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Utility of a brief index to measure diet quality of Australian preschoolers in the Feeding Healthy Food to Kids Randomised Controlled Trial

Key words: Diet quality index, Preschoolers, Diet variety, Nutrient adequacy, Dietary intake, Nutrition, Child, Parent

Abstract

Aim

The aim was to evaluate the utility of a brief dietary intake assessment tool in measuring nutritional adequacy of preschoolers and differences in food and nutrient intake between quartiles stratified by overall diet quality.

Method

Dietary intakes of preschoolers (n=146) from the Feeding Healthy Food to Kids trial were reported by parent/caregiver using a 120-item food frequency questionnaire. Diet quality was assessed using the Australian Recommended Food Score for Preschoolers. Analyses were performed using Kruskal–Wallis one-way analysis of variance, adjusted for Type 1 error. Participants were grouped into quartiles by total food score for comparison of subscale scores, food groups and nutrient intakes from the food frequency questionnaire.

Results

Participants who scored less than the median total food score of 36 were more likely to have sub-optimal micronutrient intakes. Median fruit (9 vs 5, $p<0.0001$) and vegetable (14 vs 7, $p<0.0001$) subscale scores for preschoolers in the highest quartile were significantly higher than the lowest quartile, indicating much greater fruit and vegetable variety. Statistically significant differences in diet quality score by quartiles ($p<0.05$) were found for total energy and percentage energy from core foods, protein, fibre and eleven micronutrients.

Conclusion

The Australian Recommended Food Score for Preschoolers is a practical brief diet quality assessment tool to measure food variety and nutritional adequacy in Australian preschoolers. Stratifying children by baseline diet quality in future nutrition interventions is recommended in order to identify those who are likely to benefit or require more targeted approaches to address specific nutritional needs in order to optimize food and nutrient intakes.

Utility of a brief index to measure diet quality of Australian preschoolers in the Feeding Healthy Food to Kids Randomised Controlled Trial

Introduction

Childhood dietary intake in Australia is dominated by excessive intakes of energy-dense, nutrient-poor foods and beverages,^[1, 2] whereas consumption of nutrient-dense fruits and vegetables is lower than recommended.^[1-3] These dietary patterns are risk factors for obesity and chronic diseases, including type 2 diabetes, specific cancers and cardiovascular disease (CVD).^[4, 5] The adoption of healthful eating patterns in early childhood may help to prevent nutrition-related deficiencies,^[1] development of chronic diseases,^[4, 5] and improve cognitive and physical development.^[6] Dietary habits acquired in childhood can track into adulthood, and variations in diet during childhood are predictors of diet quality in adults.^[7, 8] Therefore, the age range of two to five years is crucial for the establishment of healthy dietary habits.

Interventions designed to improve dietary intake of children are predominantly targeted at promoting fruit and vegetable consumption or decreasing discretionary foods ^[3, 9] but do not account for differing baseline child dietary intake. To the authors knowledge, no Australian interventions aimed at changing diet quality of children have taken into account differences at baseline, and therefore have not addressed the specific needs of sub-groups within the target population. It is possible that the absence of more targeted nutrition interventions within the target age group is due to the population level and health promotion focus of most interventions aimed at young children [10, 11] or the absence of validated tools to quickly and easily differentiate the needs of sub-groups within the target population or intervention group.[12, 13]

The assessment of diet quality in early childhood is important but limited research exists in this younger age group of children.^[12, 14] The challenges of measuring child diet quality include potential over-reporting bias associated with food frequency questionnaires, the social desirability bias associated with parent proxy reporting ^[14] and the lack of valid and reliable tools to confidently pursue research in this age group. ^[12]

Individuals consume combinations of foods across each meal and not individual nutrients.^[14] For this reason, foods and nutrients and their overall influence on health are often summarised into diet quality indices.^[15] Evaluation of diet quality allows for the assessment of the nutrient adequacy in reference to national nutrient and/or dietary recommendations and

food variety, all of which are influenced by social determinants, lifestyle behaviours and the environment.^[16] Diet quality indices are increasingly used in practice as methods to evaluate the quality of the whole diet.^[12] A systematic review of diet quality indices in paediatric populations identified 80 different indices that have been used and applied, of which only 20% (n=17) were used in children aged two to five years, with only two of these being Australian.^[12] The majority of included papers were published within the past five years, highlighting that the application of diet quality indices in paediatric populations is a fast developing field of research. There is a need to develop diet quality scores that can be applied to younger childhood groups.

Diet quality scores assess how closely eating patterns align with National Dietary Guidelines and summarise intake into a single numeric variable.^[17] In children, associations between lower diet quality scores and poorer health-related outcomes have been identified, including higher relative weight and adiposity.^[18] The Australian Recommended Food Score for Preschoolers (ARFS-P)^[19] is a validated, food-based brief tool which focuses on food variety, diet quality and nutritional adequacy of dietary intakes of Australian children within food groups recommended in the Australian Dietary Guidelines for Children and Adolescents.^[20]

The Feeding Healthy Food to Kids (FHFK) Randomised Controlled Trial (RCT) was a community-based nutrition intervention aimed at improving the dietary patterns of children aged two to five years by using low cost technology-based education resources to provide quality nutrition information to parents/caregivers living in rural northern New South Wales (NSW), Australia.^[21] Quantitative and qualitative analysis of the FHFK RCT indicated that greater improvements were achieved by participants with poorest baseline dietary intake,^{[21,}^{22]} although no significant overall intervention effects were identified. The results of the FHFK RCT indicated the possibility of dividing an intervention cohort into groups based on baseline outcome measures, in order to ensure that the intervention is specific to the needs of each part of the cohort.^[21, 22] For example, the lowest quartile may be not be consuming enough fruit while the highest quartile may be consuming excess fruit and therefore the intervention needs within the cohort may differ. Nutrient intakes need to be analysed in conjunction with eating patterns to identify such issues and tailor interventions accordingly.

Targeting nutrition interventions to meet the needs of sub-groups within the larger population target has the potential to direct the intervention to sub-groups of people with greatest need.

Such an approach stands to maximise the impact of the intervention within the target population, and reduce duplication or waste of resources. With the advent of technology such as online surveys and device based diet diary apps, a-priori nutrition screening of dietary patterns is emerging as a more feasible means of targeting nutrition interventions.^[23] The use of dietary intake assessment tools for the purpose of targeting nutrition interventions at baseline and measuring the outcomes of such interventions is not yet being routinely applied to pediatric populations.

The aims of the current analysis were to determine the overall diet quality of preschoolers in the FHFK study as assessed by the ARFS-P, to evaluate the nutritional adequacy of preschooler's dietary intakes and to identify differences in food group and nutrient intake between quartiles stratified by overall diet quality, in order to identify those most at need of targeted nutritional advice and support.

Methods

This study is a secondary data analysis of dietary intakes from children in the Feeding Healthy Food to Kids (FHFK) prospective Randomised Controlled Trial (RCT). The detailed methods and 12-month intervention outcomes have been published elsewhere.^[21, 24] Briefly, parents of two to five year old children were recruited by dissemination of flyers by early childhood health professionals at child care facilities located in five low socioeconomic, rural areas in NSW, Australia, and reinforced with newspaper advertisements. Inclusion criteria for the FHFK study were that participants were parents aged ≥ 18 years who had at least one child aged two to five years. The study child was defined as the eldest child aged two to five years who did not have a chronic medical condition that impacted on their dietary intake.

Parents completed baseline data measures for demographic information, child dietary intake, child feeding practices and parenting style. Demographic variables collected included child age, gender, Aboriginal or Torres Strait Islander status, child care and parental age, gender and education level.

Dietary intake was assessed using the Australian Eating Survey Preschooler Version (AES-P). The AES-P is a 120-item semi-quantitative food-frequency questionnaire (FFQ). The details of this FFQ have been published elsewhere.^[25, 26] AES-P has previously been shown to provide an accurate estimate of total energy expenditure, using the doubly labelled water method, in preschoolers^[25] and the child version shown to provide a valid estimate of

specific fatty acid intakes, using red blood cell membranes ^[27] and of fruit and vegetable intakes, using plasma carotenoids. ^[28]

To assess the adequacy of nutrient intakes, the estimated daily micronutrients intakes were compared to age-specific Nutrient Reference Values (NRVs) of Recommended Dietary Intakes (RDIs) or Adequate Intakes (AIs). ^[29] Baseline dietary data of the 146 preschoolers for whom data was collected at baseline was used for the current analysis.

Diet quality scores were calculated using the ARFS-P which utilizes a subsample of 70 questions from the AES-P FFQ ^[25, 26] consistent with the 2013 Australian Dietary Guidelines ^[30] and is described in detail elsewhere. ^[13, 19] ARFS-P was modelled on the Australian Recommended Food Score (ARFS). ^[31]

The ARFS-P has a total possible score between the range of zero and 73. This includes eight food group sub-scales: Vegetables (0-21), Fruit (0-12), Meat (0-7), Meat alternatives (0-6), Grain (0-13), Dairy (0-11), Water (0-1) and Condiments (0-2). ^[31] Briefly, points are awarded for food consumed according to frequency of consumption, with healthy foods receiving bonus points (eg. 2 points for ≥ 5 nights per week meals with vegetables, 2 points if usual bread choice is multigrain or wholemeal, 2 points if usual type of milk is reduced fat milk or skim milk, or soy milk). A maximum number of points are awarded to food group sub-scales which include foods with high saturated fat contents. The meat protein group is limited to a maximum of seven points and the dairy group is limited to a maximum of 11 points. Discretionary foods do not contribute to the calculation of the diet quality score. A higher score indicates greater alignment with National Dietary Guidelines.

Participants' demographic characteristics at enrolment were analysed using descriptive statistics: mean and standard deviation for continuous variables and relative frequencies (%) for categorical variables. Shapiro Wilks Goodness of Fit tests was conducted to evaluate the normality of continuous variables (i.e. ARFS-P score, ARFS-P subscale score, energy and nutrients intake). Data was found to be not normally distributed. Descriptive statistics (medians and IQR) were used to describe the total ARFS-P score and the subscale scores. ARFS-P total scores were used to categorise 146 participants into quartiles for analysis. The non-parametric Kruskal–Wallis one-way analysis of variance (ANOVA) method was used to compare baseline diet quality scores by quartile with macronutrient intakes and with their percentage contribution to energy. The Holm Bonferroni correction was used to adjust for

type 1 error between quartiles for total ARFS-P score, ARFS-P subscale scores, total energy intake, macro and micronutrient intakes.

Descriptive statistics (medians and IQR) were used to evaluate macro- and micronutrient intakes from AES-P FFQ and were stratified by quartiles of total score for ARFS-P and compared to the NRVs. The proportion of preschoolers in each quartile who were not meeting the NRVs were calculated. Statistical significance was set at P value < 0.05. JMP software® (Version 11 SAS Institute Inc., Cary, NC, 1989-2007) was used for all data manipulation and statistical analysis.

Approval for this study was obtained from the [removed for blind peer review] Human Research Ethics Committee and the [removed for blind peer review] Human Ethics Research Committee in 2009. The trial was registered with the Australian Clinical Trials Registration in 2009, trial number ACTRN12609000356268. Written informed consent was obtained from all participants prior to their enrolment in the Feeding Healthy Food to Kids (FHFK) study.

Results

A total of 180 parent-child dyads were assessed for eligibility, with 146 meeting inclusion criteria. Demographic characteristics of the FHFK study sample are shown in Table 1. The mean age of the preschoolers was four years and 53% were male. The majority of the preschoolers (90%) were in some form of childcare, i.e. Long Day Care, Family Day Care, Preschool Care. The majority of the parents participating in the study were female, and 78% were aged 30 years or older. Forty six percent of the parents were secondary school educated and the remaining 54% were tertiary educated (Table 1).

A secondary analysis of baseline dietary data from the total population sample (n=146) was performed. Both total ARFS-P and ARFS-P subscale scores were calculated. The total ARFS-P score was then stratified into quartiles, with differences examined by quartile. Table 2 reports the ARFS-P total and subscale scores, AES-P macronutrient and micronutrient intakes and descriptive statistics (medians and IQR), by ARFS-P total score quartiles. The ARFS-P total score range was 14 to 55, with a median of 36 of the 73 possible points. As expected, the consumption of vegetables, fruit, meat, meat alternatives, grains and dairy increased as ARFS-P score increased. Preschoolers in the highest quartile had significantly higher subscale scores compared with the preschoolers in the lowest quartile for all food groups. Median subscale scores for preschoolers in the highest total ARFS-P quartile were

twice those of the lowest quartile for fruit (9 vs 5, $p<0.0001$) and vegetables (14 vs 7, $p<0.0001$).

For preschoolers in quartile four, total energy and percentage energy from core foods were significantly higher than quartile one [4385kJ (3948, 4827) vs 2983kJ (2524, 3614) $p<0.0001$] and [78% (69, 85) vs 65% (58, 74), $p<0.0001$]. Moreover, there were statistically significant differences between total ARFS-P score quartiles ($p<0.05$) for protein, fibre, thiamin, niacin equivalents, Vitamin A, Vitamin C, folate, potassium, magnesium, phosphorus, iron and zinc intakes (Table 2), indicating that higher ARFS-P scores reflect better diet quality.

Table 3 shows the NRVs for nutrients considered in this analysis and the proportion of preschoolers in each quartiles not meeting the corresponding NRVs. In quartile one and two (lower ARFS-P score) only 19% achieved the NRV for iron, 35% achieved adequate fibre intake and 51% achieved the potassium NRV. In quartile three or four (higher ARFS-P score) only 41% were meeting the iron NRV, but adequate fibre and potassium intakes were reported. In general, all participants met the corresponding NRVs for riboflavin, niacin equivalents, magnesium, phosphorus and zinc.

Discussion

The current study used a validated paediatric diet quality index, the ARFS-P^[13] to address an identified gap in the application of diet quality indices to evaluating dietary intakes of Australian pre-school aged children.^[12] The comparison of brief dietary assessment tool scores (by quartile) with ARFS-P subscale scores and AES-P food group and nutrient intakes show the value of a brief dietary quality assessment tool in reducing participant burden without compromising quality of data. The potential for secondary analysis of data from interventions related to diet quality of preschoolers is evidenced from the quartile analysis. Such analysis is applicable to current or future interventions, and indicates the potential for implementation of highly targeted nutrition strategies for sub-groups with varying nutrition priority areas.

The analysis undertaken in the current study using AES-P data indicated that the consumption of energy-dense, nutrient-poor non-core foods contributed approximately 30% of total energy intake among preschoolers aged two to five years from the FHFk cohort.^[21] This is 10% higher than the upper recommended limit for preschoolers of 20% of energy

intake set in the Australian Guide to Healthy Eating (AGTHE).^[30] This finding is consistent with the findings from the 2011-13 Australian Health Survey (AHS) in which discretionary choices were over-consumed by children. The energy contribution of 'extra' foods increased significantly with age, ranging from 30.2% for two to three year olds to 37.5% for four to eight year olds in the AHS.^[1] Similar results were shown in American children from the Feeding Infants and Toddlers Study (FITS).^[32, 33] This is a major public health concern as overconsumption of these foods has been associated with excessive weight gain and risk of chronic disease in children.^[34] Studies have shown that these foods displace more nutritious foods and cause marginal micronutrients intakes.^[35, 36]

The lower percentage of total energy from core foods in the lowest quartile compared to highest quartile in the secondary analysis provides an example of how quartile analysis at baseline could potentially be used in targeting nutrition interventions within a study population. For example, an intervention could be developed that is aimed at replacing non core bread and grain food choices with core choices by selecting breads and grain foods with higher fibre and lower sugar or salt content.

Saturated fatty acid (SFA) intakes averaging 16% of total energy were much greater than the recommended intake of less than 10%^[5, 30] of total energy. Similar to the current study, a study at South Australia found energy contributions from SFA intake were 16% among children aged one to five years and only 5% of children aged greater than two years had a SFA intake within the recommendations.^[37] Also, findings from the 2011-13 Australian Health Survey (AHS) demonstrated that SFA intake contribute approximately 13% of total energy for children aged two to eight years old.^[1] A high SFA intake is related to an increase in plasma cholesterol level^[38] and body weight in children, both of which are risk factors for cardiovascular diseases.^[39]

Sugar consumption contributed 28% of the mean daily total energy. While the Australian Dietary Guidelines indicates that intakes up to 15-20% of total energy from total sugars are compatible with a healthy diet,^[30] intakes in the current sample population were high. Our results are consistent with other nationally representative studies which reveal that preschoolers' diets consist of excessive intakes of sweetened foods such as sugar-sweetened soft drinks and fruit juices and this was associated with lower nutrient and food group intakes, thus negatively impacting on diet quality.^[40-43] There is extensive evidence indicating the association between frequent sugar consumption and higher prevalence of

dental caries in children.^[30,44] In Australia, dental caries are the second most costly diet-related disease (second to cardiovascular disease), which is all the more concerning given 90 percent of all dental diseases is preventable.^[44]

Results for sugar intake need to be interpreted with some caution as higher intakes of total sugars consumption may also be associated with fruit consumption, as opposed to added sugar consumption. In the current study, sugar consumption across the four quartiles remained relatively consistent, while fruit subscale scores for quartile four were double that of quartile one. This indicates that a higher proportion of sugar in the diet of quartile four preschoolers is likely to have come from fruit rather than added sugar sources. This finding shows the importance of having access to both food consumption and nutrient data when planning nutrition interventions. In this case, participants from the lower quartiles require interventions aimed at reducing free or added sugars, while simultaneously increasing fruit consumption.

The current analysis indicates that the ARFS-P median score for preschoolers was 36, which was higher than the previously reported Australian Child and Adolescent Recommended Food Score (ACARFS) median score of 25 for primary school (mean age 11.0, SD 1.1) children.^[13] As the ARFS-P is determined by the variety of foods from each food group rather than volume of food from each food group, this difference between preschoolers and primary school aged children could be attributable to the high percentage of preschoolers (90%) who are in formal care. Foods provided at the day care are more likely to have a wider variety in accordance to the dietary guidelines or preschoolers may generally consume smaller portions of a wider variety of healthy nutrient-dense foods.^[45]

Despite higher overall ARFS-P scores than those found amongst older children, the current study indicates that there is room for improvement in preschoolers' dietary patterns. The ARFS-P subscale scores were low compared to the total maximum points available, particularly for subscales of vegetables, fruit and whole grains, indicating a limited variety of these foods in the diet. By contrast, the preschoolers consumed excess sugar, saturated fats, and energy-dense nutrient-poor non-core foods. By increasing intake and variety of vegetables, fruit and wholegrains relative to non-core foods, energy density can be reduced, nutrient density increased, and substantial improvements in preschoolers' diet quality are therefore possible.

Preschoolers with the lowest ARFS-P scores (poorest diet quality and lowest nutrient intakes) still met the AIs except for fibre and RDIs except iron. This indicates that even those preschoolers not consuming a wide variety of nutritious food are unlikely to be deficient in most vitamins and minerals. A possible explanation for this could be that most nutrients are easily obtained from the Australian food supply.^[29] However, the NRVs were not met by the majority of preschoolers in any quartile for iron. These results are disproportionate to the prevalence rates of iron deficiency anaemia^[46] amongst Australian preschoolers, but warrant consideration in light of the negative health consequences and costs of chronic low iron intake amongst children. Iron deficiency can have extremely serious adverse effects on children's cognitive function, attention span, and memory and some of the long-term neurodevelopment and behaviour effects may be irreversible.^[47]

The Australian RDI for iron for children aged one to eight years was set by modelling the iron requirements and estimating the requirement for absorbed iron at the 97.5th centile.^[29, 30] The high degree of estimation and extrapolation may artificially raise estimated dietary iron requirements. However, if the NRV is accurate, this result indicates that promotion of haem iron-rich food sources is a high priority across the spectrum of participants in interventions aimed at improving preschooler diet quality.

The results of the current study indicate that examining diet quality subscale scores and nutritional adequacy by quartiles of total ARFS-P adds an important dimension to understanding the dietary patterns of children within study populations. The collection and analysis of both food group and nutrient information are necessary for targeting nutrition interventions as it is necessary for nutrition educators to understand the underlying dietary causes of macro and micronutrient inconsistencies with nutrient recommendations.

Future studies could target preschoolers with low diet quality for more intensive support to increase the number of serves and variety of fruit and vegetables and to displace excess non-core foods. Technologies such as smart phone apps and web-based interventions are currently being trialed in Australian nutrition interventions^[48] aimed at changing the dietary intake of children. The use of these technologies offer a feasible method of targeting interventions at baseline to meet the differing nutrition education needs of study population sub-groups.

Limitations

Results should be interpreted within the context of the study limitations. These include lack of generalisability to populations with a higher socioeconomic status or from an urban setting. The results are generalisable across parents with wide range of educational attainment levels. The preschoolers' dietary data were completed by their parent/caregiver and are therefore subjected to parental reporting bias, due to awareness of socially acceptable or desirable dietary patterns ^[49] which may not be correlated with their actual true intake. Although the FFQ and ARFS-P are validated, the high number of items in the FFQ may result in overestimation of true dietary intake. ^[22] However, the high number of items measured allows for more accurate estimation percentage contribution of foods or nutrients and provides a more accurate indication of variety for the ARFS-P.

Conclusion

The ARFS-P is a potentially useful, practical brief index to evaluate overall diet quality, food variety and nutritional adequacy of dietary intakes of Australian preschoolers. Baseline analysis of dietary outcome measures has the potential to strengthen future nutrition interventions by identifying those who may benefit from a more intensive and targeted approach and by addressing the specific dietary needs of each quartile group.

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Conflict of Interest

The authors declare that they have no competing interests.

Authorship

Authorship details are included on title page.

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Table 1: Demographic characteristics of Feeding Healthy Food to Kids study participants at baseline (n=146)

Child characteristics	Baseline (n = 146)	Parent characteristics	Baseline (n = 146)
Health		Age	
- no chronic condition	143 (98%)	- Under 30 years	32 (22%)
- health condition*	3 (2%)	- 30 years and over	114 (78%)
Child care		Education	
- in some form of care	134 (82%)	- Secondary educated	66 (46%)
- no formal care	12 (18%)	- Tertiary educated	80 (54%)
Gender		Gender	
- male	77 (53%)	- male	1 (1%)
- female	69 (47%)	- female	145 (99%)
Indigenous status		Indigenous status	
- Aboriginal	2 (3%)	- Aboriginal	3 (2%)
Neither Aboriginal or Torres Strait Islander	73 (97%)	- Neither Aboriginal or Torres Strait Islander	143 (98%)
Mean child age in years (SD)	4.02 (0.52)	SD standard deviation	n = number

*Health conditions unrelated to dietary intake

Table 2: Reported daily Australian Recommended Food Score for Pre-schoolers diet quality, macronutrient and micronutrient intakes by quartiles at baseline for Feeding Health Food to Kids study participants (n=146)

	ARFS-P Total Score Quartiles					
	Total Sample (n=146)	Quartile 1 (n=36)	Quartile 2 (n=37)	Quartile 3 (n=37)	Quartile 4 (n=36)	P-value**
AFRS-P range						
ARFS-P (Maximum possible score)	Median (25 th %, 75 th %)					
Total (73)	36 (29, 42)	25 (22, 28)	32 (31, 34)	37 (39, 41)	45 (43, 49)	<0.0001
Vegetables (21)	11 (8, 15)	7 (5, 8)	10 (8, 12)	10 (9, 13)	14 (13, 17)	<0.0001
Fruit (12)	8 (6, 9)	5 (3, 7)	5 (4, 6)	7 (5, 8)	9 (7, 10)	<0.0001
Meat (7)	2 (2, 3)	2 (1, 2)	2 (2, 3)	2 (1, 2)	3 (2, 3)	<0.0001
Meat alt. (6)	2 (1, 2)	1 (0, 1)	1 (1, 2)	2 (1, 3)	2 (2, 3)	<0.0001
Grains (13)	6 (4, 7)	3 (2, 4)	5 (4, 6)	5 (3, 6)	7 (7, 8)	<0.0001
Dairy (11)	5 (4, 6)	4 (4, 5)	5 (4, 6)	5 (4, 6)	6 (4, 7)	0.0004
Water (1)	0 (0, 1)	0 (0, 1)	0 (0, 1)	0 (0, 1)	1 (0, 1)	0.137
Condiments (2) ^(a)	2 (1, 2)	1 (1, 2)	1 (1, 2)	2 (1, 2)	2 (1, 2)	0.127
AES-P FFQ ^(b) macronutrients						
Energy (kJ/day)	5221 (4648, 6219)	4698 (4136, 5580)	5237 (4703, 6555)	5376 (4655, 6027)	5313 (5040, 6669)	0.124
Core foods ^(c,d) (kJ)	3757.5 (3129.5, 4438)	2979 (2510, 3614)	3773 (3191, 4354)	3751 (3384, 4345)	4385 (3948, 4827)	<0.0001
Core foods (%E) ^(c,d)	70.0 (63.5, 79.0)	65 (58, 74)	71 (62, 80)	70 (65, 76)	78 (69, 85)	<0.0001
Non-core foods ^(c,e) (kJ)	1486 (1089, 2086)	1549 (1146, 2190)	1523 (1096, 2203)	1506 (1271, 1942)	1258 (805, 1770)	0.286
Serves	5.0 (3.6, 7.0)	5.2 (3.8, 7.3)	5.1 (3.7, 7.3)	5 (4.3, 6.5)	4.2 (2.7, 5.9)	
Protein (g)	53.8 (47.3, 62.3)	47.5 (38.0, 52.5)	53.6 (48.5, 62.9)	55.70 (48.4, 65.3)	59.30 (53.6, 64.7)	0.0002
Total fats (g)	46.1 (37.3, 57.2)	40.7 (33.2, 49.9)	48.7 (36.5, 60.8)	46.02 (36.6, 57.1)	48.65 (42.0, 62.6)	0.074
Saturated fats (g)	23.2 (17.1, 28.3)	22.1 (16.6, 25.3)	24.2 (18.8, 28.6)	23.27 (18.0, 28.2)	23.25 (16.4, 29.1)	0.502
Carbohydrate (g)	149.7 (129.5, 176.9)	136.8 (118.7, 163.5)	147.7 (125.2, 181.2)	155.66 (139.3, 171.3)	156.12 (135.5, 189.6)	0.6637
Fibre (g)	15.3 (12.3, 18.0)	12.5 (10.2, 15.0)	14.7 (11.9, 18.6)	15.27 (12.7, 15.9)	17.91 (15.8, 21.0)	0.0017
Sugars* (g)	88.4 (73.2, 108.7)	76.1 (65.2, 97.7)	88.1 (72.9, 112.9)	89.60 (78.6, 105.6)	88.31 (78.6, 110.2)	0.5005
AES-P FFQ ^(b) micronutrients						
Thiamin (mg)	1.29 (0.99, 1.60)	1.17 (0.96, 1.52)	1.31 (0.99, 2.06)	1.34 (1.11, 1.51)	1.45 (1.01, 1.73)	0.0453
Riboflavin (mg)	2.16 (1.66, 2.61)	1.91 (1.48, 2.34)	2.12 (1.63, 2.72)	2.33 (1.84, 2.61)	2.30 (1.80, 2.64)	0.0604
Niacin equivalents (mg)	24.1 (20.9, 27.4)	21.0 (18, 23.6)	24.3 (21.4, 28.6)	24.9 (21.8, 27.3)	26.3 (22.5, 29.3)	0.0005
Vitamin C (mg)	76.5 (59.9, 99.7)	61.1 (49, 76.3)	76.3 (66.7, 86.4)	75.4 (59.5, 85.1)	102 (89.8, 116.2)	<0.0001
Dietary folate equiv. (µg)	212.4 (182.5, 254.2)	194.9 (151.4, 219.8)	208 (172.2, 290.0)	225.7 (182.6, 251)	237.7 (203.4, 284.7)	0.0011
Retinol equivalents (µg)	744.6 (603.9, 887)	604.6 (431.7, 712.6)	745.00 (620.2, 877.6)	744.2 (621.5, 890.9)	857.8 (748.0, 1082.5)	<0.0001
Sodium (mg)	1292 (1054.6, 1565.1)	1214.2 (1006.1, 1430.7)	1353.5 (1062.9, 1603.4)	1331.3 (1159, 1503.3)	1323 (1065, 1680.8)	0.2139
Potassium (mg)	2202 (1890.2, 2613.5)	1948.9 (1608.4, 2171.6)	2212.1 (1882.7, 2545.1)	2311.4 (1922.5, 2716.6)	2466.7 (1318.5, 2857.7)	<0.0001
Magnesium (mg)	227.4 (202.4, 276.3)	199.2 (173.16, 216.3)	223.9 (203.8, 253.5)	238.5 (220.9, 268.5)	267.5 (220.0, 313.1)	0.0008
Calcium (mg)	967.3 (774.0, 1170)	845.4 (674.31, 971.6)	971.4 (823.1, 1072.4)	1034.3 (832.9, 1220.7)	1108.5 (736, 1276.0)	0.0142
Phosphorus (mg)	1108.8 (900.5, 1288.5)	970.2 (728.7, 1134)	1109.0 (965.7, 1247.6)	1139.6 (947.3, 1313.7)	1168.2 (990.1, 1333.1)	0.0075
Iron (mg)	7.7 (6.2, 8.8)	6.7 (5.3, 7.8)	7.4 (5.8, 9.0)	7.9 (6.8, 8.8)	8.4 (7.3, 9.9)	0.0423
Zinc (mg)	7.4 (6.3, 8.5)	6.5 (5.4, 7.4)	7.3 (6.5, 8.6)	7.6 (6.6, 8.6)	8.0 (6.7, 8.8)	0.0008

^(a) Condiments include vegemite and tomato sauce for their nutritional properties.

^(b) AES-P FFQ, Australian Eating Survey Preschooler Version Food Frequency Questionnaire

^(c) Calculated as a percentage of total daily energy intake

^(d) Core food include breads and cereals, fruit, vegetables, dairy and alternatives, meat and alternatives.

^(e) Non-core foods include soft drinks, sweets and energy-dense nutrient-poor foods.

*Total sugars (g) = fructose + glucose + sucrose + maltose + lactose + galactose

** P-value from Kruskal–Wallis one-way analysis of variance test adjusted for Type 1 error using Bonferroni calculation.

Table 3: Percentage of participants in each quartile achieving Australian Recommended Dietary Intakes (RDI) and Adequate Intake (AI) for selected nutrients at baseline in the Feeding Healthy Food to Kids study (n=146)

Nutrients	NRVs (RDI/AI) ^(a)		% total participants (n=146)	% Q1 (n=37)	% Q2 (n=36)	% Q3 (n=36)	% Q4 (n=37)
	< 4 yrs	≥ 4 yrs					
Fibre (g)	14	18	43	24	46	49	76
Thiamin (mg)	0.5	0.6	98	95	100	100	100
Riboflavin (mg)	0.5	0.6	100	100	100	100	100
Niacin equivalents (mg)	6	8	100	100	100	100	100
Vitamin C (mg)	35	35	94	86	90	100	100
Dietary Folate equivalents (µg)	150	200	80	68	81	89	86
Retinol equivalents (µg)	300	400	98	92	100	100	100
Potassium (mg)	2000	2300	61	41	62	62	81
Magnesium (mg)	80	130	100	100	100	100	100
Calcium (mg)	500	700	88	86	90	89	89
Phosphorus (mg)	460	500	100	100	100	100	100
Iron (mg)	9	10	30	8	30	41	41
Zinc (mg)	3	4	100	100	100	100	100