Abstract

Objective

School food intake of Australian children is not comprehensively described in literature, with limited temporal, nationally representative data. Greater understanding of intake at school can inform school-based nutrition promotion. This study aimed to describe the dietary intake of primary-aged children during school hours and its contribution to daily intake.

Design

This secondary analysis used nationally representative, cross-sectional data from the 2011-12 National Nutrition and Physical Activity Survey. Dietary intake was assessed using validated 24-hour dietary recalls on school days. Descriptive statistics were undertaken to determine energy, nutrients, food groups, and food products consumed during school hours, as well as their contributions to total daily intake. Associations between school food intake and socio-demographic characteristics were explored.

Setting

Australia.

Participants

Seven hundred and ninety-five children aged 5-12 years.

Results

Children consumed 37% of their daily energy and 31-43% of select nutrient intake during school hours, with discretionary choices contributing 44% of school energy intake. Most children consumed less than one serve of vegetables, meat and alternatives or milk and alternatives during school hours. Commonly consumed products were discretionary choices (34%, including biscuits, processed meat), bread (17%) and fruit (12%). There were limited associations with SES variables, apart from child age.

Conclusions

Children's diets were not aligned with national recommendations, with school food characterised by high intake of discretionary choices. These findings are consistent with previous Australian evidence and support transformation of the Australian school food system to better align school food consumption with recommendations.

Keywords:

children, energy intake, school health, primary school, energy-dense nutrient-poor, discretionary foods

Introduction

Children's dietary habits during childhood are linked to risk of developing chronic conditions and food consumption patterns in adulthood[1]. Within Australia, children's diets are profiled by a high intake of discretionary food products—i.e. energy dense, nutrient poor foods higher in energy, saturated fat, added sugars and/or sodium; with these foods contributing over a third (38.5%) of children's and adolescent's daily energy intake[1, 2]. Concurrently, children are not meeting national recommendations for vegetables, fruit, and milk foods and alternatives[3]. Similar dietary trends are observed in children internationally[4], with greater than 91% of children in the United States exceeding recommendations for solid fats and added sugars[5].

Schools are a key environment for health promotion and nutrition interventions, providing an opportunity to align children's diets with recommendations[6]. Children spend 6-7 hours in school daily[7], with international evidence showing food consumed during school hours contributes between 24% to 44% of daily energy intake[4, 8, 9]. Internationally, there are three predominant school food provision models including; 1) meals provided by the school (e.g., in a cafeteria format), 2) food brought to school from home (e.g., in a 'lunchbox'), or 3) a combination of these models. Past analyses of school provided models have found children are often supplied with foods that make up 23% to 33% of their daily energy intake[8, 10, 11] in the form of cooked meals, including vegetables[12-14]. However, school provided meals have been reported to include several energy dense, nutrient poor foods, such as baked sweets or hot chips[12]. Contrastingly, examination of lunchbox models internationally has found lunchboxes provide 33% to 44% of children's daily energy intake[4, 9, 10, 15] and Australian evidence showing 37% contribution of lunchbox energy to overall daily energy intake[16]. Lunchboxes commonly include fruit, breads, discretionary choices, such as packaged snacks or processed meats, and limited vegetables[10, 12].

In Australia, on any given day, 86% of primary school aged children consume foods brought in a lunchbox from home with a small proportion of children purchasing lunch or snacks from a school canteen facility[16] (i.e. a small shop within the school where students can purchase lunch, snacks, and beverages)[17]. While there are national dietary guidelines[1], providing food recommendations for children across the day, and international guidelines to support the provision of healthy food at school consistent with dietary guidelines[18], there are no national lunchbox policies to mandate food provision during school by caregivers. National canteen recommendations are available to guide the nutritional quality of food options served at canteens, supported by state/territory policies[19]. Regardless of

existing guidelines there are several barriers for school food provision by both caregivers and canteens, including food safety, facilities available, time, preference and cost[20].

Research into Australian children's school food intake is limited in terms of national, temporal evidence, collected using validated measures of intake. The latest analysis of school food intake using a nationally representative sample is outdated, using data collected in 1995[16]. Since this previous data collection, there have been changes to school food policies and practices, including the national dissemination of fruit and vegetable snack time 'Crunch & Sip'[21] and national canteen guidelines[19]. Therefore, findings may no longer reflect the dietary intake of Australian primary-aged population, hence analysis using more contemporary data is required. More recent findings from a sample of 12 catholic schools in the Hunter region of New South Wales[22] found that 67% of lunchboxes contained sweet discretionary snacks (e.g. sweet biscuits, cakes, muesli bars), and 55% contained savoury discretionary snacks (e.g. crisps, savoury biscuits). While this study used objective direct observation, it measured provision of foods in lunchboxes, rather than intake, and lacked comparison to total day intake. Furthermore, previous studies have involved primary school children from selected states or regions, therefore do not provide a national perspective of children's intake[22-24]. More broadly, available descriptions of Australian children's lunchboxes lack comprehensive analysis of nutrient content and discretionary food contribution[22] necessary to assess and guide intervention development.

A thorough understanding of Australian children's school food intake will allow for better informed public health and nutrition promotion strategies to be developed. Hence, this study aimed to describe the dietary intake of 5- to 12-year-old (primary-aged) Australian children during school hours and the contribution of this school day intake to their total day intake, using a nationally representative sample. Specifically, we sought to: 1) determine the energy and nutrients from core and discretionary choices consumed during school hours, as well as their contributions to total daily intake; 2) examine the consumption of Australian Dietary Guidelines food groups within school hours; 3) identify the types of discretionary choices most consumed during school hours and 4) identify associations between child socio-demographic characteristics and percentage of energy from discretionary choices consumed during school hours.

Methods

Data source

This secondary analysis was completed using cross-sectional data collected by the National Nutrition and Physical Activity Survey (NNPAS) 2011-12[25]. Ethics approval was not required for the secondary analysis as all data provided were deidentified. Detailed methods of the NNPAS 2011-12 can be found in the Australian Health Survey User Guide[25]. In brief, participants were recruited through a stratified multistage area sample of private households, interviewing an adult and child, if present[25]. Dietary intake data were collected by 24-hour recalls on two separate days of intake using the Automated Multiple Pass Method[26] between May 2011 to June 2012[25]. The first day of dietary recalls were performed face-to-face with 64% of the sample completing a second recall over the phone. All recalls were conducted with a parent proxy for children under the age of 15, with the child assisting where appropriate[25].

Dataset preparation

Only day one recalls, completed on a weekday, by participants aged between 5 and 12 years of age were included in this analysis (Figure 1). Recalls completed on dates that were holidays across all Australian states (except Tasmania) and territories were excluded, forming the primary sample. State or territory of residence information was not available in the dataset, therefore dates that were national public holidays or school holidays in 2011 and 2012 across most states/territories nationally were excluded. School term dates for Tasmania were not considered due to the state following a trimester school term structure, however participant data were still included. School food was defined as food consumed between 9am and 3pm, as these are common national school hours and broadly capture all school eating occasions, including morning snack, recess and lunch times. To account for potential over and under reporting in the 24-hour diet recall, only plausible reporters were included. Plausible reporters were defined using the Goldberg cut-off method[27, 28], which compares energy intake (EI) and basal metabolic rate (BMR) ratio with estimated energy expenditure (PAL). This utilised the EI:BMR variables provided in the dataset, calculated using diet recall and anthropometric information. This ratio, with the addition of PAL, provides an indication if the energy intake meets energy requirements for standard energy expenditure. Physical activity level was assumed to be 1.55 for all reporters due to lack of consistent physical activity measures available in this dataset. Plausible reporters were determined as those within two standard deviations of a PAL of 1.55 (0.87 to 2.74). Participants without anthropometric data (n= 162, 17%) were included as plausible reporters as the plausibility of their reported intake was unable to be assessed and therefore assumed to be plausible to maintain a larger primary analysis sample[29].

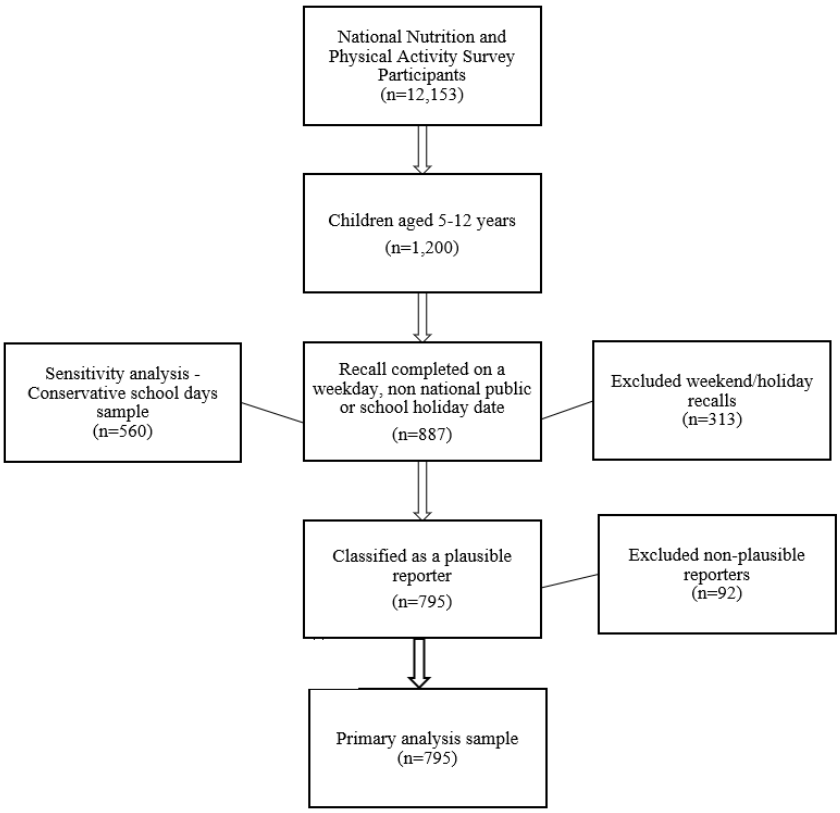

Figure 1: Participant flow of the sample of 5- to 12-year-old children from the NNPAS 2011-12*

* National Nutrition and Physical activity survey 2011-12

Dietary intake data

The primary dependent variables included energy and select nutrient intake, food group serves and commonly consumed food products, with the independent variables being school hours and contribution to the total day. The Australian Food, Supplement and Nutrient Database (AUSNUT) 2011-13[25], developed by Food Standards Australia and New Zealand based on food products consumed in the NNPAS 2011-12[30], was used to analyse food composition data. The nutrient profiles of food consumed during school hours and across the total day were collated into separate variables, as primary variables. Secondary variables included the contribution of discretionary choices to energy and nutrients consumed during school hours.

Food groups were defined according to Australian Dietary Guidelines, which categorises foods and beverages into five food groups and discretionary choices, and includes recommended daily serves of food groups, based on age and sex[1, 25]. The five food groups are: Vegetables and legumes/beans; Fruit; Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties; Lean meats and poultry, fish,

147 eggs, tofu, nuts and seeds and legumes/beans; and Milk, yoghurt, cheese and/or alternatives, mostly
148 reduced fat[1]. The guidelines also categorise foods not required for a healthy diet which are high in
149 energy, saturated fat, added sugars and/or sodium and low in nutrients as discretionary choices and
150 recommends minimising intake of these foods[1]. Serves of each of the five food groups and
151 discretionary choices were calculated for all items consumed, using the grams consumed and serve size
152 definitions[1]. This was collated into total serves consumed and those consumed during school hours.
153 This allowed primary variables, including serves consumed during school hours, and secondary
154 variables, including total serves consumed, to be determined. Food products were also categorised to
155 determine food type by the food category and subcategories defined in the AUSNUT 2013 food
156 composition dataset[30].
157
158 Covariates
159 Characteristics of participants were available in the NNPAS 2011-12 dataset. Anthropometric measures
160 for weight and height were taken by interviewers using standard procedures, and used to calculate body
161 mass index (BMI)[25]. BMI was provided in the dataset, calculated using age- and sex-specific cut-off
162 points sourced from Cole et al.[31], and used to determine weight status categories of participants. Data
163 for sociodemographic characteristics were collected during the interview, including age in whole years,
164 sex, household income and postcode. Household income in the NNPAS dataset was transformed into
165 'equivalised household income', adjusting for household size and separated into deciles[25]. Socio-
166 economic position was classified using the Socio-economic Indexes for Areas (SEIFA) Index of
167 Relative Socio-Economic Disadvantage (2011), derived from household postcode and measured in
168 quintiles; this variable was pre-calculated in the available version of the dataset[25]. This index
169 considers income, education and employment in certain living areas, showing a measure of social and
170 economic well-being in that region, with lower quintiles representing areas with more disadvantage [25].
171 Additionally, physical activity of participants was measured through the number of days in the past
172 week that one hour of physical activity was completed.
173
174 Statistical analysis
175 All statistical analyses were performed in IBM SPSS Statistics 25 (Version 25; SPSS Inc., Chicago, IL,
176 USA). Normality assessment, using histograms and skewness and kurtosis Z-scores, showed data were
177 positively skewed, therefore median and interquartile range (IQR) were examined. Descriptive
178 statistics were used to determine energy and select nutrient intake during school hours and the total
179 day. The percentage contribution of school energy intake to total intake and discretionary choice

contribution to school intake were calculated for each participant and therefore mean percentage intake for the sample was determined. This allowed for comparison of the nutrients consumed in school hours and the contribution of these to the total day. Intake of food groups were calculated using median serves in school hours and total day. The most frequently consumed discretionary food and beverage products across the sample during school hours were calculated, to identify most frequently consumed types of this diverse food group.

Multivariate linear regression analyses were used to determine the relationship between child sociodemographic characteristics and percentage of energy from discretionary choices during school hours. The predictor variables were assessed for collinearity with no associations found. Multivariate regressions were run (n=627) including participants with complete weight, age and socio-demographic data available. Model one included sociodemographic characteristics of interest and biological factors which are known to effect energy requirements[32]. This included the independent variables of SEIFA, household income deciles, child weight status and child age. Model two included all variables for model one, and additionally controlled for child sex and physical activity level (determined from the number of days physical activity recommendations were met in a week), which have been associated with children's total energy intake in the literature[33]. Weight status categories were dummy coded into new variables, with healthy weight coded as the reference category. SEIFA and income deciles, which were ordinal categories, were coded numerically and treated as continuous variables in the regression[34]. All other included variables were considered continuous in this analysis.

Sensitivity analyses

Sensitivity analyses were completed to understand whether defining school days using a more conservative method would influence the results. A sub-sample labelled as 'conservative school days' was formed including only participants who completed dietary recalls on definite school days across all states and territories, forming a smaller sample (n=560). Sensitivity analyses were completed comparing the primary sample (n=795) to the sample of participants from conservative school days (n=560). This sensitivity analysis accounted for potential differences in the consumption patterns of the primary sample, which may have included some holiday dates, e.g. for Tasmania, compared to the conservative sample, which included only recalls on confirmed school days.

Results

From the 1,200 children aged between 5- to 12-years participating in the NNPAS 2011-12, a total of 795 plausible reporters completed a dietary recall on a school day. Anthropometric and socio-demographic characteristics of the sample are presented in Table 1. The mean age was 8.5 years (SD 2.3), with majority (69%) of children being classified within a healthy weight category. Participants were distributed across all socio-economic quintiles.

Table 1: Characteristics of the sample of 5- to 12-year-old children from the NNPAS 2011-12 reporting dietary intake on a school day (N=795)

Characteristic	N	%
Sex		
Male	406	51.1
Female	389	48.9
Child Age (years), mean and SD	8.5	2.3
Socio-economic position *		
Quintile 1 (lowest)	141	17.7
Quintile 2	141	17.7
Quintile 3	158	19.9
Quintile 4	152	19.1
Quintile 5 (highest)	203	25.5
Equivalised income of household †		
Decile 1 (lowest)	91	12.7
Decile 2	41	5.7
Decile 3	75	10.5
Decile 4	74	10.3
Decile 5	87	12.2
Decile 6	78	10.9
Decile 7	87	12.2
Decile 8	75	10.5
Decile 9	55	7.7
Decile 10 (highest)	53	7.4
Weight status ‡		
Underweight	38	6.0
Healthy Weight	433	69.1
Overweight	111	17.7
Obesity	45	7.2
Physical Activity §		
None	36	4.5
1-2 days	110	13.8
3-5 days	271	34.1
6-7 days	377	47.4

* Measured by the Socio-economic Indexes for Areas including the Index of Relative Socio-Economic Disadvantage, Quintiles

† Equivalised by household size

‡ Missing weight data n = 162. Weight status determined through age- and sex-specific BMI cut-off points.

§ Number of days each child physical activity for at least 60 mins in 7 days prior to interview

Energy, nutrient and discretionary choices intake during school hours and contribution to total day

Table 2 presents children's median energy (2578kJ, IQR 1925, 3595) and selected nutrient intake in school hours. Children consumed 37% of total day energy intake, and between 31% to 43% of their total day intake of nutrients in school hours (Table 2). Mean nutrient intake contribution of products consumed during school hours was lowest for protein (31%), iron (32%), calcium (33%), compared to highest for sodium (43%), fibre (41%) and carbohydrate (40%). Of the food and beverages consumed during school hours 43.8% (Median 1033kJ, IQR491,1920 kJ) of energy was from discretionary choices (Supplementary Table S1).

Table 2: Energy and nutrient intake of Australian 5- to 12-year-old children during school hours and across the total day using the NNPAS 2011-12 (N=795)

	In School hours			Total day	
	Median	**IQR**	**Mean % contribution to total day ***	**Median**	**IQR**
Quantity (g)	715	448, 1198	38.3	2216	1758, 2758
Energy (kJ)	2578	1925, 3595	36.9	7650	6134, 9234
Energy (kcal)	616	310, 859		1828	1466, 2207
Protein (g)	18.4	13.0, 26.2	31.1	68.6	52.9, 86.9
Carbohydrate (g)	83.9	61.9, 116.4	39.5	229.6	185.7, 282.2
Total fat (g)	19.4	12.4, 32.2	35.5	64.0	47.5, 82.8
Saturated fat (g)	8.1	4.4, 13.2	35.0	26.0	18.3, 35.2
Added sugars (g)	11.9	4.3, 26.4	36.4	44.9	25.1, 75.6
Fibre (g)	7.7	5.2, 10.4	40.9	19.8	14.7, 25.7
Calcium (mg)	198.3	100.4, 353.5	32.9	739.9	505.0, 1061.5
Sodium (mg)	830	589, 1160	42.9	2128	1577, 2832
Vitamin C (mg)	15.6	65.2, 1758.7	38.4	65.2	33.4, 122.7
Iron (mg)	2.6	1.8, 3.6	32.0	9.3	6.9, 12.1

*Percentage contribution calculated for each participant and used to calculate mean

Food group intake

During school hours, children consumed a median of two serves of discretionary choices (IQR 1,3) and grains (IQR 1,2) and one serve of fruit (IQR 0,1), and no serves from the meat and alternatives (IQR 0, 0) , milk foods and alternatives (IQR 0,1) and vegetable food groups (IQR 0,1) (Table 3). Across the total day, children consumed a median of five serves of discretionary choices (IQR 3,7), four serves of grains (IQR 3,6) and one serve of each of the vegetable (IQR 0,3), fruit (IQR 1,3), milk foods and alternatives (IQR1,2) and meat and alternatives (IQR 0,2) food groups.

Table 3: Median serves of Australian Dietary Guideline food groups consumed by 5- to 12-year-old children during school hours and across the total day using the NNPAS 2011-12 (N=795)

	Serves Consumed	
Median (IQR)	**Within School**	**Total day**
Grains and Cereals	2 (1, 2)	4 (3, 6)
Vegetables and Legumes	0 (0, 1)	1 (0, 3)
Fruit	1 (0, 1)	1 (1, 3)
Milk, yoghurt, cheese and/or alternatives	0 (0, 1)	1 (1, 2)
Lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans	0 (0, 0)	1 (0, 2)
Discretionary choices	2 (1, 3)	5 (3, 7)

* For primary-aged children, recommendations range from 4-6 grain and cereal serves, 4.5-5.5 vegetable and legume serves, 1.5-2 fruit serves, 1.5-3.5 serves of milk, yoghurt, cheese and/or alternatives and 1.5-2.5 serves of lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans across the total day[1] It is recommended that more active children or adolescents have between 0-3 addition serves from the five food groups or discretionary choices [1].

Discretionary choices products most consumed during school hours

During school hours 82% of children consumed one or more serves of discretionary choices. Over a third (34%) of the food products consumed during school hours were classified as discretionary choices, with other highly consumed foods including bread (17%) and fruit (12%). Of these discretionary choices, the most frequently consumed foods were sweet biscuits (14%), processed meat (13%), savoury biscuits (12%) and muesli or cereal bars (10%) (Figure 2). The most frequently consumed beverages during school hours were water (67%), juice (19%), soft drink (6%) and cordial (4%).

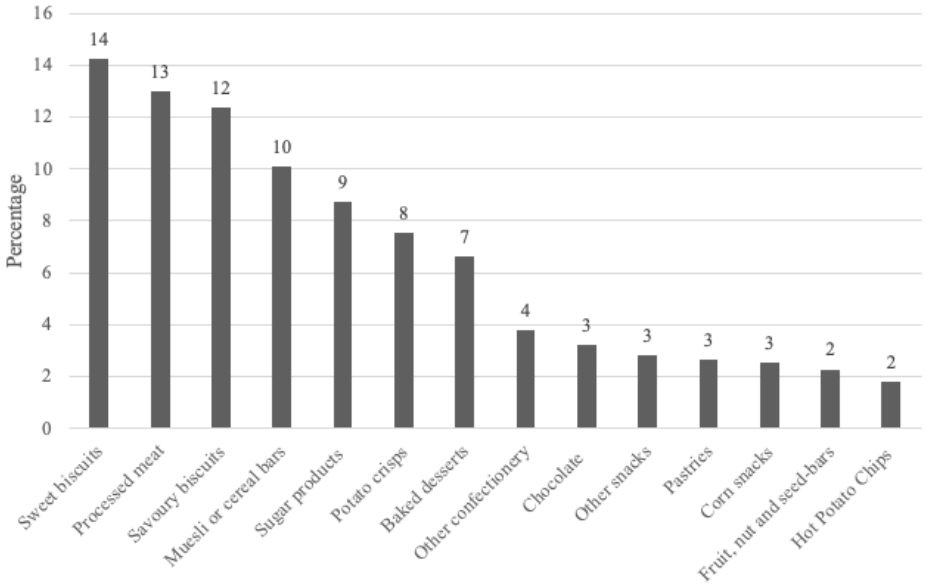

Figure 2: Most frequently consumed food product categories* of discretionary foods during school hours by Australian children aged between 5- to- 12-years using the NNPAS 2011-12

*Percentage of discretionary food products consumed within school in each food sub-category, out 1537 discretionary food products

Associations between socio-demographic characteristics and percentage of energy from discretionary choices

Multivariate linear regressions showed no significant associations (p>0.05) between SEIFA Index (Standardised B=-0.024, p=0.571), household income categories (Standardised B=-0.060, p=0.148) or weight status (Underweight Standardised B=0.001, p=0.979; Overweight Standardised B=-0.034, p=0.418; Obesity Standardised B=-0.013, p=0.758) and percent of energy from discretionary choices during school hours, when adjusting for child sex and physical activity level (F=(8,585)=1.539, p=0.140) (Supplementary Table S2). There was a significant association between age and percentage of discretionary energy consumed during school hours (Standardised B=0.126, p=0.003), indicating older children may consume more discretionary choices.

Sensitivity analyses

Sensitivity analyses were completed for the conservative school days population, of 560 primary aged children (Supplementary Table S3, S4). The population of conservative dates had fewer participants who were affected by overweight or obesity (17.9%), compared with the primary sample (19.7%). Energy and nutrients analyses showed a similar pattern of results, with values marginally lower during school hours for the conservative sample. Median energy intake during school hours was 2472kJ (IQR

1884, 3308kJ) contributing 34.7% to total day energy intake, compared to the primary sample median of 2578kJ (IQR 1925, 3595kJ), contributing 36.9%. To determine if this variance was consistent, the median values for intake of Australian Dietary Guideline food groups were calculated, with the results almost identical between the two samples.

Discussion

This study profiled 5- to 12-year-old children's dietary intake during school hours, and contribution to total day intake, using a nationally representative sample of Australian children. Children are consuming approximately one third of their daily energy intake during school hours, with a considerable proportion (44%) of this being sourced from discretionary choices. Many children are consuming fruit and grain serves during school hours yet are under consuming other food groups, such as vegetables, dairy and alternatives and meat and alternatives. Therefore, contributing to few children meeting Australian Dietary Guideline recommendations for the total day. These results reinforce schools as a key nutrition promotion setting and provide direction to inform intervention efforts in the future.

The current study finding that food consumed during school hours provides 37% of children's daily energy intake is consistent with previous findings, with 1995 data showing school food contributed 37% of daily intake[16]. There is a noted discrepancy in the energy intake in comparison with previous findings, with an overall 600kJ increase in food consumed across the total day in the 2011-12 survey data, compared to the 1995 National Nutrition Survey[16]. Despite children's diets becoming higher in energy overall, the energy consumed during school remained consistent over the decade between national surveys (1995 2602kJ vs. 2011/12 2578kJ)[16]. Our findings that 44% of children's energy during school hours were from discretionary choices is of concern and consistent with previous findings in Australian samples[2, 22]. A 2019 study examining food provided in lunchboxes to catholic school children found discretionary choices contributed 38.8% of the energy provided in lunchboxes[22]. This finding also aligns with evidence of children's intake across the total day, showing children aged 2 to 18 years are consistently overconsuming discretionary choices, with these products providing approximately 40% of daily energy intake, regardless of the school or home environment[2]. Discretionary choices products may be displacing products from the five food groups and contributing to poor consumption of these essential food groups during school hours[35].

The most consumed food products during school hours included bread, fruit and discretionary choices, such as biscuits and snack items, which are highly marketed lunchbox products[36] and are convenient with high child acceptability. The consumption patterns of these foods were consistent with previous Australian findings[16], showing that between the 1995 and 2011-12 national surveys there have been no notable improvements in the nutritional profile of school lunchboxes. The high intake of bread, fruit and discretionary choices is also consistently observed in more recent studies within smaller jurisdictions within Australian[22-24], and international evidence[10, 12]. A study investigating intake of South Australian primary school aged children (8-11 years) in 2010 showed that children were consuming fruit or discretionary choices during morning snack break, and sandwiches during the lunch break[12]. Further evidence has shown that over half of children's total day intake of discretionary choices occurs during snack eating occasions[37], which corresponds with common morning snack breaks in Australian schools. To address commonly consumed discretionary choices, school-based interventions may consider targeting snack eating occasions in school, to encourage vegetable snack consumption[21], and discourage high sugar, fat and/or sodium food and beverages.

The lack of notable change in school dietary intake of Australian children over time suggests that existing nutrition guidelines and interventions in schools have had little effect on improving the diet quality of primary-aged children. In addition, there has been limited implementation of recommended international guidelines, with no national guidelines in place supporting the provision of healthy foods at school via lunchboxes. There are numerous factors that may have limited a change in children's school food dietary intake, if not addressed in previous interventions. Previous research in Australia has highlighted the many barriers' families and canteen services face when packing, preparing and providing lunches to children in school hours, such as child preferences, time, cost and food safety[20, 38]. The poor consumption of vegetables, milk and alternatives, and meat and alternatives food groups in addition to high intake of discretionary choices may be a reflection of the Australian school food model, including the limited facilities available, for both lunchbox and canteen provided foods. These intake patterns align with the barriers expressed by parents about food safety. However, it is noted that high discretionary choices intake patterns are not solely experienced in lunchbox food provision models. For example, in London, England where food is prepared and provided by the school setting, children's lunch intake is characterised by high intake of discretionary choices[12].

Analyses showing no significant associations with socio-demographic characteristics and energy sourced from discretionary choices indicates poor diet quality during school hours is consistent across

all children, irrespective of socioeconomic position. In comparison a review of diet quality and socio-economic position have found notable differences in diet quality of children of varying family socio-economic status when considering intake across the whole day[39]. Furthermore, evidence using socio-economic indices for areas in NSW examining lunchbox provision has shown no associations during school hours[22]. This is consistent with international findings, that school hour dietary quality was similar across sociodemographic groups[40]. The findings of this study suggest that school interventions should target children in schools across the population, regardless of socio-economic areas, to improve the diets of all Australian children during school hours.

Consistently, poor diet quality of primary-aged children during school hours suggests that new approaches to improve children's school food intake are warranted, including consideration of new policies, programs, or alternate food provision models. One avenue may be to reimagine the school food system to meaningfully improve the nutrition at school, with our recent research consulting key stakeholders indicating a school lunch prepared onsite is a food provision model worth exploring in Australia[38]. A school-provided lunch model in Australia, has the potential to improve diet quality of school children, if the appropriate processes and systems are put in place to ensure lunches provided align with national dietary guidelines. Potential benefits of a school-provided lunch model are evidenced by school-provided lunch models in other countries which allow for greater vegetable intake and provision[12-14]. The current study provides important insight into Australian children's intake at school to direct future research to continue exploring policies, programs, or alternative approaches to meaningfully change school food patterns. However, continued comprehensive analyses are needed to better understand trends and diet patterns of school children.

Key strengths of this secondary analysis include the use of dietary intake data of a national sample, collected via the validated multiple automated pass method[25]. Limitations include that while the NNPAS 2011-12 is the latest available national dietary intake data it was collected ten years ago and may not reflect current dietary patterns and any potential changes to children's intake due to school nutrition promotion initiatives since this data collection[19, 21]. As a result, continued analyses are warranted to provide updated Australian evidence to better understand trends and diet patterns of school children. Therefore, repeating these comprehensive analyses to understand both the nutrients and foods consumed by children with ongoing national survey data is recommended. Other limitations of this study relate to the variables accessible for this secondary analysis. State or territory of residence and postcode data was not available in the dataset to ensure anonymity of participants. Lack of these

variables resulted in the potential for recalls completed on school holiday or public holiday dates for certain states/territories being included in the primary analysis sample, as well as preventing comparisons in intake to be made across areas of Australia. However, completing sensitivity analyses of the conservative school dates sample, which revealed consistent patterns in the results suggested incidental inclusion of non-school day recalls had limited impact. In addition, the data did not differentiate whether food were packed from home or purchased from school canteens, hence cannot provide guidance to tailor future interventions towards specific modes of food provision. Finally, this analysis only used a single day of intake, hence may not reflect usual intake of participants.

Conclusions

The present study provides an update and extension of previous research to comprehensively describe Australian children's dietary intake during school hours, using a national sample. Australian primary-aged children were found to consume a third (37%) of their daily energy intake during school hours, with 44% of that energy intake being sourced from discretionary choices. Commonly consumed discretionary food products during school hours include sweet and savoury biscuits, processed meats, and muesli- and cereal bars. Current findings are consistent with previous Australian evidence over 17 years, which calls for considering new approaches to tackling school food intake, including exploring alternate policy approaches, programs and school food provision models to meaningfully improve primary-aged children's intake during school hours.

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