

# Transitions in Infants' and Toddlers' Beverage Patterns

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## ABSTRACT

**Objective** To describe transitions and patterns in infants' and toddlers' beverage intakes, with focus on nonmilk beverages.

**Design** A cross-sectional study was conducted by telephone to obtain a 24-hour dietary recall of infants' and toddlers' food intakes, as reported by mothers or other primary caregivers.

**Subjects** A nationwide sample of infants and toddlers (n=3,022) ages 4 to 24 months, who participated in the Feeding Infants and Toddlers Study (FITS).

**Analyses** Beverages were categorized as total milks (ie, breast milk, infant formulas, cow's milk, soy milk, goat's milk), 100% juices, fruit drinks, carbonated beverages, water, and "other." Analyses included means  $\pm$  standard deviations, percentages, frequencies, nutrient densities, and linear regression.

**Results** Beverages provided 84% of total daily food energy for infants 4 to 6 months of age, decreasing to 36% at ages 19 to 24 months. Apple juice and apple-flavored fruit drinks were the most frequently consumed beverages in the 100% juice and fruit drink categories, respectively. Juices, fruit drinks, and carbonated beverages appeared to displace milk in toddlers' diets ( $P < .0001$ ).

**Applications/Conclusions** This research shows that beverages make important contributions to infants' and toddlers' energy and nutrient needs, but they must be wisely chosen. Registered dietitians should advise parents and caregivers that excessive intakes of any beverage, including milks and 100% juices, may displace other foods and beverages in the diet and/or contribute to excess food energy (kcal). Further research is needed to define excessive amounts in each beverage category, and such guidance could be very useful to parents and caregivers of infants and toddlers.

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**B**everage patterns of US youth are of considerable concern to health professionals. Reasons for concern include the increasing consumption of beverages that are high in calories and sugars (1-3), the relation-

ships between these beverages (eg, carbonated beverages, sweetened fruit drinks) and childhood obesity/overweight (4,5), and the displacement of nutritionally desirable foods and beverages in the diet (1,3,6). Carbonated beverage consumption has been shown to be related to bone fractures in adolescents (7) and dental caries in preschool children (8). Beverage intakes in young children are of particular concern because daily intakes of high-calorie, high-sugar beverages appear to increase as children grow older (6,9). Food preferences at two and four years of age are highly predictive of food preferences at eight years of age (10). Thus, transitions in beverage patterns and the development of beverage patterns prior to two years of age may be important to the establishment of healthy patterns in childhood and adolescence, as well as affecting the current health of infants and toddlers. However, relatively few studies have investigated the beverage patterns of infants and toddlers less than two years of age (6,8,11-14). Thus, this portion of the Feeding Infants and Toddlers Study (FITS) was designed to describe beverage patterns of infants four to 11 months of age and toddlers 12 to 24 months of age. A secondary purpose was to investigate whether increased intakes of carbonated beverages and sweetened fruit drinks may displace 100% juice and milk in the diet, as suggested with previous studies with older children (1-3,6,9). The major focus of this paper is on nonmilk beverages; greater detail on intake patterns and transitions in intake of milks has been described in other papers in this supplement (15,16).

## METHODS

The sample included the entire group of 3,022 infants and toddlers in the FITS with the six age groupings, four to six, seven to eight, nine to 11, 12 to 14, 15 to 18, and 19 to 24 months. Mothers or other primary caregivers provided a 24-hour dietary recall of all foods and beverages consumed by the child on the previous day by telephone. Detailed information on food intake data collection, coding, and analyses are in a previous paper (17).

Beverages consumed by the FITS children were categorized into six groups: total milks, 100% juices, fruit drinks, carbonated beverages, water, and "other" drinks; similar groupings, excluding water, have been used previously (3,6,9). Total milks included breast milk, all kinds of infant formula, cow's milk with varying fat content, soy milk, and goat's milk. Although these milks may differ in nutrient composition and nutrient bioavailability, they are more similar to one another than to any of the remaining beverage categories, which also differ in nutrient content within each category. The 100% juice category included infant and adult fruit and vegetable juices that were 100% juice, including juices fortified with calcium and/or other nutrients; this categorization is consistent with food-labeling regulations. Fruit drinks as defined in this study included beverages with less than 100% juice, many of which had added sugars (eg, lemonade, punch),

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and some of which were fortified with one or more nutrients. Although the fruit drink category included many sweetened beverages that have low amounts of real juice, it also included some beverages with higher percentages of juice (eg, cranberry) that would be too tart for consumption without additional sweeteners. Sometimes these sweeteners were other naturally sweet juices. Carbonated beverages included carbonated mineral waters and "diet" and "regular" products that may or may not have contained sugars and caffeine. The water category included noncarbonated bottled water and tap water, both consumed plain or used to dilute other beverages, but excluded water used to prepare infant formula or reconstitute juices and fruit drinks. The "other" drink category included tea, cocoa and other dry milk mixtures, and electrolyte replacement beverages for infants.

Using the six age groupings in the FITS, the percentages of infants and toddlers in each age group who consumed any amount in a beverage category in one day were tabulated. Mean amounts consumed  $\pm$  standard deviations in each beverage category were calculated, including only those infants and toddlers who consumed a beverage from that category. Mean percentages of energy and selected nutrients provided by each beverage category at each age were calculated for the entire sample. Finally, the most frequently consumed beverages in each beverage category at each age were ranked based on frequency of consumption, regardless of amount served.

Because of the difficulty in estimating the quantity of breast milk for young infants who consumed breast milk and other nonmilk foods and beverages, nutrient intakes for four- to six-month-old infants were not included in these analyses (18). Although this same issue of estimating the quantity of breast milk also applies to older breastfed infants, two factors justify including older breastfeeding infants in the analysis. (a) The assumed quantity of breast milk consumed for these older infants (600 mL for breastfed infants older than 6 months) accounts for the fact that energy from solid foods replaces energy from breast milk as solids are introduced. (b) The proportion of infants breastfeeding is substantially lower among infants seven to 11 months of age, suggesting that the issue related to estimating the quantity of breast milk is less important for older infants.

To explore the notion that some beverages may displace others in the diets of toddlers, two linear regression models were developed using SAS, version 8.2, 2001 (Cary, NC). Analyses were limited to data from 15- to 24-month-old toddlers because the numbers of children consuming carbonated beverages at younger ages were too small for analyses with only 24-hour data. The dependent variable in model 1 was nutrient density for calcium (mg/1,000 kcal) with the following independent variables: mother's age (years), toddler's weight for age percentile, toddler's age in weeks, oz/day milk consumed, oz/day 100% juice consumed, oz/day fruit drinks consumed, and oz/day carbonated beverages consumed. The second model included these same independent variables, but the independent variable was nutrient density for vitamin C. A nutrient density approach was selected to control for energy intakes; thus, patterns of beverage consumption could be identified among toddlers whose energy intakes differed. The dependent variables (ie, nutrient densities for calcium and vitamin C) were selected because beverages provide substantial proportions of the total daily intake for these nutrients. The independent variables included

four beverage categories and other factors thought to possibly influence toddlers' diets. A significance level of  $P \leq .05$  was established.

## RESULTS

Beverages, including breast milk and formula, provided 84% of total energy (kcal) for infants four to six months of age, 43% at 12 to 14 months, and 36% at 19 to 24 months. Beverages also provided at least one-third of the daily intakes of calcium; vitamins A, C, and D; protein; and zinc (data not shown).

Some form of milk beverage was consumed by almost all children at each age, although total amounts of milk beverages decreased with increasing age (Table 1). Forty-nine toddlers (4.9% of the samples at 12 to 24 months of age) did not consume any type of milk beverage on the day described by the 24-hour recall. Most of these non-consumers of milk were consuming an electrolyte replacement beverage, which is often prescribed for illness. Along with changes in the percentage of total energy provided by the milks category, the types of milks also changed with increasing age (Table 2). Among infants, breast milk and infant formula were the most common beverages in the milks category, and whole cow's milk was the predominant choice among toddlers. By 19 to 24 months of age, however, over one-third of the sample consumed some form of reduced fat milk. Initially, breast milk and/or formula were the sole sources of energy and nutrients. By 19 to 24 months of age, milks contributed about one-third of the daily protein and vitamin A, more than half of the calcium and vitamin D, and less than one-fourth of the day's energy intake (data not shown).

About one-fifth of the infants four to six months of age drank 100% juice on the day of the 24-hour recall (Table 1), with the percentage increasing to about 60% of the sample at 19 to 24 months. Average amounts consumed by those drinking 100% juice more than doubled from 4.1 oz at four to six months of age to 9.5 oz at 19 to 24 months, and about 10% of toddlers 15 to 24 months of age had over 14 oz of 100% juice. Thus, the increase in the percentage of infants drinking juice occurred by seven to eight months of age, and the major increase in the amount of juice consumed occurred between 12 to 14 and 15 to 18 months of age. Apple juice was the most frequently consumed juice for each age group (Table 2), with baby food apple juice the predominant choice in the four to 11 months of age samples and regular apple juice in the 12- to 24-month samples. Frequencies for apple juice were approximately double that of orange juice, which was ranked second. As shown in Table 2, there was little variety in the kinds of juices offered to infants and toddlers. From seven to 11 months of age, 100% juices provided about 20% of the daily intake of vitamin C and about 4% of daily energy; for toddlers 100% juices provided 32% to 38% of the daily vitamin C and 5% to 7% of energy. Less than 1% of daily vitamin A and less than 5% of daily folate were provided by 100% juices.

The percentage of very young children consuming fruit drinks was less than 10% at four to eight months of age (Table 1), but rose to over 40% at 19 to 24 months. Amounts of 100% juice and fruit drinks consumed were similar, as were the increases with age in the percentages of infants and toddlers consuming these beverages, and the mean amounts consumed per child (Table 1). However 5% of the sample reportedly consumed  $\geq 16$  oz of

**Table 1.** Consumption of beverages by infants and toddlers

Beverage category	Age (mo)											
	4-6 (n=862)		7-8 (n=483)		9-11 (n=679)		12-14 (n=374)		15-18 (n=308)		19-24 (n=316)	
	Consumers % <sup>a</sup>	Mean±SD oz/d	Consumers % <sup>a</sup>	Mean±SD oz/d	Consumers % <sup>a</sup>	Mean±SD oz/d	Consumers % <sup>a</sup>	Mean±SD oz/d	Consumers % <sup>a</sup>	Mean±SD oz/d	Consumers % <sup>a</sup>	Mean±SD oz/d
Total milks <sup>b</sup>	100	26.3±8.7 <sup>c</sup>	100	23.4±8.7	99.7	22.3±9.6	98.2	20.9±9.9	94.2	19.6±10.3	93.4	18.0±9.5
100% juice <sup>d</sup>	21.3	4.1±3.0	45.6	4.9±3.7	55.3	5.4±4.3	56.2	6.3±4.9	57.8	9.3±6.4	61.6	9.5±6.4
Fruit drinks <sup>e</sup>	1.6	3.4±2.6	7.1	3.3±2.6	12.4	5.3±4.7	29.1	7.8±6.3	38.6	8.8±7.8	42.6	10.3±10.4
Carbonated	0.1	2.9±0	1.1	0.2±0.3	1.7	3.0±3.1	4.5	3.9±2.8	11.2	5.3±3.6	11.9	5.5±5.8
Water	33.7	5.5±7.8	56.1	5.9±7.4	66.9	7.1±7.9	72.2	10.2±10.7	74.0	10.6±8.8	77.0	11.4±8.3
Other <sup>f</sup>	1.4	6.8±6.5	2.2	6.8±7.4	3.5	5.7±5.6	6.6	8.5±12.8	12.2	6.7±7.8	11.2	5.6±8.4
Total beverages	100	29.2±8.6	100	29.3±10.5	100	30.8±12.2	100	34.4±13.5	100	36.5±13.5	100	37.1±16.3

<sup>a</sup>Weighted percentages, adjusted for over sampling, nonresponse, and under representation of some racial and ethnic groups.  
<sup>b</sup>Includes breast milk, infant formula, cow's milk, soy milk, and goat's milk.  
<sup>c</sup>Amounts consumed only by those children who had a beverage from this beverage category.  
<sup>d</sup>Fruit or vegetable juices with no added sweeteners.  
<sup>e</sup>Includes beverages with less than 100% juice and often with added sweeteners; some were fortified with one or more nutrients.  
<sup>f</sup>Other beverages category included tea, cocoa and similar dry milk beverages, and electrolyte replacement beverages for infants.

fruit drinks in one day (data not shown). Apple-based fruit drinks were most popular at each age group, and, as with 100% juices, there was little variety (Table 2). For the samples over 15 months of age, the percentages of daily vitamin C, folate, and vitamin A provided by fruit drinks were 6% to 15%, less than 1%, and less than 1% to 4%, respectively. Fruit drinks provided 4% to 6% of total daily energy.

Although the percentage of infants and toddlers drinking carbonated beverages was less than 5% from four to 14 months of age, the percentages more than doubled to over 11% from 15 to 24 months (Table 1). Types of carbonated beverages consumed included colas, fruit-flavored carbonated drinks, and carbonated mineral waters (Table 2). Diet and regular, caffeinated and caffeine-free carbonated beverages were consumed by children in this sample. Carbonated beverages did not contribute to nutrient and energy intakes for the sample as a whole because relatively small amounts of carbonated beverages were consumed; only 1% of the sample had ≥10 oz.

Percentages of infants and toddlers consuming water ranged from 34% at four to six months of age to 77% at 19 to 24 months (Table 1). Toddlers (12 to 24 months of age) had mean intakes of about 11 oz water per day. Tap water had the highest frequency of consumption at each age category (Table 2).

The "other" beverage category was dominated by various types of tea and by fluid and electrolyte replacement beverages formulated for infants. Average amounts ranged from about six to 12 oz/day for those children consuming "other" beverages.

The regression models developed to explore the notion of substitutions among beverage categories are shown in Table 3. In model 1, variables positively related to the calcium density (mean=763 mg/1,000 kcal) in diets of toddlers ages 15 to 24 months were milk consumption and mother's age (mean=30.2±6.4 years). Intakes of 100% juice, fruit drinks, and carbonated beverages were negatively related to calcium density, indicating intakes of these beverages decreased calcium density in the diet. In model 2, variables positively related to density of vitamin C (mean=65 mg/1,000 kcal) were intakes of 100% juice and fruit drinks; negatively related variables were the child's age (mean=19.3±2.7 months) and milk intake. The data support the hypothesis that some beverages displace others in the diet.

**DISCUSSION**

This study confirms that children were consuming a wide variety of beverages prior to two years of age. Milks including breast milk and formula as well as other milks remained the major beverage in children's diets prior to age two years and were the major source of many nutrients. It is appropriate that more milks were consumed than any other beverage category because it is difficult for children to meet daily needs for calcium and vitamin D without some type of milk in the diet (19). The findings that 100% juice appeared to displace milk in the diet and also that milk displaced juice emphasizes the importance of dietary balance. Both milk and 100% juice are nutritious beverages; therefore, parents may not believe that restrictions are necessary (20). Usually they are not, but excessive amounts of any food or beverage must be avoided.

Although the American Academy of Pediatrics (AAP) recommends that juices not be introduced before six

**Table 2.** Most frequently consumed beverages<sup>a</sup> at ages 4 to 24 months

Beverage category	Age of infant/toddler (mo)					
	4-6	7-8	9-11	12-14	15-18	19-24
Milks	Breast milk <sup>b</sup> Formula	Breast milk Formula	Formula Breast milk Milk, whole	Milk, whole milk, 2% Breast milk Formula	Milk, whole Milk, 2% Soymilk Breast milk	Milk, whole Milk, 2% Breast milk Milk, skin
100% juices <sup>c</sup>	Apple <sup>d</sup> White grape <sup>d</sup> Pear <sup>d</sup> Apple, regular	Apple <sup>d</sup> White grape <sup>d</sup> Pear <sup>d</sup> Apple, regular	Apple <sup>d</sup> Apple, regular White grape <sup>d</sup> Grape, regular Pear <sup>d</sup>	Apple, regular Orange, regular Apple <sup>d</sup> Grape, regular	Apple, regular Orange, regular Grape, regular Apple <sup>d</sup>	Apple, regular Grape, regular Orange, regular Mixed berry
Fruit drinks <sup>e</sup>	Apple, sweet	Apple, sweet Dry pkg mix	Apple, sweet	Apple, sweet Punch, regular Dry pkg mix Sports drink	Apple, sweet Punch	Apple, sweet Orange Dry pkg mix Punch
Carbonated	Mineral water	Mineral water Cola	Mineral water Citrus flavor	Cola Mineral water Citrus flavor	Citrus flavor Cola	Cola Citrus flavor Mineral water

<sup>a</sup>Frequencies, product not included if consumed by <10% of sample within an age category; calculations excluded non consumers of that beverage category.

<sup>b</sup>Beverages rank ordered within each category at each age.

<sup>c</sup>Includes only unsweetened products.

<sup>d</sup>Baby food products.

<sup>e</sup>Includes beverages with less than 100% juice and often with added sweeteners; some were fortified with one or more nutrients.

**Table 3.** Influences of toddlers<sup>1a</sup> beverages on nutrient densities for calcium and vitamin C<sup>b</sup>

Variable	Parameter estimate+SE	t-Value	P value
<b>Model 1. Dependent variable: Calcium density (mg/1,000 kcal/d); F=44.61, P&lt;.0001, R<sup>2</sup>=.36.</b>			
Mother's age, y	3.37±1.55	2.17	.03*
Wt/age, percentile <sup>c</sup>	0.40±0.32	1.27	.21
Age, wk	-1.47±0.86	-1.72	.09
Milk, oz	14.26±1.01	14.09	.0001***
100% juice, oz	-6.60±1.62	-4.09	.0001***
Fruit drink, oz	-8.92±1.40	-6.37	.0001***
Carbonated beverage, oz	-9.03±3.75	-2.41	.02*
<b>Model 2. Dependent variable: Vitamin C density (mg/1,000 kcal/d) F=23.94, P&lt;.0001, R<sup>2</sup>=.23.</b>			
Mother's age, y	0.57±0.30	1.90	.06
Wt/age, percentile <sup>b</sup>	-0.11±0.06	-1.72	.09
Age, wk	-0.43±0.17	-2.59	.01**
Milk, oz	-0.59±0.20	-3.01	.003**
100% juice, oz	3.58±0.31	11.46	.0001***
Fruit drink, oz	1.60±0.27	5.91	.0001***
Carbonated beverage, oz	-1.21±0.72	-1.66	.10

<sup>a</sup>Toddlers 15-24 months, only; n=561.

<sup>b</sup>From a 24-hour recall provided by mothers or other primary caregiver.

<sup>c</sup>From Center for Disease Control percentiles.

\*≤.05.

\*\*≤.01.

\*\*\*≤.0001.

months of age (20), it appears that some infants in this study may have had 100% juice earlier than age 6 months (ie, 21% of infants age four to six months drank 100% juice). AAP also recommends that daily juice intake be limited to four to six oz for children one to six years of age; high intakes by a few infants and toddlers suggest that some of the FITS parents did not heed that advice. Other researchers also have reported early introduction of 100%

juices (12,14) and daily amounts over six oz consumed by some children (9). From the data presented in this study, we can conclude that, although 100% juices provide concentrated energy (kcal) and sugars to the diet, they also make significant contributions to daily vitamin C intake. The low contributions of dietary folate by 100% juices reflect the popularity of apple juice, which is low in folate compared with orange juice. Dietitians can help parents

and caregivers recognize the health advantages of juices that provide an array of nutrients. Most parents and caregivers of infants appear to be following AAP recommendations about juice. Among toddlers, the variety of juice consumed could be improved, and amounts should be limited to avoid excessive intakes.

The AAP does not make any recommendations about limiting amounts of fruit drinks or carbonated beverages in the diets of infants and toddlers. Perhaps such guidance is needed. AAP does state that fruit drinks are not nutritionally equivalent to 100% juice, and fruit drinks cannot be considered as a fruit serving (20). However, fruit drinks vary considerably in nutritional quality. In general, fruit drinks with higher percentages of real juice are more nutritious than those with lower percentages of juice; parents and caregivers may be in need of dietary advice about selecting fruit drinks that are beneficial to the diet. Factors to consider are percentages of juices, energy and nutrient content, and limited amount of added sweeteners. Among the FITS toddlers, fruit drinks contributed significantly to vitamin C density.

Results of this study indicate that milk may be displaced in toddlers' diets by 100% juice, fruit drinks, and carbonated beverages. In studies with older children, milk intake decreased as fruit drinks and carbonated beverages increased (3,6,9). The decreasing milk intake and increasing intakes of fruit drinks and carbonated beverages with increasing age in this study may be cause for concern. Infants and toddlers are developing food preferences and food patterns that are likely to carry over to preschool and early school age years (10,21).

This study is among the first to document water intake in infants and toddlers. Water is an appropriate choice for quenching thirst and does not contribute to excessive energy intake. Breastfed and formula-fed infants usually do not need additional water. It has been estimated that infants need 1.5 mL water/kcal of energy expenditure for adequate intakes; this water-to-energy ratio corresponds to that found in breast milk and common infant formulas (22). Caution also must be used so that water does not displace needed energy and nutrients in the diet (23). However, infants are particularly susceptible to dehydration because of their large surface area per unit of body weight, their higher percentage of body water, and their inability to communicate thirst (22). Thus, in unusually hot weather, infants may need some additional water (23). Introducing infants to sips of water also may help them learn to drink water to quench thirst. Of course, these recommendations are based on the availability of a safe water supply.

Excessive amounts of any beverage, including milk, 100% juice, and even water, should be avoided because other foods and beverages may be displaced in the diet, and dietary variety may be decreased (21,24). Further research is needed to define excessive beverage intakes for each type of beverage at various ages, and such definitions would be very helpful to parents of infants, toddlers, and young children. The definitions of excessive intakes of various beverage categories are beyond the scope of this study. The water-energy ratio of 1.5 mL/kcal energy expenditure is a recommendation for adequacy rather than a maximum level. Factors to consider in developing excessive guidelines include toxicity issues (such as those with water), desirable ranges of proportions of solid food to liquid foods in the diet, nutrient needs (especially those provided primarily by beverages),

displacement issues, and the percentage of daily intake that can be allowed for beverages low in nutrients but high in calories.

## APPLICATIONS

- Breast milk and formula are important sources of energy and nutrients for infant; milks also are so for toddlers.
- In addition to milk, wisely chosen juices and fruit drinks with substantial portions of real juice can provide many nutrients and varied flavors to the diets of older infants and toddlers.
- Water is a good choice to quench toddlers' thirst.
- Milk was displaced in toddlers' diets by 100% juice, fruit drinks, and carbonated beverages. However, parents and caregivers should limit excessive intakes of any beverage. The definition of "excessive" will vary among beverage categories.

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