics including service type, size,
9 socio-economic area and geographical location are also shown in Table 2. Children
10 attending services located in rural areas consumed significantly more serves of
11 vegetables compared to those attending services located in urban areas (0.3 serves (SD
12 0.7) versus 0.1 serves (SD 0.2), $p=0.05$). There were no significant differences in child
13 dietary intake of any food group by any service characteristic in the multivariate
14 analyses.

15
16 A total of 4152 SOPLAY child physical activity counts were completed across all services.
17 Child physical activity levels during the observations can be seen in Table 3. Across all
18 scans most child counts (48.6%) were classified as 'sedentary'. During outdoor free play
19 time, 19.0% of child counts were classified as 'very active', while during structured
20 physical activity sessions, 34.2% of child counts were classified as 'very active'.

21
22 Differences in child physical activity by service characteristics including service type, size,
23 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.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

1 childcare.³³ During the six hour observation period of 9am to 3pm child dietary intake
2 should account for approximately 38% of daily dietary requirements. However, levels
3 for four of the five foods groups did not meet this proportion, with the proportion of
4 vegetables and lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans
5 considerably lower at 5%. Given that the usual dietary intakes of children, including
6 foods provided at home, often do not meet nutrition guidelines,³⁴ it is unlikely that
7 children would achieve the recommended quantities of these food groups outside of
8 care. While common eating patterns in Australia often include the highest intake of
9 serves of meats and vegetables at the evening meal, it is unlikely that children would
10 obtain the remaining 95% of the recommended serves of these foods in one meal.
11 Further, children also consumed 0.7 serves of discretionary foods during the observation
12 period. Given dietary guidelines recommend that such foods are limited, and if chosen,
13 are only eaten sometimes and in small amounts, it is concerning that children consumed
14 such a high amount of discretionary foods while in care. Such findings are consistent
15 with those of previous international studies that have investigated the dietary quality of
16 foods brought from home in a lunchbox (although not necessarily consumed).^{32,35} One
17 study conducted in the United States, found that more than 80% of the sample did not
18 provide or consume the recommended amount of vegetables, 70% did not pack or
19 consume enough wholegrains, seafood and plant proteins, and 60% to 70% exceeded
20 recommendations for refined grains, sodium and saturated fats.³² An additional study
21 that undertook audits of Australian children's lunchboxes also found that 60% of
22 lunchboxes contained more than one serve of 'extra' or discretionary foods, with an
23 average of 1.8 serves per lunchbox.³⁶ Such findings reinforce the need for interventions

1 in this setting to improve child nutrition, with a particular focus on increasing vegetable
2 intake and decreasing intake of discretionary foods. The provision of nutrition
3 information to parents, staff monitoring of lunchboxes and enforcement of specific food
4 guidelines while in care³³ have been suggested as potentially effective approaches to
5 achieve this objective.

6
7 The child physical activity observations indicated that approximately 22% of child counts
8 were classified as 'very active' (moderate-to-vigorous physical activity), while almost
9 half of all child counts were classified as 'sedentary'. These results are consistent with
10 another childcare-based study that assessed child physical activity using the SOPLAY
11 tool. Berg found that children attending four Canadian childcare services were engaged
12 in 'very active' physical activity during 20% of child counts, and 51% of child counts were
13 'sedentary'.³⁷ However, previous research conducted internationally and in Australia
14 utilising accelerometers to measure physical activity suggests that children engage in
15 moderate-to-vigorous physical activity for just 6% to 15% of the time spent at
16 childcare.¹⁰⁻¹⁴ There is also evidence to suggest that observational measures of physical
17 activity (for example SOPLAY) may over-estimate the amount of time children spent in
18 moderate-to-vigorous physical activity.^{38,39} While the SOPLAY tool has been shown to
19 provide valid indicators of moderate-to-vigorous physical activity,³¹ the use of
20 accelerometers provides a more reliable and robust measure of physical activity and
21 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.⁴⁰ However, such differences represent just 15 grams of vegetables.²⁸ 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.⁴¹ 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

1 interpretation of the dietary intake data, particularly as there may be substantial
2 differences in intake between 3 year olds and 5 year olds for example, and between girls
3 and boys. Additionally, the SOPLAY tool itself does not directly assess moderate-to-
4 vigorous physical activity and future studies could consider using alternate objective
5 measures of child moderate-to-vigorous physical activity, such as accelerometers.
6 Further the nature of the data collected via the SOPLAY tool did not allow for comparison
7 against national physical activity guidelines for children. Future research should consider
8 assessing the dietary intake and physical activity behaviours of children attending
9 services that provide on-site meals to children in Australia. The use of visual observation
10 methods to assess the types and portions of foods and drinks consumed by children,
11 while based on a validated protocol, may have resulted in inaccurate estimations of child
12 dietary intake. Future studies should consider utilising more objective assessments of
13 child dietary intake such as plate waste. Finally, the study was conducted in a small
14 sample of childcare services from one region of New South Wales, Australia which may
15 limit the generalisability of the study findings.

16
17 There is considerable scope to improve the dietary intake and physical activity
18 behaviours of children attending centre-based childcare. Childcare services located in
19 urban areas and with smaller child enrolment numbers may require additional support
20 to implement initiatives to improve such behaviours in children. Future research is
21 required in order to identify effective strategies to best support childcare services in
22 implementing evidence-based policies and practices to improve the healthy eating and
23 physical activity behaviours of children.

1 REFERENCES

- 2 1. World Health Organization: Global strategy on diet, physical activity and health.
3 Geneva, Switzerland; 2004.
- 4 2. Jones RA, Hinkley T, Okely AD, Salmon J. Tracking physical activity and sedentary
5 behavior in childhood: a systematic review. *American J Prev Med* 2013;
6 44(6):651-658.
- 7 3. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-
8 related behaviours from childhood to adulthood: a systematic review. *Maturitas*
9 2011; 70(3):266-284.
- 10 4. Shrestha R, Copenhaver M. Long-Term Effects of Childhood Risk Factors on
11 Cardiovascular Health During Adulthood. *Clinical Med Rev Vasc Health* 2015; 7:1.
- 12 5. World Health Organization: Summary Report: Interventions on Diet and Physical
13 Activity: What Works? Geneva, Switzerland; 2009.
- 14 6. Australian Bureau of Statistics. Childhood Education and Care, Australia, June
15 2014
16 <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4402.0>
- 17 7. OECD: Enrolment in childcare and pre-schools. In OECD Family Database; 2014.
18 [[http://www.oecd.org/els/soc/PF3_2_Enrolment_in_childcare_and_preschools](http://www.oecd.org/els/soc/PF3_2_Enrolment_in_childcare_and_preschools.pdf)
19 .pdf]
- 20 8. Australian Children's Education and Care Quality Authority. National Quality
21 Framework
22 <http://www.acecqa.gov.au/national-quality-framework>

- 1 9. Kaphingst KM, French S, Story M. The role of child care settings in obesity
2 prevention. *Future Child* 2006; 16(1):143-168.
- 3 10. Henderson KE, Grode GM, O'Connell ML, Schwartz MB. Environmental factors
4 associated with physical activity in childcare centers. *Int J Behav Nutr Phys Act*
5 2015; 12(1):43.
- 6 11. Tandon PS, Saelens BE, Christakis DA. Active play opportunities at child care.
7 *Pediatrics* 2015; 135(6):e1425-e1431.
- 8 12. Olesen LG, Kristensen PL, Korsholm L, Froberg K. Physical activity in children
9 attending preschools. *Pediatrics* 2013; 132(5):e1310-e1318.
- 10 13. Sugiyama T, Okely AD, Masters JM, Moore GT. Attributes of child care centers
11 and outdoor play areas associated with preschoolers' physical activity and
12 sedentary behavior. *Environ Behav* 2012; 44(3):334-349.
- 13 14. Jones RA, Riethmuller A, Hesketh K, Trezise J, Batterham M, Okely AD. Promoting
14 fundamental movement skill development and physical activity in early
15 childhood settings: a cluster randomized controlled trial. *Pediatr Exerc Sci* 2011;
16 23(4):600-615.
- 17 15. Yoong SL, Skelton E, Jones J, Wolfenden L. Do childcare services provide foods in
18 line with the 2013 Australian Dietary guidelines? A cross-sectional study. *Aust N*
19 *Z J Public Health* 2014; 38(6):595-596.
- 20 16. Wallace R, Costello L, Devine A. Over-provision of discretionary foods at childcare
21 dilutes the nutritional quality of diets for children. *Aust N Z J Public Health* 2017.

- 1 17. Ball SC, Benjamin SE, Ward DS. Dietary intakes in North Carolina child-care
2 centers: are children meeting current recommendations? *J Am Diet Assoc* 2008;
3 108(4):718-721.
- 4 18. Gubbels JS, Raaijmakers LG, Gerards SM, Kremers SP. Dietary intake by Dutch 1-
5 to 3-year-old children at childcare and at home. *Nutrients* 2014; 6(1):304-318.
- 6 19. Erinosh T, Dixon LB, Young C, Brotman LM, Hayman LL. Nutrition practices and
7 children's dietary intakes at 40 child-care centers in New York City. *J Am Diet*
8 *Assoc* 2011; 111(9):1391-1397.
- 9 20. Nathan N, Wolfenden L, Butler M et al. Vegetable and fruit breaks in Australian
10 primary schools: prevalence, attitudes, barriers and implementation strategies.
11 *Health Ed Res* 2011; 26(4):722-731.
- 12 21. Wolfenden L, Neve M, Farrell L et al. Physical activity policies and practices of
13 childcare centres in Australia. *J Paed Child Health* 2011; 47(3):73-76.
- 14 22. Jones J, Wolfenden L, Wyse R et al. A randomised controlled trial of an
15 intervention to facilitate the implementation of healthy eating and physical
16 activity policies and practices in childcare services. *BMJ Open* 2014;
17 4(4):e005312.
- 18 23. Jones J, Wyse R, Finch M et al. Effectiveness of an intervention to facilitate the
19 implementation of healthy eating and physical activity policies and practices in
20 childcare services: a randomised controlled trial. *Implement Sci* 2015; 10(1):147.
- 21 24. Baxter J. Child care and early childhood education in Australia. Melbourne,
22 Australia: Australian Institute of Family Studies; 2015.

- 1 25. Finch M, Wolfenden L, Falkiner M et al. Impact of a population based
2 intervention to increase the adoption of multiple physical activity practices in
3 centre based childcare services: a quasi experimental, effectiveness study. *Int J*
4 *Behav Nutr Phys Act* 2012; 9(1):101.
- 5 26. Ball SC, Benjamin SE, Ward DS. Development and reliability of an observation
6 method to assess food intake of young children in child care. *J Am Diet Assoc*
7 2007; 107(4):656-661.
- 8 27. Xyris Software Inc. Foodworks 7 Professional
9 <http://www.xyris.com.au>
- 10 28. National Health and Medical Research Council. Australian Dietary Guidelines
11 [https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/n55_austr](https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/n55_australian_dietary_guidelines_130530.pdf)
12 [alian_dietary_guidelines_130530.pdf](https://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/n55_australian_dietary_guidelines_130530.pdf)
- 13 29. Australian Bureau of Statistics. Australian Health Survey. Users' guide, 2011-13 -
14 discretionary food list. Canberra, Australia; 2014.
- 15 30. McKenzie T. SOPLAY system for observing play and leisure activity in youth.
16 Description and procedures manual. San Diego, California; 2006.
- 17 31. Saint-Maurice PF, Welk G, Ihmels MA, Richards Krapfl J. Validation of the SOPLAY
18 direct observation tool with an accelerometry-based physical activity monitor. *J*
19 *Phys Act Health* 2011; 8(8):1108.
- 20 32. Romo-Palafox MJ, Ranjit N, Sweitzer SJ et al. Dietary Quality of Preschoolers' Sack
21 Lunches as Measured by the Healthy Eating Index. *J Acad Nutr Diet* 2015;
22 115(11):1779-1788.

- 1 33. New South Wales Ministry of Health. Caring for Children Birth to 5 years (Food,
2 Nutrition and Learning Experiences)
3 [http://www.healthykids.nsw.gov.au/downloads/file/teacherschildcare/CaringF](http://www.healthykids.nsw.gov.au/downloads/file/teacherschildcare/CaringForChildrenManualWEBBOOKMARKCOMPLETEmanualFeb15.pdf)
4 [orChildrenManualWEBBOOKMARKCOMPLETEmanualFeb15.pdf](http://www.healthykids.nsw.gov.au/downloads/file/teacherschildcare/CaringForChildrenManualWEBBOOKMARKCOMPLETEmanualFeb15.pdf)
- 5 34. Chai LK, Macdonald-Wicks L, Hure AJ et al. Disparities exist between the
6 Australian Guide to Healthy Eating and the dietary intakes of young children aged
7 two to three years. *Nutr Diet* 2015.
- 8 35. Sweitzer SJ, Briley ME, Robert-Gray C. Do sack lunches provided by parents meet
9 the nutritional needs of young children who attend child care? *J Am Diet Assoc*
10 2009; 109(1):141-144.
- 11 36. Kelly B, Hardy LL, Howlett S, King L, Farrell L, Hattersley L. Opening up Australian
12 preschoolers' lunchboxes. *Aust N Z J Public Health* 2010; 34(3):288-292.
- 13 37. Berg S. Children's activity levels in different playground environments: an
14 observational study in four Canadian preschools. *Early Child Educ J* 2015;
15 43(4):281-287.
- 16 38. McClain JJ, Abraham TL, Brusseau Jr TA, Tudor-Locke C. Epoch length and
17 accelerometer outputs in children: comparison to direct observation. *Med Sci*
18 *Sports Exerc* 2008; 40(12):2080-2087.
- 19 39. Hollis JL, Williams AJ, Sutherland R et al. A systematic review and meta-analysis
20 of moderate-to-vigorous physical activity levels in elementary school physical
21 education lessons. *Prev Med* 2015.
- 22 40. Burns C, Gibbon P, Boak R, Baudinette S, Dunbar J. Food cost and availability in a
23 rural setting in Australia. *Rural Remote Health* 2004; 4(311):1-9.

- 1 41. Mehtälä MAK, Sääkslahti AK, Inkinen ME, Poskiparta MEH. A socio-ecological
2 approach to physical activity interventions in childcare: a systematic review. *Int*
3 *J Behav Nutr Phys Act* 2014; 11(1):22.

1 **Table 1: Childcare service characteristics**

CHARACTERISTIC		n=18 services	
		n	%
Service operates five days per week	Yes	17	94.4
	Preschool	6	33.3
	Long day care service	12	66.7
	Small (<50 child enrolments)	3	16.7
	Large (>50 child enrolments)	15	83.3
Children of Aboriginal and/or Torres Strait Islander background	Yes	13	72.2
	High (top 50% of the state)	6	33.3
	Low (bottom 50% of the state)	12	66.7
	Urban	9	50.0
	Rural	9	50.0
		Mean	SD
Hours of operation		9.1	1.9
Number of children enrolled		85.8	52.0
Number of children of Aboriginal and/or Torres Strait Islander background enrolled		3.8	2.0
Number of primary contact teaching staff		9.5	5.9

2

3

4

5

6

7

8

9

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

		VEGETABLES	FRUIT	GRAIN (CEREAL) FOODS	LEAN MEAT AND POULTRY, FISH, EGGS, NUTS AND SEEDS, AND LEGUMES/BEANS	MILK, YOGHURT, CHEESE AND ALTERNATIVES	DISCRETIONARY FOODS ^B
		n=49 children, mean (SD) serves					
Overall serves		0.2 (0.6) ^c	0.7 (0.6) ^d	1.4 (0.8) ^e	0.1 (0.3) ^f	0.6 (0.6) ^g	0.7 (0.7) ^h
Proportion (%) of daily recommendation consumed ^a		5.0 (12.2)	49.3 (41.7)	35.5 (19.1)	5.2 (20.4)	32.1 (31.0)	N/A
Independent Variable	Class	Mean (SD) serves	p value	Mean (SD) serves	p value	Mean (SD) serves	p value
	Pre-school	0.3 (0.6)		0.7 (0.7)		1.5 (0.8)	
	Long day care	0.2 (0.5)		0.8 (0.6)		1.4 (0.7)	
	Small (<50 child enrolments)	0.6 (1.0)		0.8 (0.4)		1.6 (0.8)	
	Large (>50 child enrolments)	0.2 (0.4)		0.7 (0.7)		1.4 (0.8)	

2

Independent Variable	Class	VEGETABLES		FRUIT		GRAIN (CEREAL) FOODS		LEAN MEAT AND POULTRY, FISH, EGGS, NUTS AND SEEDS, AND LEGUMES/BEANS		MILK, YOGHURT, CHEESE AND ALTERNATIVES		DISCRETIONARY FOODS ^B	
		Mean (SD) serves	p Value	Mean (SD) serves	p Value	Mean (SD) serves	p Value	Mean (SD) serves	p Value	Mean (SD) serves	p Value	Mean (SD) serves	p Value
	High (top 50% of the state)	0.4 (0.7)		0.7 (0.6)		1.3 (0.8)		0.2 (0.5)		0.8 (0.9)		0.7 (0.7)	
	Low (bottom 50% of the state)	0.2 (0.4)		0.7 (0.7)		1.5 (0.8)		0.02 (0.1)		0.6 (0.4)		0.6 (0.5)	
	Urban	0.1 (0.2)		0.7 (0.6)		1.3 (0.7)		0.1 (0.4)		0.6 (0.5)		0.7 (0.6)	
	Rural	0.3 (0.7)		0.8 (0.7)		1.5 (0.8)		0.1 (0.2)		0.7 (0.7)		0.6 (0.7)	

^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, 4 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

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

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

^a Services were classified as small/large if they enrolled less/more than 50 children.

^b 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.

^c 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.