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Consumption of 'extra' foods (energy-dense, nutrient-poor) among children aged 16–24 months from western Sydney, Australia

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Abstract

Objective: This study evaluates the contribution of energy-dense, nutrient-poor 'extra' foods to the diets of 16–24-month-old children from western Sydney, Australia.

Design: An analysis of cross-sectional data collected on participants in the Childhood Asthma Prevention Study (CAPS), a randomised trial investigating the primary prevention of asthma from birth to 5 years. We collected 3-day weighed food records, calculated nutrient intakes, classified recorded foods into major food groups, and further classified foods as either 'core' or 'extras' according to the *Australian Guide to Healthy Eating*.

Setting: Pregnant women, whose unborn child was at risk of developing asthma because of a family history, were recruited from all six hospitals in western Sydney, Australia. Data for this study were collected in clinic visits and at participants' homes at the 18-month assessment.

Participants: Four hundred and twenty-nine children participating in the CAPS study; 80% of the total cohort.

Results: The mean consumption of 'extra' foods was $\sim$150 g day^{-1} and contributed 25–30% of the total energy, fat, carbohydrate and sodium to the diets of the study children. 'Extra' foods also contributed around 20% of fibre, 10% of protein and zinc, and about 5% of calcium. Children in the highest quintile of 'extra' foods intake had a slightly higher but not significantly different intake of energy from those in the lowest quintile. However, significant differences were evident for the percentage of energy provided by carbohydrate and sugars (higher) and protein and saturated fat (lower). The intake of most micronutrients was also significantly lower among children in the highest quintile of consumption. The intake of 'extra' foods was inversely associated with the intake of core foods.

Conclusions: The high percentage of energy contributed by 'extra' foods and their negative association with nutrient density emphasise the need for dietary guidance for parents of children aged 1–2 years. These preliminary data on commonly consumed 'extra' foods and portion sizes may inform age-specific dietary assessment methods.

Keywords
Children
Diet
Nutrition
Non-core foods
Beverages
Snacking
Childhood obesity

The consumption of energy-dense, nutrient-poor foods by very young children is of public health concern[1–3]. Information about the contribution of these foods to energy intake is needed, both in view of the rising prevalence of obesity and diet-related diseases among children and adults and because poor eating habits formed in early childhood may persist into later childhood and adulthood[4–8]. If 'extra' foods displace those that are more nutrient-dense, the risk of low or marginal intakes of micronutrients increases[9,10].

Research, surveillance and policy development regarding consumption of energy-dense nutrient-poor foods, among children and adults, has been limited by the lack of clear and accepted terminology and taxonomy to identify and classify these foods.

The first problem concerns what to call these foods. The terms 'unhealthy foods' and 'junk foods' are imprecise and imply that the foods, rather than the quantity consumed in relation to the total diet, are problematic. The terms 'snacks'

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and 'snack foods' distract attention from the types of foods and their quantities by confounding them with the time of consumption. The term 'fast foods' is usually applied only to the subset of 'take-away' foods. 'Energy-dense, nutrient-poor foods' is awkward although technically correct. Food selection guides, developed in many countries, use various terms: for example, 'foods containing fat/foods containing sugar'[11], 'fats and sweets'[12] or 'other foods'[13]. The *Australian Guide to Healthy Eating* (AGHE)[14] classes these foods as 'extras' to distinguish them from nutrient-dense core foods. Fat spreads and cooking oils, usually consumed daily, but recommended in small amounts, are included in this category. For the purpose of this study, we have used the term 'extra' foods, as used by the AGHE, recognising that this term has limitations.

A second problem is the lack of accepted criteria for classifying such foods. The food groups traditionally used to report food consumption patterns from population surveys include core foods as well as those that nutritionists regard as 'extras'. For example, the cereal food group may contain a mixture of core foods (e.g. bread, pasta, porridge) and 'extra' foods (pies, cakes, biscuits) and 'borderline' foods (e.g. reduced-, but not low-, fat crackers). National food selection guides do not provide a basis for classifying 'extra' foods consumed, although they do give examples, such as 'biscuits, cakes, pastries, soft drinks, crisps, pies, take-aways, lollies and chocolate'. These kinds of foods are typically classified in survey data as cereal-based products, beverages, snacks, mixed dishes or confectionery[14].

A third problem is the lack of clear guidance about quantities of 'extra' foods that can be included in a healthy diet. This contrasts with specific numbers (or a range) of servings for core food groups, e.g. fruits and vegetables. Most guides recommend that the intake of 'extra' foods be limited, but not necessarily eliminated in a healthy diet. The AGHS goes further, specifying an acceptable range of servings of 'extra' foods (a serving is defined as the amount of food containing 600 kJ) for various age and gender groups, which approximates 10–20% of the energy intake for children aged 4–18 years.

For children aged 1–2 years, there is a vacuum both of advice and policy about 'extra' foods. Nutrition professionals have urged the development of dietary guidance for families and institutions who feed young children during this important dietary transition[15–17]. Feeding guidelines for infants and toddlers were recently developed in the USA but these contain no specific advice about 'extra' foods[18,19]. The authors note that, in planning menus to meet nutrient requirements, there was 'little leeway for foods that provided predominantly "empty" calories'. Guidelines to address which 'extra' foods, how much and when they can be included in diets of infants and toddlers remain to be developed.

Dietary surveys of children aged over 2 years in the USA, UK and Europe have reported high proportions of children consuming 'extra' foods, such as soft drinks, chips and sweets[2,20–27]. Several of these studies have shown that high intakes of selected 'snack' foods tend to compromise intakes of more nutrient-dense foods, but few studies have assessed the contribution of total 'extra' food consumption to energy and nutrient intakes. Dietary surveys of children younger than age 2 years are rare, and only a few of these have reported intakes of 'extra' foods[28–30].

Information is required about the most common 'extra' foods and the portion sizes eaten by very young children to tailor dietary assessment and surveillance tools and dietary recommendations for this age group. We could find no population-based data on the total diets or consumption of 'extra' foods among children aged less than 2 years in Australia.

The Childhood Asthma Prevention Study (CAPS), a randomised controlled trial investigating the effects of two interventions (house dust mite reduction and omega-3 fatty acid supplementation), separately and together, on the primary prevention of asthma from birth to 5 years[31], provided a rare opportunity to investigate food habits and nutrient intakes in young Australian children. Diets were assessed by weighed food records for over 400 children at their 18-month assessment during 1998–2000. The dietary intervention for the trial did not attempt to influence the food habits of children other than by changing the types of polyunsaturated fat spreads and cooking oils used, and thus was unlikely to affect intake of other foods and nutrients, including quantities of fats.

In this paper we report the types of 'extra' foods and amounts consumed by study children, the contribution of 'extra' foods to total energy and nutrient intakes, and the differences in nutrient intake among higher and lower consumers of extra foods. Information about the consumption of meats and other core foods is reported elsewhere[32].

Participants and methods

Pregnant women, whose unborn child was at risk of developing asthma because of a parent or sibling with a current diagnosis of asthma or with frequent wheeze, were recruited from antenatal clinics of all six hospitals in western Sydney, Australia. Of 7171 women screened, 2095 satisfied the selection criteria: family history of asthma, resides within 30 km radius of the hospital, fluency in English and a telephone at home. Exclusion criteria were: a pet cat at home, multiple births and less than 36 weeks' gestation. When recruitment was complete, 29.4% of those who met the selection criteria ($n = 616$) agreed to participate and were randomised into four groups to receive one, both or no interventions. Sixty-two women withdrew from the study after randomisation, which resulted in 554 study participants, of whom 538 attended the 18-month assessment. The extent to which the study

population differed from parents who were eligible for the study but did not participate, and parents attending antenatal clinics at all six hospitals in western Sydney during recruitment, has been reported in detail elsewhere[33]. There were no significant differences between the CAPS parents and the antenatal clinic population in mean age of mothers, the proportion in full-time employment and those who were primigravida. A significantly larger proportion of CAPS mothers and fathers were tertiary-educated (47%, 44% vs. 36%, 37%) and were Australian-born (74%, 69% vs. 64%, 62%) compared with mothers and fathers attending western Sydney antenatal clinics. Ethics approval was obtained from the human research ethics committees of the participating hospitals, the Area Health Services, and the University of Sydney.

Diet was assessed at the same time that study physicians made medical assessments of the children at about 18 months of age. Food consumption was assessed from 3-day weighed food records, collected on consecutive days (two weekdays and one weekend day). A research dietitian instructed mothers how to keep records and issued a food record booklet and a set of Tanita digital kitchen scales (measuring up to 2 kg with a precision of 1 g). At the end of the recording period, the dietitian visited homes to collect records and check their completeness.

Of 538 participants approached, 483 agreed to keep food records and 465 actually did so. Of these, 36 were excluded either because all three days were not complete, the quality of the data supplied was poor, the child's food intake on these days was reported as highly atypical due to illness, or because the child was breast-feeding more than twice per day. Thus, a total of 429 food records were included in the final dataset, comprising an 80% response rate of all those asked to keep records. Further details about study attrition and reasons for refusal are given elsewhere[32].

Raw data from the food records were checked, coded and entered into the SERVE nutrient analysis program (version 3.95; Williams, Sydney, Australia, 1998) based on the Australian Composition of Foods database (version 3.0; National Food Authority, Canberra, Australia, 1995) to derive nutrient data for all foods eaten on each eating occasion. Data on foods, nutrients and anthropometry for each participant were then exported into a Microsoft Access™ database. To calculate the total intake of 'extra' foods and various sub-types of these, individual foods were classified as 'core foods' or 'extra' foods' according to the AGHE[14]. Food groups classified as 'extra' foods included: cereal-based products (such as cakes, biscuits, pastries and batter-based products, but excluding mixed dishes in which cereal was the major ingredient such as pasta dishes and fried rice); non-milk beverages (except for fruit juices); fats and oils; snack foods; sugar products and dishes; confectionery; savoury sauces and condiments; and miscellaneous foods. Generally entire food groups were classified as 'core' or 'extra' foods. Exceptions were fried potatoes from the vegetables group and ice cream and milkshakes from the milk group, which were classified as 'extra' foods because they were specifically identified as such in the AGHE. As part of the 18-month medical assessment, research nurses measured the children's weight in kg and recumbent length in cm, as described in the CAPS protocol[31].

Statistical analyses

SPSS for Windows release 11 (SPSS Inc., Chicago, IL, USA, 2001) and Minitab for Windows release 12 (Minitab Inc., State College, PA, USA, 1998) were used for statistical analyses. Independent sample *t*-tests were used to assess diet group and gender differences in dietary variables. Data for both diet groups and for boys and girls were combined after the initial analysis because differences in intake of 'extra' foods (in grams and percentage of energy) were small and not significant. The differences between quintiles of 'extra' food consumption (expressed as percentage of energy from 'extra' foods) in nutrient intakes were tested using both a non-parametric procedure (Moods median test) and analysis of variance. The results with both procedures were similar except for β-carotene and sodium, which were therefore log-transformed prior to analysis of variance although the effect of doing so was minimal. A conservative estimate of effect size was calculated as the difference between the average 'extra' food intake for the highest and lowest quintiles divided by the larger standard deviation.

Results

The mean age of the children, at the time of the dietary assessment, was 18.9 months (range 16–24 months) and 70% were aged 19–20 months. All but one of the children in this study consumed 'extra' foods during the 3-day recording period. Fats and oils and cereal-based products (biscuits, cakes and pastries, etc.) were consumed by 90% of children or more (Table 1). Study children, on average, consumed 157 g of 'extra' foods daily, the greatest quantity coming from sweetened beverages, cereal-based products and fried potatoes. Table 2 presents the most commonly consumed individual items and the portion sizes consumed per eating occasion. On average, cordials were consumed on a daily basis by 41% of children and soft drinks consumed on alternate days by 29% of children. Two-thirds of the children ate sweet biscuits on the majority of record-keeping days. Other popular 'extra' foods included potato chips, chocolate and ice cream, which were consumed by 54%, 38% and 24% of children, respectively. One in five children consumed cakes, sweet buns or cake-type muffins, and one in 10 children ate take-away pizza, hamburgers and/or doughnuts during the 3-day period. The median portion sizes of many 'extra' foods, per eating occasion, were relatively small; for example, less than 1/2 cup (100 ml) of soft drink, one

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Table 1 'Extra' foods consumed, categorised by main food group, among 429 children aged 16–24 months

Food groups*	Percentage of consumers†	Mean per capita intake ($g\,day^{-1}$)‡	Percentage of total energy‡
Cereal-based products§	90	23.1	8.0
Sweetened non-milk beverages¶	70	87.1	4.7
Fats and oils	94	5.8	3.4
Confectionery	60	8.1	3.0
Fried potatoes‖	58	10.4	2.5
Snack foods	39	3.7	1.8
Sugar and products	63	6.7	1.1
Ice cream	26	5.4	1.0
Sauces and condiments	54	4.6	0.5
Miscellaneous	77	2.3	0.5
All 'extra' foods	99.9	157	26.5

* Foods were grouped as in the Australian 1995 National Nutrition Survey[34].
† A consumer was any child who consumed 'extra' foods at least once during the 3-day recording period.
‡ Derived over all participants, rather than consumers only.
§ Includes biscuits, cakes, pastries and other foods in which cereal is the major ingredient, such as pies, pasties, pizza and hamburgers.
¶ Includes cordials, soft drinks and fruit drinks, but excludes fruit juice.
‖ Fried potatoes include hot chips, wedges, hash browns, potato scallops and gems.

(12 g) sweet biscuit, 1/2 piece (26 g) of cake, 1/3 (58 g) of a hamburger, 2/3 (50 g) of a piece of pizza and 1/3 of a sausage roll, although there was a large range of serving sizes among this sample of children.

'Extra' foods contributed about a quarter of energy (27%) and sodium (26%) intake and approximately 30% of total fat, carbohydrate and sugar intake. They also contributed about 20% of the intakes of fibre, iron, thiamin, niacin and vitamin C; between 15 and 20% of magnesium, potassium, riboflavin and β-carotene; but only 10% of protein, retinol and zinc, and less than 7% of calcium (Table 1 and Table 3). Of all 'extra' food groups, cereal-based foods contributed most to energy, all macronutrients and several micronutrients. Non-milk sweetened beverages contributed substantially to energy and carbohydrate intakes, while fat spreads and oils contributed about 3% to energy and 10% of total fat.

Children in the highest quintile of consumption of 'extra' foods had diets that were slightly but not significantly higher in energy. Percentage energy from carbohydrate and sugars, however, was significantly higher and percentage energy from protein and saturated fat significantly lower than for children in the lowest quintile of consumption of 'extra' foods (Table 4). However, absolute intakes of saturated fat were not significantly different across the quintiles (data not shown). Absolute intakes of micronutrients were significantly lower for children in the highest quintile of consumption of 'extra' foods for calcium, magnesium, phosphorus, potassium, zinc, β-carotene, retinol, vitamin A and riboflavin, and the effect size greatest for calcium. Nutrient density ($mg\,MJ^{-1}$) was significantly lower also for thiamin and niacin. The effect size for nutrient density was greatest for magnesium, potassium, phosphorus and calcium.

Consumption of 'extra' foods' was significantly and inversely associated with the total quantity of core foods consumed and for each of the following groups: cereals, dairy products, fruit, vegetables and infant foods. There was no significant association between the quintile of 'extra' foods intake and children's weight, height or body mass index (BMI) (data not shown).

Discussion

The CAPS study provided a unique opportunity to examine food and nutrient intakes in a relatively large sample of Australian children, aged 16–24 months, living in western Sydney. The study, although not population-based, provides indicative patterns of consumption of 'extra' foods among very young Australian children, who are in transition from a milk-based diet to a full solid food diet. Until such time as population-based studies of health and nutrition routinely include infants and children less than 2 years of age and use detailed methods of dietary assessment, datasets obtained from studies such as this provide an indication of dietary intakes in this age group. Our sample was from a group who had a family history of atopy and whose parents were better educated than the population of the area in which they resided. An association between high 'snack' food intake and lower socio-economic status has been previously documented in the UK[22,24,29,35] and may also be the case in Australia. Moreover, mothers with children at high risk of atopy may exclude particular foods from their children's diets. Thus our results may be biased in the direction of lower 'extra' food consumption than would be evident in a random population sample of Australian children in this age group. With this caveat, the data provide some interesting glimpses into the diets of young children.

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Table 2 'Extra' foods consumed most commonly* within main food groups among 429 children aged 16–24 months

	Percentage of consumers	Consumption frequency (per 30 days)†	Amount consumed per eating occasion‡	
			Median (g)	Interquartile range (g)
Sweetened non-milk beverages§				
Cordial (concentrated syrup)	41	35.2	30	15–55
Soft drink	29	16.5	100	50–173
Fruit juice drinks	33	36.2	81	39–150
Cereal-based products				
Sweet biscuits	67	23.4	12	8–20
Savoury biscuits	31	16.7	10	6–18
Cakes, buns and muffins	20	13.1	26	17–40
Pizza	11	11.0	50	30–76
Hamburgers and filled rolls	11	10.4	58	39–86
Doughnuts	10	11.1	30	20–49
Meat pie, pasty	6	11.7	51	22–86
Sausage roll	5	10.0	55	25–70
Fried potatoes				
Potato chips	54	13.2	30	15–50
Sugar and products				
Sugar	28	20.2	4	2–5
Jam	19	14.2	5	3–10
Honey and syrup	16	13.5	4	2–6
Ice confectionery	9	13.3	40	32–65
Nutella	7	12.9	6	4–10
Jelly	5	14.0	40	23–100
Confectionery				
Chocolate	38	15.9	15	10–20
Lollies/confectionery	28	14.7	10	6–17
Muesli and fruit bars	18	19.7	21	17–27
Fats and oils				
Margarine	90	35.2	4	2–6
Oil	45	19.6	3	1–3
Dairy fats	5	14.0	4	1–6
Ice cream	24	13.2	40	26–60
Snack foods				
Potato crisps	22	14.3	18	10–25
Extruded snacks	14	12.1	16	10–22
Corn chips	6	13.3	9	3–21
Sauces and condiments				
Tomato and other sauces	27	14.5	18	4–20
Cheese or white sauce	6	11.7	25	11–40
Gravy commercial	6	11.7	15	7–50
Other extra foods				
Vegemite, Promite, Marmite	50	20.2	2	1–4
Beverage flavourings¶	17	24.1	7	5–10

* Consumed by at least 5% of children during the 3-day recording period.
† Frequency of intake is expressed per 30 days of intake data for those children who consumed the food during the period of the 3-day record.
‡ Among consumers only.
§ Includes cordials, soft drinks and fruit drinks containing fruit juice, but excludes 100% fruit juice.
¶ Includes cocoa, malted milk, Milo™ and Ovaltine™.

We have limited capacity to compare our results meaningfully with those of other investigators because our sample was younger than in most published surveys, and because we used a weighed food record, regarded as superior to other methods in quantifying and describing the precise types and quantities of foods consumed, but not widely used to assess dietary intakes of sizeable samples of young children. Under-recording of 'extra' foods is a potential source of measurement error with weighed records, yet other methods are not immune to this and suffer from additional sources of measurement error. For example, snack foods are likely to be omitted in 24-hour recalls[36], and larger quantities are often underestimated. In relation to the definition and classification of 'extra' foods, most published papers have reported either selected foods typically regarded as discretionary or 'snacks', i.e. all foods consumed between major meals.

Our classification of 'extra' foods is not ideal and requires further development. Whole food groups were classified as either 'extra' or core, with the exceptions of those foods specifically identified in the AGHE as 'extras'. This meant that some foods, e.g. high-fat meats, were

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Table 3 Intake of energy and selected nutrients from 'extra' foods, expressed as mean per capita daily intake and percentage of daily total energy intake, among 429 children aged 16–24 months

	Per capita daily intake			
	Mean (SEM)	95% CI	Percentage of total daily intake (SEM)	Food groups* contributing ≥ 3% to total intake
Energy (MJ)	1.17 (0.03)	1.11–1.23	26.5 (0.61)	1, 2, 3, 4
Protein (g)	3.9 (0.15)	3.6–4.2	10.3 (0.37)	1
Total fat (g)	13.2 (0.35)	12.5–13.9	31.0 (0.70)	1, 3, 4, 5
Saturated fat (g)	5.4 (0.16)	5.1–5.7	26.0 (0.96)	1, 3, 4, 5
Monounsaturated fat (g)	4.9 (0.13)	4.6–5.1	34.7 (0.76)	1, 3, 5
Polyunsaturated fat (g)	2.2 (0.08)	2.0–2.3	51.8 (1.88)	1, 3, 5
Carbohydrates (g)	38.5 (1.25)	36.0–40.9	29.2 (0.76)	1, 2, 4
Sugars (g)	25.1 (1.04)	23.0–27.1	31.1 (0.98)	1, 2, 4, 7
Starch (g)	13.4 (0.46)	12.5–14.3	26.2 (0.71)	1, 5, 6
Fibre (g)	1.4 (0.06)	1.3–1.5	19.6 (0.69)	1, 5, 6
Calcium (mg)	42.7 (1.75)	39.3–46.1	6.6 (0.32)	–
Phosphorus (mg)	88.6 (3.25)	82.2–94.9	11.3 (043)	1
Magnesium (mg)	19.2 (0.65)	18.0–20.6	14.2 (0.47)	1
Sodium (mg)	318 (11.6)	295–341	26.5 (0.65)	1, 9, 10
Potassium (mg)	218 (7.40)	204–233	14.1 (0.48)	5
Iron (mg)	1.0 (0.05)	0.9–1.1	18.6 (0.69)	1, 10
Zinc (mg)	0.5 (0.02)	0.5–0.6	10.9 (0.42)	–
Thiamin (mg)	0.2 (0.02)	0.2–0.3	22.4 (0.92)	1, 10
Riboflavin (mg)	0.3 (0.02)	0.3–0.3	16.1 (0.76)	10
Niacin (mg equivalents)	2.9 (0.12)	2.0–2.4	17.0 (0.66)	1, 10
Vitamin C (mg)	17.5 (1.80)	14.0–21.1	19.4 (1.19)	2
Retinol (μg equivalents)	51.4 (3.45)	44.7–58.2	11.4 (0.58)	10

SEM – standard error of the mean; CI – confidence interval.
*Food groups: 1 – cereal-based foods; 2 – sweetened non-milk beverages; 3 – fats and oils; 4 – confectionery; 5 – fried potatoes; 6 – snack foods; 7 – sugar and sugar products; 8 – ice cream; 9 – sauces and condiments; 10 – miscellaneous.

excluded from the 'extras' category, while other foods, which were not particularly energy-dense or nutrient-poor such as filled rolls and Vegemite, were classified as 'extras' and could have led to underestimation of the displacement effect of high consumption of 'extra' foods on core foods and nutrient intakes.

The types of 'extra' foods consumed by our participants were similar to those reported by other investigators. Sweetened beverages, biscuits, cakes and sweet desserts were the most commonly reported in this category of foods. A large UK national survey of diet in children aged 1.5 to 4.5 years found that 80% consumed sweetened soft drinks and 86% consumed sweet biscuits over the 4-day recording period[37], similar to our findings of 70% and 67%, respectively. In another large UK dietary study of young children using a food-frequency questionnaire (FFQ), 51% of 18-month-olds were given sweetened drinks and 51% consumed chocolate and other confectionery at least once per week[28,35]. In a recent US study, 36% of children aged 15–18 months consumed sweetened beverages, 60% consumed cakes, pies, cookies and pastries, and 20% consumed fried potatoes on the day prior to the survey[30].

Feeding of 'extra' foods appears to start early. A large UK survey[24] found that 56% of infants aged 8 months had consumed sweetened drink in the previous 24 h, while a US survey[30] found that 27% had consumed cakes, pies, cookies and pastries in the previous 24 h. The percentages of infants and children consuming sweets and snack foods increased steadily and substantially as age increased from 6 to 24 months. Hoffmans *et al.*[20] showed that the contribution to energy from sweets and snacks tracked between 4, 16 and 28 months. Although the CAPS study was longitudinal, we are unable to assess trends in 'extra' food consumption because we collected detailed dietary data only at the 18-month assessment.

The mean and median quantities consumed of various 'extra' foods and food groups were relatively small, and close to the mean intakes per day reported for UK children of this age using similar measurement methods[28]. Portion sizes have not been previously reported in this age group. Our data provide a preliminary basis for use in tailoring portion sizes to this age group in survey questions and in food selection recommendations. The median portion size can be used as a 'medium' or 'reference' portion, and the interquartile range (25th to 75th percentile) can be used to define small and large portions, as the basis for designing FFQs[38]. For example, from our data, a 'medium' size portion of hot chips (French fries), as indicated by the median, was 30 g; a small portion (25th percentile) was 15 g; and a large portion (75th percentile) 50 g.

Several FFQs in common use in Australia use reference portion sizes for some 'extra' foods which are as much as 2–4 times the median portion sizes consumed by CAPS children. For example, the FFQ used in the Blue Mountains Eye Study of older people lists the reference size of soft drink, cake, hot chips and ice cream as 1 can, 1 slice, 1 cup and 1/2 cup. These equate to 375 ml, 45 g, 113 g and 70 g, respectively, compared with the median

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Table 4 Differences* between quintiles of 'extra' food consumption (as a percentage of total energy) and intake of energy and selected nutrients among 429 children aged 16–24 months

	Mean intake for quintile of 'extra' foods (1 = low, 5 = high)					Test results	
	1 (<16%)	2 (16–22%)	3 (22–29%)	4 (30–37%)	5 (>37%)	*P*-value	Effect size for significant associations†
Mean total energy (MJ day^{-1})	4.2	4.4	4.4	4.4	4.6	0.15	–
Macronutrients (% of total energy)							
Carbohydrate	47	49	49	50	54	**0.000**	+0.96
Starch	18	20	18	19	20	0.044	–
Sugars	26	26	28	28	31	**0.000**	+0.80
Protein	18	16	16	15	13	**0.000**	−1.68
Fat	37	36	37	37	34	0.011	–
Saturated fat	20	19	19	18	17	**0.000**	−0.48
Monounsaturated fat	12.2	11.4	11.8	12.3	11.6	0.295	–
Polyunsaturated fat	4.3	3.9	3.5	4.2	3.6	0.358	–
Micronutrients and fibre‡							
Calcium (mg)	921	868	810	683¶	593¶	0.000	−1.12
Magnesium (mg)	153	153	142	132	127	0.000	−0.71
Phosphorus (mg)	942	928	859	782	721	0.000	−0.88
Potassium (mg)	1815	1759	1668	1550	1421	0.000	−0.81
Sodium (mg)	1047	1170§	1154§	1208§	1228§	0.033	+0.48
Zinc (mg)	6.1	5.3	5.1	4.8	4.5	0.000	−0.42
β-Carotene (μg)	1285	1072	870	731	971	0.000	−0.47
Retinol (μg)	346	317	323	266	254	0.000	−0.61
Vitamin A (μg equivalents)	559	494	466	386	415	0.000	−0.60
Riboflavin (mg)	1.98	1.88	1.77	1.51	1.38	0.000	−0.74
Nutrient density							
Calcium (mg MJ^{-1})	221	198	185	155	129	0.000	−1.71
Magnesium (mg MJ^{-1})	36.7	34.9	32.4	30.3	27.7	0.000	−2.01
Phosphorus (mg MJ^{-1})	226	211	196	178	156	0.000	−1.78
Potassium (mg MJ^{-1})	437	400	380	356	310	0.000	−1.81
Zinc (mg MJ^{-1})	1.5	1.2	1.2	1.1	1.0	0.000	−0.55
β-Carotene (μg MJ^{-1})	314	245	196	173	208	0.000	−0.67
Retinol (μg MJ^{-1})	83	72	74	60	55	0.000	−0.87
Vitamin A (μg equivalents MJ^{-1})	135	112	106	89	90	0.000	−0.85
Riboflavin (mg MJ^{-1})	0.48	0.43	0.41	0.35	0.30	0.000	−1.01
Thiamin (mg MJ^{-1})	0.22	0.22	0.21	0.19	0.17	0.001	−0.52
Niacin (mg equivalents MJ^{-1})	4.1	4.1	3.9	3.8	3.4	0.000	−0.90
Fibre (g MJ^{-1})	2.0	1.9	1.7	1.7	1.7	0.008	−0.36

* Statistically significant associations were defined as $P < 0.01$ (shown in bold for macronutrients).
† (Q5 mean minus Q1 mean)/larger standard deviation.
‡ Only those micronutrients for which statistically significant relationships were found (except for sodium) are shown.
§ Above the upper end of the range of Australian Recommended Dietary Intake (RDI) for sodium for this age group (320–1150 mg).
¶ Less than the Australian RDI for calcium for this age group (700 mg).

portions consumed by CAPS children of 100 ml, 26 g, 30 g and 40 g. A version of the CSIRO FFQ, currently in use in several studies of children's diets, lists somewhat different standard serving sizes for the same foods; for example, 1 medium glass of soft drink, 17–18 hot chips and 2 scoops of ice cream, equivalent to approximately 250 ml, 70 g and 50 g, respectively[39,40].

In practical terms, this means that the current 'standard' portions used to assess diets are not applicable for very young children – 'extra' food intake and associated energy and macronutrient intakes are likely to be substantially overestimated.

'Extra' foods contributed over a quarter of total energy intake in our study of children aged 16–24 months. A study of 15–18-month-old US children found that 25% of energy was obtained from between-meal snacks[8]. It is notable that a large US survey of adults also showed that 27% of energy intake came from energy-dense, nutrient-poor foods using similar classification criteria to ours[10]. Nevertheless, in our study, energy from these foods was likely to have been underestimated because some foods, such as sausages, were not included as 'extra' foods. In a US survey (1989–1991) that did account for all high-fat and high-sugar foods, 38% of energy was found to be consumed as discretionary fat and sugar by children aged 2–5 years[41]. At present, the AGHE does not address the diets of children younger than 4 years old. It allows for 1–2 daily servings of 'extra' foods for children aged 4–7 years, which equates to approximately 10–20% of energy intake. Our study has shown that, on average, children exceed that recommendation at considerably younger ages, with 'extra' foods contributing nearer to 30% of energy. The highest quintile of 'extra' food consumers exceeded the recommended limit by more than two-fold (45% of energy).

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The difference in energy intake between the highest and lowest quintiles of 'extra' food intake was not statistically significant. Percentage of energy from saturated fat was lower in the highest quintile of 'extra' food intake, largely due to the increase in the percentage of energy from carbohydrate, as absolute intakes of saturated fat did not change across the quintiles. That 'extra' food consumption was not related to BMI is not unexpected in view of the short-term nature of the dietary record, the small difference in energy intake between the highest and lowest quintiles of 'extra' food intake, and the long lag period for the development of obesity from small but cumulative excesses in energy intake. Intake of snack foods has not been associated with BMI in cross-sectional studies in adolescents or adults[42,43], although a randomised trial has reported a decrease in BMI among those restricting soft drinks consumption[44].

In the absence of other information about the general health or nutritional status of our sample, it is not possible to conclude whether high 'extra' food consumption is deleterious to health at this age. Other investigators have found that several micronutrients are likely to be low in children's diets, particularly calcium, iron, zinc, vitamin E and vitamin D[16,23,28,45–47]. Our findings that 'extra' foods displaced core foods, and that micronutrient intakes and protein intakes, in terms of both absolute intake and nutrient density, were lower among those with the highest intakes of 'extra' foods suggest that at this level of 'extra' food intake nutritional status of children this age may be compromised. In our study only mean calcium intake was below the current Recommended Dietary Intake[48] for children in the highest quintile of extra food intake. Indeed, several previous studies have found that 'extra' foods, particularly sweetened drinks, displace core foods such as milk and consequently micronutrient intake among children[49–51]. Further investigation is required in longitudinal studies to assess the links between total 'extra' food consumption, energy and nutrient intakes, and health/nutritional status. Investigators would be advised to seek consensus on the definition and classification schemes for 'extra' foods prior to commencing such research.

Conclusion

'Extra' or non-core foods made a significant contribution to the total energy intake of children aged 16–24 months from western Sydney, exceeding the upper limit advised by official food selection guides for adults. 'Extra' foods displaced more nutrient-dense foods in the diets of those with the highest intake of 'extra' foods, and their diets were lower in most micronutrients.

The development of standard definitions, a food classification system and reporting methods are required with regard to 'extra' foods, to enable the rational development of dietary policy and dietary assessment tools suitable for young children. Standard methods will also support more rigorous research investigating the links between 'extra' food consumption patterns and indicators of health and weight status in childhood and adulthood.

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