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Results Foods in the Extra Foods (non-nutritious foods) and Cereals groups of the *Australian Guide to Healthy Eating* were highly liked (mean: 4.02 and 4.01, respectively), whilst foods in the Vegetables group were liked least (mean: 3.01). A large percentage of foods in the Cereals and Extra Foods groups were liked (64% and 56%, respectively) in contrast to the other food groups, especially Vegetables (7%). Children liked foods that were higher in sugar ($r = 0.29$, $P < 0.0001$) and more energy-dense ($r = 0.34$, $P < 0.0001$) but not those higher in saturated fat ($r = 0.16$, $P = 0.03$), total fat ($r = 0.12$, $P = 0.12$) or sodium ($r = 0.10$, $P = 0.18$). Sociodemographic variables (e.g. socio-economic status, parental education, children's age and sex) explained little of the variation in children's food preferences.

Conclusions Australian pre-school children's food preferences align with dietary guidelines in some respects, but not others. Interventions are needed to shift children's preferences away from non-nutritious foods that are high in energy density and sugar, and towards vegetables and fruits.

Keywords

children, food, align, preferences, recommendations, dietary, do

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Do children's food preferences align with dietary recommendations?

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Abstract

Objectives: To examine how Australian children's reported everyday food preferences reflect dietary recommendations, and the impact of sociodemographic factors on these associations.
Design: Cross-sectional survey.
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Keywords
Food preferences
Pre-school children
Socio-economic factors
Child nutrition
Australia

In Western societies where food supplies are generally consistent and ample, children's food intakes may largely be influenced by their liking or disliking (preference) for a food. In light of discrepancies between recommended and actual food intakes in children, targeting children's food preferences may be a useful way in which to improve children's diets[1–3] and advance progress in the prevention of the current obesity epidemic (e.g. reference 4). In order to achieve this, we need a good understanding of the child population's food preferences and their determinants.

A growing body of both experimental and population-based work indicates that children eat what they like and not what they dislike. For instance, in an early study, Birch[5] investigated pre-school children's ($n = 17$) sandwich consumption in an American nursery school. Children were observed eating the sandwiches, and they indicated their preferences using a ranking procedure. Correlations of $r = 0.80$ between children's food preferences and their consumption of the sandwiches were found, with children consuming more of the sandwiches they ranked higher. Similarly, children's preferences for foods high in fat and/or sugar are also associated with them choosing these foods if possible[6], and intakes of fruits and vegetables increase when liking increases[2].

Moreover, children's food preferences are repeatedly reported as one of the most important determinants of children's food intakes in a naturalistic setting. Domel *et al.*[7], for instance, examined several psychological, social and demographic factors in relation to schoolchildren's fruit and vegetable consumption and found that the children's food preferences were the only significant predictor of consumption, although the amount of variance explained was quite low (13%). Resnicow *et al.*[8] reported a similar result, with preferences for fruit and vegetables being more strongly correlated with children's intakes than fruit and vegetable knowledge and negative outcome

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expectancies. These findings have been corroborated by findings from other studies[9–11]; they suggest that changing children's food preferences may be a worthwhile avenue in which to effect changes in children's diets.

Food preferences are predominantly learned through experiences with foods (e.g. references 12 and 13), although they do have some genetic predispositions (e.g. an aversion to bitterness[14,15]). Important learning experiences with foods include exposure, associative conditioning, flavour–flavour learning, parent and peer modelling, exposure to food advertising, parental feeding behaviours and cues about post-ingestive consequences[16,17]. Additionally, children have biologically based biases towards some tastes and nutrients. The research in this area, which is primarily experimental in design, has advanced knowledge on children's liking of sweet tastes, fat, energy density and salt, and their aversion to bitter tastes. This has been reviewed elsewhere[18–20].

However, these findings from the laboratory require confirmation and extension to children's everyday food preferences. That is, knowledge of children's liking for foods (as opposed to tastes or nutrients) which are likely to resemble the foods children may typically encounter in daily life is also necessary in order to effect changes in children's diets and understand the aetiology of children's food preferences. Children learn their food preferences in the wider social environment through socialisation processes[21]. Therefore, surveying the preferences of population groups allows examination of the distribution of food preferences within the general population and within specific population groups, which may aid in directing public health campaigns and provide additional insight into the aetiology of children's food preferences. Furthermore, the pre-school stage is thought to be a critical period during development in which children are particularly sensitive to learning about food acceptability[22]. Despite this, currently there is little information that allows us to characterise children's everyday food preferences in this age bracket. The notable exceptions are from the UK[23], the USA[24] and France[25], which describe children's preferences for some common foods.

These studies have ranged in their sample sizes, the scales used and the numbers of foods examined, but they suggest that children's favourite foods are typically those recommended to be consumed in small amounts or infrequently (e.g. French fries, chocolate) whilst children's least liked foods often include vegetables. However, these studies have not provided in-depth analyses of children's food preferences, mostly limiting analyses to listing those foods that children strongly liked and disliked. Beyond this, there has been minimal examination of children's everyday food preferences in terms of how they may hinder or facilitate the consumption of a prudent diet. Knowing that children like one food (e.g. muffins) and dislike another (e.g. raw onion), as in the studies cited above, is relatively unhelpful when promoting consumption of a prudent diet in which a large number and variety of foods are consumed. It is unlikely and unfeasible for a public health campaign to address such idiosyncratic preferences. Rather, it may be more useful to examine preferences in terms of dietary recommendations to determine which aspects of children's food preferences need to be addressed. Furthermore, advancement of knowledge in this area would benefit from supplementing research that is experimental in design, and has therefore often utilised only a small number of foods in a relatively controlled and artificial environment, with studies of children's food preferences as they occur in the real world. Studies in this context provide insight into food preferences as they have been learned for large numbers of foods (as opposed to nutrients or isolated taste or sensory properties) and that may affect diets.

Dietary recommendations consider the consumption of fruits, vegetables, cereals, dairy products, meats, variety, fat, sugar and salt. Knowing where children's food preferences align and where they diverge from dietary consumption recommendations would extend upon experimental findings to provide additional focus for intervention studies aimed at improving children's diets. Accordingly, a population-based food preference study enables the examination of a wide variety of foods which are likely to resemble the foods children may typically encounter and that may affect diets. Hence the present study sought to fill this gap.

It is also unclear whether there are some children whose food preferences are more likely to reflect dietary recommendations, compared with others. That is, there is a paucity of data on the associations between socio-economic status (SES), parental education and other descriptor variables and children's food preferences. Unfortunately, the population-based studies of children's food preferences by Wardle *et al.*[23], Skinner *et al.*[24] and Nicklaus *et al.*[25] did not report on differences in food preferences aside from age and sex comparisons. However, it is likely that food preferences may be affected by such variables, as are intakes.

For instance, older children may like more foods than younger children[26], due to greater opportunities for exposure and a possible reduction in food neophobia with age, although this was not reported in the Skinner *et al.*'s study of 4–8-year-old children[24]. Furthermore, other socio-demographic variables, such as SES, may be important when understanding food preferences. Adult data suggest that people of higher SES have greater preferences for healthy foods compared with those from lower-SES backgrounds[27]. Indeed, children from lower-SES areas appear to have less healthy diets (e.g. lower intakes of fruits and vegetables and more foods lower in nutritional quality) than their higher-SES counterparts (e.g. references 28 and 29). Because food preferences are learned through experiences, children from lower-SES backgrounds may have preferences that reflect their patterns of intakes.

Other potentially important descriptor variables include history of breast-feeding, the child's sex and attendance at care facilities. Breast-fed children appear more likely to accept new foods than formula-fed children[30], although it is unknown whether this extends to the food preferences of children of pre-school age. The effects of sex differences in children's food preferences are also unclear[31,32], although recent findings suggest that girls may be more likely to like vegetables[23] and fruits[26] and boys may have a greater liking for fatty and sugary foods, meat, processed meat and eggs[26]. Children's food preferences may also be affected by eating in the company of their peers through both positive and negative modelling[1]. Accordingly, children who are exposed to peers, for example at kindergarten, may be likely to have different preferences than children who are less exposed to peers. However, these putative associations between children's food preferences and their experiential and sociodemographic characteristics are tenuous due to a scarcity of published evidence. Consequently, another aim of this study was to examine the influence of these factors on children's food preferences.

In sum, although children's food preferences influence their food intakes, little is known about the nature of children's food preferences and whether sociodemographic variables are important determinants. Accordingly, the two aims of the present study were: (1) to examine how well children's food preferences align with dietary recommendations; and (2) examine the effects of SES, parental education, sex, age, history of breast-feeding and attendance at a care facility on children's food preferences.

Methods

Recruitment

The sampling frame for this study consisted of parents of pre-school children. A convenience sample of parents of 2–5-year-old children was recruited from swimming centres, playgroups, kindergartens, crèches and child-care centres in low-, middle- and high-SES areas around Melbourne and Adelaide, Australia. This was achieved by ranking all the suburbs in each city according to SEIFA, the 1998 Index of Relative Socio-Economic Advantage/Disadvantage (a composite measure of incomes and workforce skills; Australian Bureau of Statistics), before splitting them into quintiles. Three suburbs were selected from the bottom, middle and top quintiles and centres within these suburbs were contacted subsequently. The objective in this study was not to obtain a representative sample, but to gather data from parents from a variety of socio-economic backgrounds to test the study hypotheses. As such, recruitment needed to be purposefully targeted. For these reasons a variety of participants were recruited so that comparisons could be made between the variables of interest, and the hypotheses could be tested. Directors of centres were approached in the first instance and the nature of the study was explained. None of the directors refused to participate. Following this, two recruitment procedures were used in accordance with the needs and wishes of each of the centre directors. At the swimming centres, two of the playgroups and one kindergarten, parents were approached directly by the study researcher who explained the nature of the study. Participants were subsequently asked to complete a questionnaire. Those who agreed were given the study materials (questionnaire, plain language statement and consent form). Participants either returned the questionnaire to the centre, directly to the study researcher the same day, or posted it in a reply-paid envelope, according to their preference. In the second procedure, questionnaires were distributed by the centre staff to parents by placing them in their pigeon holes. The parents received the same materials and returned the questionnaire either to the centre or in a reply-paid envelope directly to the study researcher. This procedure was followed in both cities.

Foods tried by fewer than 75% of the sample were not used in the analyses of these food groups, and questionnaires with greater than 10% of food preference data missing were excluded. Hence a total of 371 usable questionnaires were returned, representing a response rate of 53% of those who received a questionnaire.

Measures

A parent-reported questionnaire was constructed containing 176 food and drink items with liking reported on a 5-point Likert-type scale (anchored between 'dislikes extremely' and 'likes extremely') with the additional options of 'never tried' and 'do not know'. Demographic items included the parent's education and postcode; as well as their child's sex, age and whether they were breast- and/or formula-fed. Additional questions about children's food neophobia, eating behaviours and parental food choices were included as part of the questionnaire but are not reported here. Ethical approval for the study was provided by the Deakin University Human Research Ethics Committee.

Data management

Not all of the Australian dietary recommendations could be assessed. For instance, 'encourage and support breast-feeding' was not considered to be relevant to children of this age group. To assess the other recommendations, foods and beverages were grouped into the food groups defined in the *Australian Guide to Healthy Eating*[33] using the foods listed in the guide, by a dietitian and one of the authors (C.G.R.). These groups were: Meat, Fish, Poultry, Eggs, Nuts and Legumes ('Meats', $n = 33$); Fruit ('Fruit', $n = 26$); Extra Foods ('Extra Foods', $n = 46$);

Table 1 Dietary recommendations, analyses used and construction of the Healthy Preference Index (HPI)

Recommendations/guidelines	Indicators and analyses used	How the HPI was constructed
Enjoy a wide variety of nutritious foods	Variety score: using the Variety Index[34]. An individual was assigned a score of 1 when he or she liked (likes moderately, likes extremely) any one of the foods within a group. There were a total of 58 variety groups, so the maximum score a participant could receive was 58 and the minimum, 0	A child's variety score (0–58) was converted to a score between 1 and 10
Eat plenty of vegetables and legumes (4 servings)	Mean liking for 'Vegetables' group; percentage of foods within the group liked	A child's liking of each of the foods making up the 'Vegetables' group was averaged over the number of foods they had scores for, multiplied by the recommended number of servings (4) and then converted to a score between 1 and 10
Eat plenty of fruits (2 servings)	Mean liking for 'Fruit'; percentage of foods within the group liked	As for 'Vegetables', × 2 servings
Eat plenty of cereals (including breads, rice, pasta and noodles), preferably whole-grain (3.5 servings)	Mean liking for 'Cereals'; percentage of foods within the group liked	As for 'Vegetables', × 3.5 servings
Include lean meat, fish, poultry and/or alternatives (0.75 servings)	Mean liking for 'Meats'; percentage of foods within the group liked	As for 'Vegetables', × 0.75 servings
Include milks, yoghurts, cheese and/or alternatives (3 servings)	Mean liking for 'Dairy'; percentage of foods within the group liked	As for 'Vegetables', × 3 servings
Choose water as a drink	Liking for water	The item 'liking for water' was converted to a score between 1 and 10
Limit saturated fat and moderate total fat intake	Relationship between food preferences and the saturated fat and fat content of foods, using values derived from the Australian Food and Nutrient Database for Nutrition Labelling – Release 3 (AUSNUT) database	A Pearson correlation between a child's food preferences (all foods for which they had scores) and the saturated fat content of each food was produced, and then converted to a score between 10 and 1. Negative correlations thus received a higher score than positive correlations
Choose foods low in salt	Relationship between food preferences and the salt content of foods, using values derived from the AUSNUT database	As for saturated fat
Consume only moderate amounts of sugars and foods containing added sugars	Relationship between food preferences and the sugar (total available) content of foods, using values derived from the AUSNUT database	As for saturated fat

Bread, Cereal, Rice, Pasta and Noodles ('Cereals', $n = 15$); Vegetables and Legumes* ('Vegetables', $n = 41$); Yoghurt, Cheese and Milk ('Dairy', $n = 15$). The *Australian Guide to Healthy Eating* describes Extra Foods as those foods 'not essential to provide nutrients the body needs and some contain too much added salt, fat and sugars'. It includes food such as biscuits, cakes, pies and lollies. A list of foods in each category is available from the authors upon request. A reliability analysis (Cronbach's α) was performed on each *Australian Guide to Healthy Eating* food group. Values of α ranged from 0.66 to 0.97. A variety score was based on Hodgson *et al.*'s[34] Variety Index. A total of 58 variety groups was constructed from the present list of foods, so the maximum score a participant could receive was 58 and the minimum was 0. Each of the measures used is outlined in Table 1.

As the dietary guidelines are intended to be taken as a cohesive set of population recommendations, as opposed to individual guidelines, a Healthy Preference Index (HPI) was constructed as a global index of the congruence between each child's food preferences and the recommendations. The HPI was based on the Healthy Eating Index, an overall measure of diet quality developed by the US Department of Agriculture[35]. Each child received a score (ranging between 1 and 100) comprising 10 sub-scores (each scored between 1 and 10), reflecting the components of the dietary recommendations assessed here. The HPI consisted of: the mean liking for each *Australian Guide to Healthy Eating* food group (excluding Extra Foods) weighted according to the recommended number of servings per day (as outlined in the *Australian Guide to Healthy Eating* for a 'balanced diet'); a variety score; liking for foods higher in saturated fat; mean liking for water; liking for foods higher in sodium; and liking for foods higher sugar. The HPI is outlined in Table 1.

Parental education was categorised into three groups: those who had not completed high school (coded 1), those who had completed high school and/or had a technical or trade certificate (coded 2), and those who had completed tertiary education (coded 3).

*Due to the way in which these food groups were constructed, this resulted in legumes being counted twice.

Statistical analyses

All statistical analyses were carried out using SPSS[36] and α level of $P < 0.01$ was selected for statistical significance. One-sample *t*-tests, one-way analyses of variance with Tukey HSD *post hoc* analyses and paired-sample *t*-tests were conducted. Correlations were calculated with Pearson's product moment correlations for pairs of continuous variables and Spearman's ρ for non-parametric variable pairs. Fisher's *Z*-test was used to test for significant differences between correlations.

Results

Participant profile

Ninety per cent of the respondents were mothers or female carers, with the remainder being fathers or adult male carers. Respondents were aged between 19 and 61 years (mean 36.0 (standard deviation (SD) 5.00) years) and the children were aged between 2 and 5 years (mean 3.7 (SD 0.88) years). Most (96%) usually spoke English at home and 83% were Australian-born. Forty-eight per cent of the children were exclusively breast-fed, 38% were formula- and breast-fed, whilst 13% had been exclusively formula-fed. The majority of respondents were tertiary-educated (56%), a further 33% reported having completed high school or holding a technical or trade certificate and 11% had not completed high school. Twenty-six per cent of the respondents lived in SEIFA quintile 5 (highest advantage), 19% in quintile 4, 25% in quintile 3, 12% in quintile 2 and 18% in quintile 1 (lowest advantage). The sample was better-educated, more likely to speak English at home and be born in Australia, compared with the general population[37].

Australian Guide to Healthy Eating *food groups*

The children's reported preferences for the *Australian Guide to Healthy Eating* food groups were assessed. These are: (1) Eat plenty of vegetables and legumes (4 servings); (2) Eat plenty of cereals (3.5 servings); (3) Include milks, yoghurts, cheese and/or alternatives (3 servings); (4) Eat plenty of fruits (2 servings); (5) Include lean meat, fish, poultry and/or alternatives (0.75 servings); (6) 'Extra Foods' (choose sometimes or in small amounts). Associations between food preferences and these food groups were examined by looking at overall means for each food group and the percentage of foods that were liked within each group. Foods in the Cereals group were liked the most, followed by the Extra Foods group, whilst the Vegetables group was liked least on average (Table 2).

Paired sample *t*-tests indicated that preferences for Vegetables were significantly different from those of all other food groups. Cereals, Extra Foods and Dairy were not significantly different in their mean scores, although they were significantly higher than Fruit and Vegetables. In Table 2 the food groups sharing a superscript letter were not significantly different.

Table 2 Descriptive information on children's preferences for the food groups

Food group	*n*	Min	Max	Mean	SD
Cereals[a]	371	2.08	5	4.13	0.49
Extra Foods[ab]	371	2.55	5	4.08	0.42
Dairy[ab]	371	1.21	5	4.06	0.64
Meats[c]	370	1.22	5	3.89	0.63
Fruit[c]	371	1.19	5	3.88	0.67
Vegetables	370	1.06	4.94	3.15	0.71

SD – standard deviation.
[abc] Food groups sharing a superscript letter were not significantly different.

The percentage of foods in each *Australian Guide to Healthy Eating* food group liked by the sample is shown in Fig. 1. A larger percentage of foods in the Cereals group was liked (64%) compared with the other food groups, especially Vegetables of which only 7% was liked.

Choose water as a drink

It is recommended that children and adolescents 'choose water as a drink'. This recommendation was assessed by examining the mean liking for water, which was 4.53 (SD 0.77).

Enjoy a wide variety of nutritious foods

To examine the recommendation to 'enjoy a wide variety of nutritious foods' the mean variety score was calculated. The mean variety score was 32.66 (SD 7.62) suggesting a moderately varied range of food preferences in this sample, with a relatively large variation (range 9–52) between children.

Macronutrients

The dietary guidelines recommend that care should be taken to (1) 'limit saturated fat' and (2) 'moderate total fat intake', (3) 'choose foods low in salt' and (4) 'consume

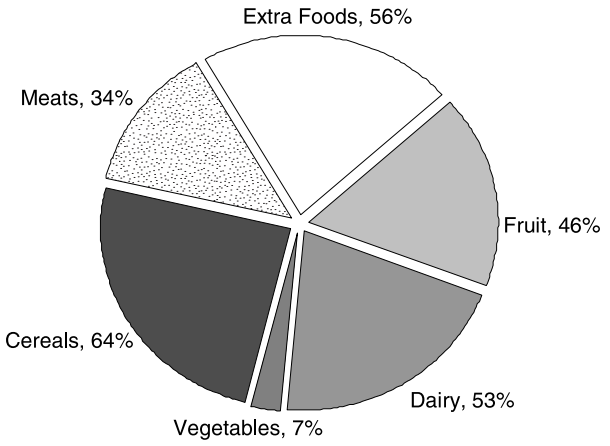

Fig. 1 Percentage of foods liked in each *Australian Guide to Healthy Eating* food group

only moderate amounts of sugars and foods containing added sugars'. Two-tailed Pearson's correlations showed that children liked foods that were higher in sugar ($r = 0.29$, $P < 0.0001$), and this relationship was still significant when controlling for energy density ($r = 0.22$, $P < 0.01$). However, there were no statistically significant associations between children's food preferences and the saturated fat ($r = 0.16$, $P = 0.03$), total fat ($r = 0.12$, $P = 0.12$) or sodium ($r = 0.10$, $P = 0.18$) content of the foods.

Sociodemographic associations with food preferences

SES (SEIFA)

As detailed in Table 3, there were no statistically significant relationships between SEIFA quintiles and the any of the measures of food preferences. Similarly, no differences in children's food preferences emerged by parental education level (Table 4).

Child's sex

There were no significant differences between girls and boys in the measures of food preferences. The one result that approached significance was for mean liking for Vegetables ($P = 0.04$), with girls scoring slightly higher than boys (Table 5).

Child's age

The children's age was related to the number of foods they had tried, with 2-year-olds and 3-year-olds having tried significantly fewer foods than 4-year-olds (Table 6). The number of untried foods was approximately 10% lower in 4-year-old children than in 2-year-old children. Age was also related to the number of foods liked, with 4-year-olds liking more foods than 2-year-olds (significant at $P < 0.05$ in *post hoc* analyses). There were no significant differences in mean liking for the food groups and the HPI (Table 6). The number of disliked foods approached significance ($P = 0.04$), with 5-year-olds disliking more foods than 2-year-olds. The variety score also approached significance ($P = 0.02$), although *post hoc* analyses revealed no significant differences between groups.

A one-way analysis of covariance was also conducted to examine the effects of age on food preferences when controlling for the number of foods a child had tried. The dependent variables were the measures of food preferences, the independent variable was the child's age and the covariate was the number of foods a child had tried. After adjusting for the number of foods a child had tried, there was no significant effect of age on HPI ($P = 0.28$), Vegetables ($P = 0.20$), Fruit ($P = 0.94$), Cereals ($P = 0.14$), Dairy ($P = 0.27$), Meats ($P = 0.12$), Extra Foods ($P = 0.39$), Variety ($P = 0.67$), total number of liked foods ($P = 0.78$) and total number of disliked foods ($P = 0.18$). There was a moderately strong relationship between Variety and number of foods tried (partial $\xi^2 = 0.27$), and between total number of liked foods and number of foods tried (partial $\xi^2 = 0.30$).

Breast-feeding

Children who were exclusively breast-fed did not differ in their food preferences from children who were exclusively formula-fed or formula- and breast-fed (Table 7). No interactions were observed between breast-feeding and parental education on any of the measures of food preferences (data not reported here).

Attending a care facility

There were no significant associations between attendance at a care facility and children's food preferences. However, several differences approached significance ($P < 0.05$). These were preferences for Extra Foods (higher in children attending care, $P = 0.03$), Variety (higher in children attending care, $P = 0.04$) and total liked foods (higher in children attending care, $P = 0.02$) (Table 8).

Correlations were performed between liking and the macronutrient content of foods, separately for each of the

Table 3 Children's food preferences by socio-economic status (SEIFA quintile): results of one-way analysis of variance for differences and means

					Mean				
Food preference measure	DF1	DF2	*F*	*P*	Quintile 1 ($n = 65$)	Quintile 2 ($n = 44$)	Quintile 3 ($n = 92$)	Quintile 4 ($n = 70$)	Quintile 5 ($n = 98$)
Vegetables	4	363	0.70	0.60	3.24	3.18	3.10	3.21	3.10
Fruit	4	364	0.19	0.94	3.94	3.86	3.88	3.87	3.85
Dairy	4	364	1.83	0.12	3.91	4.13	4.15	4.12	4.01
Cereals	4	364	1.66	0.16	4.03	4.09	4.13	4.23	4.16
Meats	4	363	1.20	0.31	3.81	3.84	3.83	3.97	3.97
Extra Foods	4	364	1.04	0.39	3.99	4.06	4.10	4.08	4.12
Untried Foods	4	364	0.43	0.79	40.51	39.68	43.47	43.60	41.57
Liked Foods	4	364	0.04	1.00	88.68	89.80	88.27	88.66	88.58
Disliked Foods	4	364	0.15	0.96	23.32	22.61	21.23	22.13	21.81
Variety	1	364	0.53	0.71	32.32	32.91	32.30	32.21	33.61

SEIFA – 1998 Index of Relative Socio-Economic Advantage/Disadvantage (Australian Bureau of Statistics).

Table 4 Children's food preferences by parental education: results of one-way analysis of variance for differences and means

Food preference measure	DF1	DF2	*F*	*P*	Mean: Less than high school ($n = 39$)	Mean: High school and trade ($n = 123$)	Mean: University or tertiary ($n = 205$)
Vegetables	2	362	0.28	0.76	3.09	3.18	3.16
Fruit	2	363	0.05	0.95	3.88	3.87	3.89
Dairy	2	363	0.45	0.64	3.98	4.09	4.05
Cereals	2	363	2.85	0.06	3.97	4.18	4.14
Meats	2	363	2.30	0.10	3.70	3.93	3.91
Extra Foods	2	363	0.39	0.68	4.08	4.11	4.06
Untried Foods	2	363	0.38	0.68	43.82	40.58	41.98
Liked Foods	2	363	1.47	0.23	84.41	91.02	88.23
Disliked Foods	2	363	0.01	0.99	22.54	22.13	22.09
Variety	2	363	2.38	0.09	30.28	33.09	33.03
HPI	2	363	2.14	0.12	59.79	62.91	62.17

HPI – Healthy Preference Index.

descriptor variables. Fisher's *Z*-test determined that there were no significant relationships between preferences for the energy density, saturated fat, sugar, fat and sodium content of the foods and the child's sex, age, SES (SEIFA), parental education level, breast-/formula-feeding, or whether or not the child attended some form of care (data not reported here).

Discussion

This study is unique in its description of the food preferences of Australian pre-school children and associations with dietary recommendations and socio-demographic characteristics. As noted in the introduction, there have been few satisfactory studies of young children's everyday preferences and their associations. The findings suggest that Australian pre-school children's food preferences reflect national dietary recommendations in some respects, but not others. Sociodemographic variables were not strong predictors of children's food preferences.

Table 5 Children's food preferences by sex: results of one-way analysis of variance for differences and means

Food preference measure	DF1	DF2	*F*	*P*	Mean: Girls ($n = 164$)	Mean: Boys ($n = 191$)
Vegetables	1	352	4.17	0.04	3.25	3.10
Fruit	1	353	1.43	0.23	3.93	3.84
Dairy	1	353	0.49	0.49	4.09	4.04
Cereals	1	353	0.00	0.99	4.14	4.14
Meats	1	353	0.75	0.39	3.94	3.88
Extra Foods	1	353	0.08	0.77	4.09	4.08
Untried Foods	1	353	0.80	0.37	43.02	41.01
Liked Foods	1	353	0.45	0.50	89.61	88.04
Disliked Foods	1	353	0.67	0.41	21.28	22.80
Variety	1	353	1.36	0.24	33.26	32.32
HPI	1	353	2.16	0.14	62.97	61.69

HPI – Healthy Preference Index.

In terms of the dietary recommendations assessed, children's food preferences reflected national dietary recommendations in some aspects. For instance, Cereals were highly liked by the children in the sample, which is consistent with previous American research[24]. Children also liked water. These findings suggest that children's preferences for Cereals and water are not a barrier to their consumption.

However, children's food preferences also diverged from dietary recommendations in other ways. As a group, the most preferred foods in this study were similar to those reported in other Western countries[23–25]. These were predominantly foods from the low-nutrient 'Extra Foods' group (e.g. cake, chocolate, pies and potato crisps) of the *Australian Guide to Healthy Eating*. This group had a relatively high overall mean liking and children liked more than half of the foods within this group. Indeed, Extra Foods were liked more than Meats, Fruit and Vegetables groups. Many of these 'Extra Foods' are discretionary snacks. Children's consumption of discretionary snacks is high in Australia[38], which may be partially explained by the children's high preferences for this group of foods.

In contrast to high preferences for Extra Foods, children had relatively low preferences for Vegetables. The average liking for Vegetables was lower than that for all of the other food groups. Although not in line with dietary recommendations, this result is not unexpected in the light of reported low consumption of these foods in children and previous research suggesting that children dislike vegetables (e.g. references 24 and 26). It is possible that children's great liking for Extra Foods and disliking of Vegetables may be hindering the consumption of a healthful diet.

The reasons underlying the liking of the Extra Foods group and not the Vegetables group may have something to do with children's biological biases. The Extra Foods group had the highest average energy density and sugar whereas the Vegetables group was low in energy density and sugar; and children tended to like foods

Table 6 Children's food preferences by age: results of one-way analysis of variance for differences and means

Food preference measure	DF1	DF2	*F*	*P*	Mean			
					2-year-olds ($n = 31$)	3-year-olds ($n = 96$)	4-year-olds ($n = 169$)	5-year-olds ($n = 75$)
Vegetables	3	367	1.58	0.19	3.21	3.09	3.23	3.04
Fruit	3	367	0.08	0.97	3.89	3.87	3.86	3.90
Dairy	3	367	1.55	0.20	4.25	4.02	4.08	3.98
Cereals	3	367	1.97	0.12	4.26	4.12	4.16	4.03
Meats	3	367	1.99	0.12	3.97	3.81	3.96	3.79
Extra Foods	3	367	1.01	0.39	4.17	4.03	4.10	4.06
Untried Foods	3	367	7.85	0.00	54.23[a]	47.18[ab]	38.53[b]	38.25[b]
Liked Foods	3	367	3.88	0.00	79.87[a]	84.54[ab]	91.57[b]	90.12[ab]
Disliked Foods	3	367	2.83	0.04	14.65	22.10	22.26	25.52
Variety	3	367	3.27	0.02	30.03	31.30	33.72	32.69
HPI	3	367	1.43	0.23	62.29	61.15	62.97	60.00

HPI – Healthy Preference Index.
[ab] Groups sharing a superscript letter were not significantly different.

higher in energy density and sugar. Children learn to like energy-dense foods likely through positive post-ingestive consequences (feelings of satiation)[16,17] and have an innate predisposition towards sweet[19]. Whilst this pattern of preferences is contrary to international dietary recommendations for consumption (e.g. references 39–41), it was expected in the light of high consumption patterns and children's biological biases. It is also possible that the effects of television advertising are reflected in these children's preferences. Vegetables and legumes are infrequently advertised to children in Australia, in contrast to the often advertised Extra Foods[42], and it is possible that advertising effects also contribute to the pattern of food preferences observed here.

Foods higher in saturated fat, sodium or total fat were not consistently preferred by these pre-school children, which tends to align with consumption recommendations. These findings were not expected given a reported biological bias towards foods higher in fat and possibly salt in children[18,19]. However, previous research by Wardle *et al.*[23] showed that children's everyday food preferences did not cluster according to simple factors like sweetness or fattiness, but rather they may have had something more to do with complex cognitive structures, and that finding is somewhat supported here. It is likely, then, that whilst higher energy density and sugar may have increased liking for Extra Foods and decreased liking for Vegetables, there are other factors aside from macronutrient contents that may also explain greater preferences for Extra Foods and low preferences for Vegetables, suggesting interactions between biological biases and individual experiences.

This study was also among the first to assess the variety of children's food preferences. The mean variety score suggested that, on average, children's preferences were somewhat diverse. Previous research has suggested that children do not meet consumption recommendations for variety[43,44]. It is possible that children's food preferences may be hindering the consumption of a varied diet. Interesting, though, was the large range and standard deviation which indicated that there was a lot of variation between children in this sample on this measure. Further research is needed to determine why some children like a variety of foods and others do not.

The dietary guidelines are meant to be taken as a cohesive set of recommendations, so the HPI was created to assess how well children's food preferences aligned with

Table 7 Children's food preferences by history of breast-feeding: results of one-way analysis of variance for differences and means

Food preference measure	DF1	DF2	*F*	*P*	Mean		
					Breast-fed only ($n = 177$)	Formula-fed only ($n = 49$)	Breast- and formula-fed ($n = 141$)
Vegetables	2	363	0.09	0.91	3.16	3.13	3.18
Fruit	2	364	0.51	0.60	3.92	3.87	3.84
Dairy	2	364	0.75	0.48	4.09	3.97	4.05
Cereals	2	364	0.27	0.77	4.16	4.12	4.12
Meats	2	363	0.45	0.64	3.88	3.97	3.90
Extra Foods	2	364	1.64	0.20	4.07	4.18	4.05
Untried Foods	2	364	0.18	0.84	42.00	43.10	41.09
Liked Foods	2	366	0.35	0.97	88.87	89.00	88.28
Disliked Foods	2	364	0.16	0.85	21.64	22.80	22.64
Variety	2	366	0.19	0.82	32.99	32.59	32.48
HPI	2	364	0.80	0.93	62.34	62.03	61.99

HPI – Healthy Preference Index.

Table 8 Children's food preferences by attending care vs. not attending care: results of one-way analysis of variance for differences and means

Food preference measure	DF1	DF2	*F*	*P*	Mean: Child does not attend care ($n = 50$)	Mean: Child attends care ($n = 318$)
Vegetables	1	365	0.17	0.68	3.12	3.17
Fruit	1	366	0.22	0.64	3.84	3.89
Dairy	1	366	1.02	0.31	4.14	4.05
Cereals	1	366	0.05	0.83	4.12	4.14
Meats	1	365	0.13	0.72	3.87	3.90
Extra Foods	1	366	4.69	0.03	3.96	4.10
Untried Foods	1	366	5.62	0.05	48.38	40.73
Liked Foods	1	366	5.23	0.02	82.20	89.81
Disliked Foods	1	366	1.45	0.23	19.34	22.56
Variety	1	366	4.23	0.04	30.74	33.08
HPI	1	366	0.10	0.75	61.84	62.24

HPI – Healthy Preference Index.

the recommendations overall. The mean HPI was moderate and no child reached the maximum possible score. This suggests that children's food preferences may be hindering the consumption of a diet as outlined in the dietary guidelines. However, like the variety score, there was also a large range and standard deviation in the HPI. This requires further investigation. This study suggested that biological biases may contribute to some aspects of children's food preferences, although these biases (e.g. propensity to like energy-dense foods) are common to all children and cannot explain the individual variation observed here in liking for the food groups, variety and the HPI.

It was hypothesised that children's food preferences may be affected by parental education and SES. However, the findings suggest that these factors may be relatively weak in determining children's food preferences: there were no statistically significant relationships between the measures of food preferences reported here and parental education or SES. Further research is therefore needed to determine how such differences arise. It is likely that other factors, such as children's individual psychological characteristics (e.g. food neophobia) and their unique experiences with foods (e.g. parental feeding behaviours, exposure to television advertising), may be more important determinants of food preferences than these indices of parental education and SES[20].

The effects of age on food preferences appeared to be due to an increase in the number of foods a child had tried as he or she got older. This suggests that increases in age are associated with having tried more foods and this may result in healthier food preferences. Positive relationships between the number of foods tried and the variety score and the total number of foods liked support this. However, it should be noted that a lack of significant results for age may be partially due to a small number of 2-year-old children, compared with the other groups, so it is difficult to draw any firm conclusions about a child's age and their food preferences at this stage.

Previously, researchers have shown that infants who had been breast-fed were more likely to accept new foods than formula-fed infants[30]. However, the present findings suggest that there are no effects of breast-feeding on children's food preferences at pre-school age. Thus, whilst breast-feeding may be important in the initial stages of learning to eat, it appears that its effects are weakened by the pre-school age. However, it should also be noted that there were relatively few children who had been exclusively formula-fed in the sample and this may have affected the results.

A comparison was made between children attending a care facility (e.g. crèche or kindergarten where they are likely exposed to peer modelling) and those who did not attend a care facility. The results showed that there were trends for children attending care to like Extra Foods more, a greater variety of foods and more foods in total. Attendance at a care facility, then, may be both a positive and negative influence on children's food preferences. This may reflect greater exposure to peers and an expansion of food preferences possibly though increased opportunities for exposure to new foods. Care facilities may therefore provide an opportunity for improving children's food preferences.

The results reported here must be interpreted in the context of the limitations of the study. The study was constrained by those factors common to parent-report surveys such as parental reporting biases. Whilst child reports may provide more accurate indications of their food preferences[45], these measures are also problematic. For instance, sensory profiling with children is difficult[46], and other techniques such as Birch and Sullivan's rating and ranking procedure[47] are time-consuming. Parental reports of children's behaviours are frequently used in behavioural and nutrition research[48], in both clinical and research settings (e.g. the Child Eating Behaviour Inventory[49]); and mothers' reports of children's food preferences have previously been demonstrated to be

highly correlated with children's reports[24] as well as reliable and valid[50]. They also allow the examination of a large number of foods, which would otherwise have been unfeasible with child-reported measures, and we feel that on balance their use aided achievement of the study's aims. An additional bias may have arisen due to the non-random sampling method. Although the sample was relatively diverse and there was large variation in children's food preferences, the parents were in general better-educated than the general population and therefore the ecological validity of the study is uncertain. Furthermore, approximately half of the parents who were contacted responded (53%) and it is likely that the questionnaire was returned by parents with an interest in their child's eating and nutrition. Despite these limitations, we feel the study provides useful data on children's food preferences and their determinants.

Conclusions

This study showed that there was a gap between children's preferences for Vegetables, Fruits, Extra Foods, variety, foods higher in sugar and energy density, and dietary recommendations. Sociodemographic items explained little of this variation. High preferences for water and Cereals, a lack of association between sodium, saturated fat and total fat, and children's food preferences are generally in concordance with recommendations and suggest that preferences may not necessarily be promoting their consumption. Children's food preferences are important predictors of both present and future food choices and further investigation of the determinants of children's food preferences are needed. Additionally, parents and health-care providers need to be educated on effective strategies for promoting the development of food preferences that align with dietary recommendations.

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