



Are the nutrient and textural properties of Australian commercial infant and toddler foods consistent with infant feeding advice?

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Abstract

Infant feeding guidelines worldwide recommend first foods to be Fe rich with no added sugars and that nutrient-poor discretionary foods are to be avoided. Feeding guidelines also recommend exposing infants to a variety of foods and flavours with increasingly complex textures. Here, we compare nutritional and textural properties of commercial infant and toddler foods available in Australia with established infant feeding guidelines. Nutrition information and ingredient lists were obtained from food labels, manufacturer and/or retailer websites. In total, 414 foods were identified, comprising mostly mixed main dishes, fruit and vegetable first foods and snacks. Most products were poor sources of Fe, and 80% of first foods were fruit-based. Half of all products were purées in squeeze pouches, and one-third of all products were discretionary foods. The nutritional content of many products was inconsistent with guidelines, being low in Fe, sweet, smooth in consistency or classified as discretionary. Reformulation of products is warranted to improve Fe content, particularly in mixed main dishes, expand the range of vegetable-only foods and textural variety. Greater regulatory oversight may be needed to better inform parents and caregivers. Frequent consumption of commercial baby foods low in Fe may increase the risk of Fe deficiency. Excessive consumption of purées via squeeze pouches may also have implications for overweight and obesity risk.

Key words: Commercial complementary foods: Infant foods: Toddler foods: Nutrient and textural properties

The first 24 months of life is a period marked by rapid growth and neurodevelopment which requires a high intake of energy and nutrients^(1–4). Indeed, requirements during this period on a per kg body weight basis exceed any other life stage. Poor food choices have adverse effects on health and development which persist into later life^(4,5). Infant feeding guidelines from the UK, the European Union, USA, Canada and Australia recommend exclusive breastfeeding for the first 6 months and introduction of Fe-rich foods as first foods along with a variety of other foods introduced in any order at around 6 months (Fig. 1)^(6–13). Furthermore, recommendations state that from 6 to 12 months, parents should offer foods with increasingly complex textures with the aim of transitioning to nutritious family foods around the end of the first year of life^(6,7). Discretionary foods high in saturated fat, added sugars and/or added salt are not recommended for young children⁽⁶⁾. The few available studies assessing the nutritional quality of these products indicate that ready-to-feed puréed baby foods are high in total sugars increasing the risk for overweight and obesity⁽¹⁴⁾. Others have also reported

that a substantial proportion of these products contain free sugars^(15,16). The WHO recommends that free sugars should not exceed 5–10% of total energy intake, while the National Health and Medical Research Council (NHMRC) recommends no sugars to be added to foods for infants <1 years^(6,17).

The range of foods available on the infant and toddler food market has expanded in recent years. Between 2013 and 2018, the retail value of the Australian baby food industry doubled from \$573.8 million to \$1.2 billion, and similar increases have been reported internationally^(16,18). In the past, weaning foods of varying textures were primarily sold in jars and designed to transition the child to family foods. However, since the last iteration of the Australian NHMRC feeding guidelines in 2013, many puréed baby foods sold in pouches have entered the marketplace. The nozzle featured on these pouches allows food to be squeezed directly into children's mouths which may lead to poorer acceptance of foods with lumpy textures and delay acquisition of independent feeding skills if frequently used as a mode of feeding^(14–16). In addition to baby food purées, there

Abbreviation: NHMRC, National Health and Medical Research Council.

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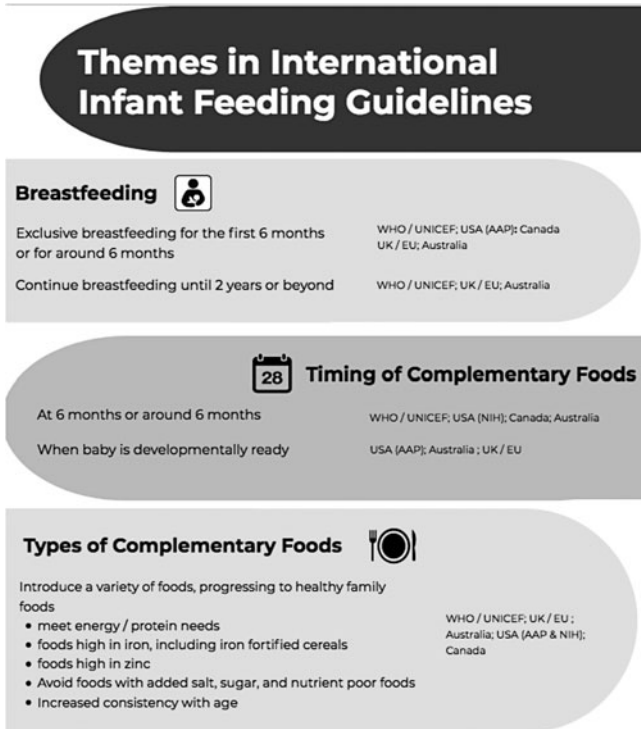


Fig. 1. Themes in international feeding guidelines. Adapted from Netting & Makrides⁽¹³⁾.

has been a marked increase in the number of discretionary (snack foods) marketed towards toddlers 12 months and up.

In Australia, the most recent data on the nutritional content of commercial infant and toddler foods are from 2013⁽¹⁹⁾. Given the rapid growth in this market sector in the past 5 years, including the expansion of foods aimed specifically for toddlers, an updated analysis is needed. Here we examine the types of commercial infant and toddler foods and compare their properties with current Australian and International Infant Feeding Guidelines.

Methods

Infant and toddler food products available as of August 2019 were identified by searching for 'baby food' on retailer websites and by location in the 'baby food' section of major supermarket chains (Coles, Woolworths, Aldi and Foodland) in Adelaide, South Australia, which is representative of foods available nationally. Supermarkets in Australia do not distinguish between infant and toddler foods, referring to them all as baby foods. Manufacturer websites were cross checked to identify all products available. The nutrient composition of the foods was obtained from the nutrient information panel on the product label, manufacturer or retailer websites. In total, 446 products from seventeen brands were reviewed, which accounted for over 90% of the market share⁽¹⁸⁾. Infant and toddler formula were not included as these are covered by a different set of standards⁽²⁰⁾.

Products were categorised according to the classification system of Tedstone *et al.*⁽¹⁶⁾. Briefly, foods were grouped into three

main product types, meals, finger foods and drinks. Within meals, products were further classified into categories: mixed main dishes, fruit and vegetable first foods (single fruit, mixed fruit, single vegetable, mixed vegetable and mixed fruit and vegetable), dry cereals/foods (savoury or sweet), readymade desserts and breakfasts and other (plain cereals and grains). Finger foods were sub-categorised into savoury finger foods, fruit- and vegetable-based finger foods and sweet finger foods. Finger foods were defined as savoury if the name suggested a plain or savoury flavour profile and were primarily starchy or legume-based. Products were classified as sweet finger foods if the name indicated a sweet flavour profile or were fruit flavoured. Finally, foods had to contain more than 25% fruit and vegetables to be classified as fruit- and vegetable-based finger foods. The target age for consumption (as identified on the packet), textural properties and product packing were described.

To enable comparison with similar reports, energy and nutrient content were expressed per 100 g of product and per recommended serve. Since very few products declared the quantity of free sugars, ingredient lists were used to determine the presence of free sugars as defined by Food Standards Australia New Zealand which includes 'all sugars defined as added sugars plus the sugar component of honey, fruit juice and fruit juice concentrates'⁽²¹⁾. Fruit pastes were coded as free sugars. Products were classified as containing or not containing free sugars. All products are reported as sold, except for dry cereals where the reported quantity is per 100 g as prepared according to manufacturer directions. All statistical analyses were completed using SPSS version 25.0⁽²²⁾.

Results

Of the 446 products identified, 414 had nutrition information and ingredient lists. Thirty-two products were excluded due to incomplete product information on manufacturer or retailer websites or because products were not stocked on shelves during supermarket visits. The most common product types identified were meals which accounted for two-thirds of the foods included in this analysis (Table 1). Within this category, mixed main dishes comprised 30% of products, followed by readymade desserts and breakfasts (29%) and puréed fruit and vegetable first foods (25%). Approximately, 80% of fruit and vegetable first foods were fruit-based and less than 10% were vegetable-based. Finger foods accounted for one-third of all products, and over half of the finger foods were sweet. Fruit- and vegetable-based finger foods accounted for less than 10% of products. Approximately, 30% of all products (125 of 414) were targeted at older infants 6 months of age (Table 2). Products intended for toddlers 12 months and older comprised one quarter of the market with nearly two-thirds of all the snack foods identified aimed at toddlers.

Fe content was reported for fifty products, mostly cereals and fortified snacks (Table 3). Based on ingredient lists, most foods were poor sources of Fe except Fe fortified cereals (data not shown). Among meals, fruit and vegetable first foods were highest in total sugar at 10.9 (range 2.3–15.5) g/100 g followed by



Table 1. Number and proportion of infant and toddler food products on the market by category and sub-category (Numbers and percentages)

Product category/sub-category	Number of products (n 414)	Proportion of products within category (%)	Proportion of all products (%)
Meals	282	100	68.1
Mixed main dishes	84	30	20.3
Fruit and vegetable first foods	73	26	17.6
Single vegetables	0	0	0
Single fruit	7	10	1.7
Mixed fruit	49	67.1	11.8
Mixed vegetables	7	9.6	1.7
Mixed fruits and vegetables	10	13.7	2.4
Dry cereals/foods	23	8.2	5.6
Desserts and breakfasts	83	29.4	20.0
Other	19	6.7	4.3
Finger foods	130	100	31.4
Savoury finger foods	45	34.6	10.8
Fruit- and vegetable-based finger foods	9	6.9	2.2
Sweet finger foods	76	58.5	18.4
Drinks	2	100	0.5
Drinks	2	100	0.5

Table 2. Target age of infant and toddler food products by product category (Numbers and percentages)

Age range product is marketed at	All products		Meals		Finger foods		Drinks	
	n	%	n	%	n	%	n	%
4 Months+	69	17	69	25	0	0	0	0
5 Months+	2	1	2	1	0	0	0	0
6 Months+	125	30	119	42	6	5	0	0
7 Months+	30	7	6	2	24	19	0	0
8 Months+	44	11	40	14	4	3	0	0
10 Months+	34	8	17	6	17	13	0	0
12 Months+	107	26	39	10	75	59	2	100
18 Months+	3	1	0	0	3	2	0	0
Total	414	100	282	100	130	100	2	100

desserts and breakfasts at 8.2 (range 4.3–17.5) g/100 g, respectively. The quantity of free sugars was not available, but based on ingredient lists, 40 % of products contained free sugars. Savoury finger foods contained more Na than other product categories with a median of 70 (range 0–1160) mg/100 g. The most energy-dense foods were savoury and sweet finger foods containing on average 1810 (range 1437–2222) and 1711 (range 1580–2380) kJ/100 g, respectively. Serve sizes were most varied within desserts and breakfasts relative to packaging with several products containing >1 serve. Nutrient content per serve is available in online supplementary materials (online Supplementary Table S1).

Almost 50 % of all products were smooth purées (Table 4) including nearly all fruit and vegetable first foods and readymade desserts and breakfasts. Among snack foods, 40 % of savoury finger foods and 15 % of sweet finger foods were extruded puffs. The most common packaging type identified was the 'squeeze pouch' (Table 5). More than 70 % of products marketed to infants four to 6 months, and nearly 40 % of products marketed for older infants 8 months and up were presented in these pouches.

Discussion

The primary aims of the present study were to provide contemporary data on the types of commercial infant and toddler foods currently available in Australia in comparison with infant feeding advice. This is only the second study to examine commercial foods aimed at children under 2 years of age in Australia, and the first to assess product packaging and food texture. In 2013, Dunford *et al.*⁽¹⁹⁾ completed an audit of baby foods stocked in Sydney supermarkets and concluded that most products were nutritionally adequate. However, since Dunford *et al.*⁽¹⁹⁾ published their findings, the number of available products has increased by 30 %, from 341 to 446, highlighting a need for updated information.

At minimum, Food Standards Australia New Zealand requires all products to declare information on servings, energy and key nutrients or active substances on the nutrition information panel⁽²³⁾. However, only 12 % of products, mostly fortified cereals and snack foods, declared Fe content. Only one product marketed as a mixed main dish included Fe. For infants 7–12 months, the recommended daily intake for Fe is 11 mg/d⁽²⁴⁾. To meet this high

Table 3. Serve size and nutrient content per 100 g of infant and toddler food products (Median values and ranges)

Product category	n	Serve size (g)		Energy (kJ) per 100 g		Protein (g) per 100 g		Total fat (g) per 100 g		Carbohydrate (g) per 100 g		Total sugars (g) per 100 g		Na (mg) per 100 g		Fe (mg) per 100 g*	
		Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range
Mixed main dishes	84	170	85–220	271	166–527	3.1	0.9–6.5	1.7	0.2–7.4	8.8	4.9–17.7	2.6	0.7–7.7	19.5	5–118	0.8	0.5–1
Fruit and vegetable first foods	73	120	55–120	249	128–339	0.6	0.1–2.8	0.2	0.1–2.5	12.4	3–18.1	10.9	2.3–15.5	3	0–24	–	–
Dry cereals/foods†	23	96	50–180	308	188–1650	2.4	0.7–11.9	1.1	0.2–6.3	14.4	7.7–85.2	4.3	0.02–12	5.3	1–50	3.4	2.5–5.7
Desserts and breakfasts	83	120	55–150	311	192–465	1.5	0.6–7.7	1.2	0.1–4.5	13.5	4.8–20.9	8.2	4.3–17.5	14	1–61	–	–
Other	19	90	25–111	269	170–1630	1.4	0.7–15	0.8	0.1–2.6	12.8	7.6–84.2	1.0	0–3.5	2.2	0–25	3.2	1.4–21
Savoury finger foods‡	45	12	3–25	1810	1437–2222	8.0	1–20	13.6	0.2–29.3	69.3	10–93.9	3.8	0–35	70	0–1160	20	20–20.5
Fruit- and vegetable-based finger foods	9	15	12–17	1410	1281–1520	2.3	0.8–7.7	0.5	0.5–6.3	72	61.3–81.2	59	35–67.5	20	6.7–85	–	–
Sweet finger foods§	76	10	4–30	1711	1580–2380	7.1	3.1–17.3	11.3	0.3–34.4	70.5	0.8–92.8	18.8	2.6–62.9	29	0–330	20	20–35
Drinks	2	200	200–200	127	119–134	0.1	0.1–0.1	0.1	0.1–0.1	7.4	7.1–7.7	6.7	6.5–6.9	3.7	1–6.3	–	–

* Fe was reported for n 50 products.

† Quantity per serve and nutrient content for dry cereals were reported as prepared products made up with water, milk or expressed breast milk.

‡ Serve size for n 6 savoury finger foods was missing.

§ Serve size for n 2 sweet finger foods was missing.

Commercial infant and toddler food properties

Table 4. Texture profiles of products within each category (Numbers and percentages)

Product category	n	Product texture															
		Smooth		Lumpy		Mashed		Extruded		Crunchy		Chewy		Chunky		Liquid	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Mixed main dishes	84	27	32	20	24	18	21	0	0	0	0	0	0	19	23	0	0
Fruit and vegetable first foods	73	72	99	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Dry cereals/foods	23	15	65	6	26	0	0	0	0	0	0	0	0	2	8.7	0	0
Desserts and breakfasts	83	73	88	2	2	8	10	0	0	0	0	0	0	0	0	0	0
Other	19	13	68	0	0	0	0	0	0	0	0	6	32	0	0	0	0
Savoury finger foods	45	0	0	0	0	0	0	18	40	26	58	1	2	0	0	0	0
Fruit- and vegetable-based finger foods	9	0	0	0	0	0	0	0	0	0	0	9	100	0	0	0	0
Sweet finger foods	76	0	0	0	0	0	0	12	16	42	55	22	29	0	0	0	0
Drinks	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100
Total	414	200	48	28	7	27	7	30	7	68	16	38	9	21	5	2	1

Table 5. Target age of food products and packaging type (Numbers and percentages)

Target age (months)	Squeeze pouch		Resealable pouch (non-squeeze)		Jar		Plastic bag/wrapping		Box	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
4 months+	55	80	6	9	6	9	0	0	2	3
5 months+	0	0	2	100	0	0	0	0	0	0
6 months+	88	70	9	7	13	10	1	1	14	11
7 months+	0	0	0	0	2	7	24	80	4	13
8 months+	18	41	10	23	7	16	3	7	6	14
10 months+	0	0	14	41	0	0	8	24	12	35
12 months+	9	8	5	5	0	0	38	36	52	49
18 months+	0	0	0	0	0	0	0	0	3	100
Total	170	41	46	11	28	7	74	18	93	23

nutrient demand, the NHMRC recommends offering 30 g of meat or meat alternatives each day^(6,7); however, the actual meat content in meat-based mixed main dishes amounted to 9.0 (SD 2.7) % of the total ingredients (data not shown) conservatively equating to approximately 0.26 mg or, 2 % of the recommended daily intake⁽²⁵⁾. Despite this, all of these products indicated the type of meat, poultry or fish used prominently within the product name suggesting to consumers it was a good source of protein and, by extension, Fe. Given this nutrient's significance for the developing infant brain, this misleading package labelling is concerning^(19,26). Greater government regulatory oversight may be needed to better inform parents and caregivers.

We found a high proportion of fruit-based products sold as first foods (80 %), and a high proportion of products with free sugars (40 %), mostly snack foods and readymade desserts and breakfasts. Since infants have an affinity towards sweet tastes, foods with intrinsically bitter taste profiles such as vegetables are not as readily accepted⁽²⁷⁾. Three recently published systematic reviews on strategies to improve vegetable acceptance in infants and toddlers all concluded that repeated taste exposure to a variety of vegetables is the most effective approach to increase children's vegetable intake^(27–29). Pairing of vegetables with familiar sweet flavours does not appear to improve vegetable acceptance⁽³⁰⁾. The few available vegetable-only first foods in this audit were sweet varieties, typically carrot or sweet potato, and the mixed fruit and vegetable first foods contained 50–70 % puréed apple. The ubiquity of fruit-based products and limited variety of vegetable-based first foods are concerning as this may limit exposure to and reduce acceptance of vegetables and foods with plain or bitter tastes in infants mostly consuming commercial baby foods. However, further research is needed to better describe the degree to which consumption of these foods impacts dietary diversity later in life⁽³¹⁾.

According to the Australian NHMRC Infant Feeding Guidelines, by 12 months, special baby foods are no longer necessary, and toddlers should eat family foods consistent with the Australian dietary guidelines. Before 12 months, children should be exposed to a variety of family foods^(6,7). In our audit, nearly one half of all products aimed at older infants 8 months and up were packaged in squeeze pouches, most of which were smooth puréed foods. This is inconsistent with guidelines that infants should be exposed to a variety of foods of increasingly

challenging textures moving from smooth purées, to mashed and soft lumpy foods and finally to solid foods⁽⁶⁾. Recent surveys echoed similar findings^(14–16). The concern is that squeeze packs may lead to poor feeding skills acquisition and oro-motor development, delaying self-feeding skills⁽⁶⁾. Feeding directly from a squeeze pouch discourages active exploration and handling of food that facilitates independent feeding skills such as picking up food, finger and spoon feeding and drinking from a cup^(14,15,32).

The NHMRC recommends that discretionary foods such as cakes, biscuits or potato chips should be limited or avoided in young children's diets as they are high in saturated fat, added sugars and/or added salt⁽⁶⁾. We identified a high number of discretionary snack foods aimed specifically at toddlers. Although the serve sizes were smaller, these products were the most energy dense and contained the highest amounts of total sugars and Na compared with other categories. Sweet and savoury snack food intake is established early in life and may set up dietary habits contributing to excess discretionary food consumption. Data from the 2011–2012 Australian National Nutrition and Physical Activity Survey revealed that Australian children and adolescents consume more discretionary foods than recommended⁽³³⁾. Among children 2–3 years old, discretionary foods accounted for 29 % of total energy intake, and sweet biscuits, butter and dairy fats, and processed meat dishes were the most commonly consumed products⁽³³⁾.

Moreover, 40 % of the savoury finger foods identified were highly processed extruded puffs, mostly made of rice and corn flour, low in dietary fibre. These products, primarily packaged in smaller quantities, are also designed to melt upon ingestion limiting the oro-sensory exposure time for the eating occasion⁽³⁴⁾. Smooth purées in squeeze packs also have reduced oral processing facilitated by their trademark packaging; however, the uniform packaging size can be misleading as several products contain two serves within a single package. Indeed nearly 20 % of readymade desserts and breakfasts contained two serves (data not shown). Taken together, the packaging and serve size of extruded snack foods and puréed squeeze pack foods may promote snacking behaviour and excess energy intakes, respectively. The textural properties of these products may also be disruptive to normal physiological responses to food intake and satiation^(14–16,35).

The present study has several strengths, specifically, the thorough identification of foods for sale specifically targeted at children <24 months. Researchers surveyed retailer and manufacturer websites of seventeen popular brands and visited major supermarket chains in metropolitan Adelaide to compile nutrition information. Furthermore, the present study provides nutrition information on products currently on the market as well as new information on the packaging type and texture profiles of Australian commercial baby foods. A potential limitation is that the information presented on product packages and/or manufacturer websites may not necessarily reflect true nutrient content; however, brands included in our analysis covered 90% of the market share, and therefore, we can be confident in our results. Another limitation is the nutrient analysis of dry cereals. Nutrition information was presented as prepared products, made up with water, milk or expressed breast milk. Thus, it was not possible to evaluate true nutrient content of products as sold.

Conclusion

The nutritional and textural properties of a high proportion of commercial infant and toddler products were poorly aligned with feeding guidelines, being low in Fe, sweet tasting, smooth in consistency and classified as discretionary foods. Only 12% of products included information on Fe. Most products, especially mixed main dishes, were poor sources of Fe. Vegetable first foods were most commonly sold in combination with sweet fruits and, when presented alone, were sweet varieties. Most puréed products were packaged in non-traditional squeeze pouches that may not encourage spoon feeding. A high proportion of savoury snack foods were extruded puffs with low nutritional value, and 40% of all products contained free sugars. More stringent monitoring to ensure compliance with Food Standards Australia New Zealand food labelling requirements is needed, particularly with Fe content.

There is scope for manufacturers of commercial baby foods to improve their products to support implementation of infant feeding guidelines, specifically, reformulation to offer vegetable-only first food varieties, mixed main dishes with increased meat content and reduced proportions of sweet fruits in mixed vegetable and fruit products. Moreover, we encourage companies to include the required nutritional information on all products.

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M. J. N. designed the research. M. J. N. and N. A. M. developed the research protocol and conducted the research. N. A. M. performed the statistical analysis. M. J. N., N. A. M., T. J. G. and R. K. G. drafted, reviewed and edited the manuscript. M. J. N. had primary responsibility for the final content. All authors read and approved the final version of the manuscript.

The authors declare that there are no conflicts of interest.

Supplementary material

For supplementary material referred to in this article, please visit <https://doi.org/10.1017/S0007114520001695>

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