TECHNICAL SCIENTIFIC REPORT

Healthy Beverage Consumption in Early Childhood

Recommendations from Key National Health and Nutrition Organizations

Healthy Eating Research

September 2019

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DEFINITIONS

100% Juice
Beverage made from the extraction or pressing of the natural liquid found in fruits or vegetables; 100% juice means that everything in the container came from a fruit or vegetable with no added sugars or artificial ingredients.

Beverages with Low-Calorie Sweeteners (LCS)
Beverages with no- or reduced-calorie sweeteners. The term LCS includes the six high-intensity sweeteners currently approved by the U.S. Food and Drug Administration as food additives (saccharin, aspartame, acesulfame-potassium, sucralose, neotame, and advantame) and 2 additional high-intensity sweeteners permitted for use in the food supply (steviol glycosides and monk fruit). Other terms for LCS include non-nutritive sweeteners, artificial sweeteners, and sugar substitutes.[1]

Caffeinated Beverages
Drink that contains caffeine, a legal stimulant that is mildly addictive. Common caffeinated beverages include coffee, tea, soft drinks, and energy drinks.

Flavored Milk
Cow's milk to which caloric sweeteners have been added for the main purpose of improving palatability. Common examples include chocolate milk or strawberry milk. These products have also been referred to as sweetened milk.

Plain Drinking Water
Unflavored, unsweetened, uncarbonated, fluoridated drinking water.

Plain, Pasteurized Milk
Cow's milk that has been heated to a specified temperature and for a specific length of time to kill pathogens that may be found in raw milk, and to which no caloric sweeteners, artificial sweeteners, or flavorings have been added. Common varieties include whole milk (also known as Vitamin D milk), reduced fat (2%), low-fat (1%), and skim (fat-free).

Plant Milks/Non-Dairy Beverages
Non-dairy, alternative milk beverages that are derived from plant-based ingredients (e.g., rice, nuts/seeds, coconut, oats, peas, or blends of these ingredients) and often fortified with nutrients found in dairy milk. Many plant milks come in both sweetened and unsweetened varieties; sweetened varieties generally contain added sugars.

Sugar-Sweetened Beverages (SSB)
Liquids to which any forms of sugar are added. This category does not include beverages sweetened with low-calorie sweeteners (see definition for "Beverages with LCS"), 100% juice, or flavored dairy and/or plant-based milks.

Toddler Milk
Milk drink supplemented with nutrients and often containing added sugars.[2] These products are marketed as appropriate for children ages 9 to 36 months, and may be marketed as "transition formulas," "follow-on formulas," or "weaning formulas" for children 9 to 24 months and "toddler milk," "growing-up milk," or "young child milk" for children 12 to 36 months.[3]

Whole Fruit
Fresh, frozen, canned, and dried forms of fruit that do not have added caloric or low-calorie sweeteners.[4]

INTRODUCTION

Early childhood (ages 0 to 5 years) is a critical period for establishing healthy dietary patterns and taste preferences, which are important in supporting optimal growth and development and in preventing diet-related chronic disease. Dietary habits established early in life track into childhood and adolescence, and influence diet quality during adulthood.[5,6,7,8,9,10,11] Reported dietary patterns and habits appear to be stable after 3 to 4 years of age,[12] highlighting a unique opportunity during the infant and toddler years to influence children's lifelong dietary patterns.

Beverages play a critical role in young children's health as they comprise a larger portion of the recommended overall diet during early life, serving as key contributors to both hydration and nutrition. Establishing healthy beverage patterns during this period of life could be an important public health intervention to help promote adequate intake of nutrients to encourage and to reduce excess intake of nutrients to limit, which could help mitigate risk of adverse health outcomes such as dental caries[13] and obesity.[14] For these reasons, promoting healthy beverage intake during early childhood is a public health priority.

Despite the importance of consuming healthy beverages in early childhood, U.S. survey data indicate that young children's beverage intakes diverge from recommendations. For example, many infants consume cow's milk and 100% juice before their first birthday, and consumption of sugar-sweetened beverages is common among 2 and 3-year-olds.[15] Significant disparities in beverage intake exist by race/ethnicity and income groups; for example, black children are more likely to consume SSB than their white or Hispanic peers.[16] In addition, much remains unknown about beverage consumption patterns and their impact on health outcomes among racial/ethnic minority groups, warranting attention in future research efforts.

In 2018, Healthy Eating Research (HER) received funding from the Robert Wood Johnson Foundation (RWJF) to develop a consensus statement on what young children (ages 0 to 5 years) should be drinking as part of a healthy diet. The consensus statement, developed by an expert panel of representatives from (in alphabetical order) the Academy of Nutrition and Dietetics (AND), the American Academy of Pediatric Dentistry (AAPD), the American Academy of Pediatrics (AAP), and the American Heart Association (AHA), provides authoritative guidance on optimal beverage consumption during early childhood and supports a life course approach to the development of healthy dietary patterns and prevention of chronic disease. The *consensus statement* provides recommendations for what children from birth to age 5 should be drinking as part of a healthy diet and is intended to aid health care providers and practitioners in communicating with parents and caregivers about healthy beverages. The technical report describes the rationale, methods, and evidence that support the consensus recommendations and is intended for stakeholders, such as researchers, policymakers, practitioners, and health care providers.

BACKGROUND

Given the importance of establishing healthy dietary patterns early in life, both national and international health and nutrition organizations have established evidence-based recommendations for beverage consumption—what to drink, how much, and when to introduce—for children ages 0 to 5 years. To date, these recommendations tend to focus primarily on a specific beverage type, such as cow's milk or 100% juice, or on a specific age range during early childhood, such as ages 12 to 24 months. Many of these recommendations are inconsistent and notable gaps exist, such as quantitative recommendations for plain drinking water and guidance regarding plant milks/non-dairy beverages, beverages with low-calorie sweeteners (LCS), and toddler milks. Furthermore, over the past decade, an increasing variety of plant milks/non-dairy beverages, juice beverages, fermented beverages, flavored waters and teas, and other beverages have entered the marketplace, many of which are targeted to children. This increasingly crowded, diverse beverage landscape and the variety of existing, and sometimes inconsistent, recommendations have contributed to confusion among parents and caregivers, health care providers, and other stakeholders about what and how much young children should drink as part of a healthy diet.

To explore the inconsistencies and gaps in existing recommendations, an intensive narrative scientific review, which included a comparison of existing recommendations, was conducted and served as a foundation for the expert panel. The resulting recommendations in the consensus statement are intended for healthy children in the United States and do not address medical situations in which specific nutrient guidance is warranted to manage acute or chronic conditions. In addition, the expert panel did not address breast milk or infant formula, as recommendations in these areas, such as those issued by the AAP[17] and HER,[18] vary by the infant's age, weight, and developmental milestones, and are generally well understood and widely accepted.

METHODOLOGY

This technical report (and the accompanying consensus statement) is the culmination of a structured, multi-component process.

1 Expert Panel and Scientific Advisory Committee Recruitment

HER invited the AND, AAPD, AAP, and AHA to participate in the expert panel process and to designate 2 representatives to serve on the panel. HER engaged an expert in child nutrition to serve as chair of the expert panel and a research consultant to support the expert panel's work (for a total of 10 expert panel members). A scientific advisory committee, consisting of 6 experts with experience in establishing dietary guidance, early childhood nutrition, and nutrition science, was also formed. The scientific advisory committee provided input on the background research strategy and protocols, identified important resources or papers to be included in the technical report and consensus statement, and reviewed the final consensus recommendations for scientific rigor and accuracy.

2 Review of Existing Recommendations

The research consultant and HER staff conducted a review and qualitative analysis of existing policy statements, evidence-based recommendations, and guidelines on beverage consumption among children ages 0 to 5 years. Approximately 50 existing source documents and reports were identified from authoritative bodies including AND; AAPD; AAP; AHA; HER; U.S. government agencies, including the Centers for Disease Control and Prevention (CDC), U.S. Department of Agriculture (USDA), U.S. Food and Drug Administration (FDA), and U.S. Department of Health and Human Services (HHS); the National Academies of Sciences, Engineering, and Medicine; and other national and international bodies. Beverage recommendations and other relevant information were extracted from these resources and qualitatively reviewed for areas of inconsistency and consistency. This information was consolidated into a set of comprehensive background materials that was shared with the expert panel prior to its first meeting and referenced throughout the duration of the project.

While the review identified consistency in many areas, several gaps in recommendations were also found, as well as conflicting guidance for whether certain beverages should be consumed and/or the amounts in which they should be consumed. These inconsistencies clustered around 1) 100% juice; 2) flavored milk, plant milks, and toddler milk; 3) beverages with low-calorie sweeteners; and 4) drinking water and overall hydration.

3 Working Group Activities and Literature Review Execution

These 4 categories of beverages (identified to have inconsistencies or gaps in recommendations) led to the development of 4 working groups tasked with 1) further exploring the health impacts of consumption of these beverages in early childhood; and 2) developing clear and consistent recommendations for various age subgroups, as the evidence allowed. Each working group had 4 members, 1 individual from each of the 4 organizations represented on the expert panel, and was assisted by a research consultant and HER staff. Each working group developed research questions related to their topic and outcomes of interest, and subsequently developed a string of search terms for the literature review. Consistent inclusion and exclusion criteria were used across all 4 working groups. The methodology for each search/literature review was developed in consultation with, or reviewed by, members of the scientific advisory committee.

Additionally, the water and hydration working group conducted an analysis of 2011-2016 National Health and Nutrition Examination Survey (NHANES) data to derive a recent estimate of median total water intakes among various age subgroups of young children (see the section on water and hydration, as well as *Appendix A*, for more information).

Additional detail on the literature reviews, including the research questions explored, inclusion/exclusion criteria, and search strategy is provided in *Appendix A*. A list of included studies with their respective funding sources is provided in *Appendix E*.

4 Expert Panel Discussion and Deliberation

The expert panel members met approximately 1 to 2 times per month, either as a full group or in their working groups, to discuss and deliberate the existing beverage recommendations and findings of the literature reviews. Over a 6-month period, the full expert panel met 5 times virtually and 1 time in person, and the 4 working groups each met 3 times virtually. At the in-person meeting, the working groups shared the results of the literature reviews with the full panel, and the group established preliminary recommendations for the 4 beverage categories of interest. The group also discussed other ancillary aspects of beverage consumption, including caffeination and mode of consumption. Throughout the project, the scientific advisory committee was consulted periodically as needed.

5 Development of Final Consensus Recommendations

The overall research efforts and literature review results were instrumental in developing the consensus statement. The final recommendations and their supporting rationale were drafted and reviewed by all members of the expert panel, as well as the scientific advisory committee, and refined as needed. The recommendations were incorporated into a brief consensus statement and this technical report, which were circulated to the 4 national health and nutrition organizations represented by the expert panel for final review and approval. These 2 products were finalized after full consensus was achieved among the 4 organizations, HER, and RWJF.

EXPERT RECOMMENDATIONS

The expert panel's recommendations are presented in 3 categories: 1) Beverages recommended as part of a healthy diet (plain drinking water and plain, pasteurized milk); 2) Beverages to limit (100% juice); and 3) Beverages not recommended as part of a healthy diet in early childhood (plant milks/non-dairy beverages, flavored milk, toddler milk, sugar-sweetened beverages, beverages with LCS, and caffeinated beverages). Table 1 provides an overview of the recommendations, which are broken into age subgroups.[a] In the following report sections, the recommendations for each beverage category are presented along with background information (including a brief summary of existing recommendations), consumption data, and findings from the literature review about the health impact associated with consumption of that beverage category. A summary of the literature review key findings is presented first, followed by additional details about the findings for each outcome of interest.

Table 1: Summary of Recommendations for Healthy Beverage Consumption, Ages 0 to 5 Years[b]

		0-6 months	6-12 months	12-24 months	2-5 years		Notes
					2-3 years	4-5 years	
Beverages Recommended as Part of a Healthy Diet	Plain drinking water	No supplemental drinking water needed	Approximately 0.5-1.0 cups (4-8 oz.)/day in a cup. Begin offering during meals once solid foods are introduced.	1-4 cups (8-32 oz.) per day	1-4 cups (8-32 oz.) per day	1.5-5 cups (12-40 oz.) per day	Where an individual child falls within these ranges for 12 months to 5 years will depend on the amounts of other beverages consumed during the day.
	Plain, pasteurized milk	Not recommended	Not recommended	2-3 cups (16-24 oz.) per day whole milk	Up to 2 cups (16 oz.) per day skim (fat-free) or low-fat (1%) milk	Up to 2.5 cups (20 oz.) per day skim (fat-free) or low-fat (1%) milk	For 12-24 months, reduced-fat (2%) or low-fat (1%) milk may be considered in consultation with a pediatrician, especially if weight gain is excessive or family history is positive for obesity, dyslipidemia, or other cardiovascular disease; the total amount of milk consumed during this age will depend on how much solid food is being eaten.
Beverages to Limit	100% juice	Not recommended	Not recommended	Whole fruit preferred. No more than 0.5 cup (4 oz.) per day 100% juice.	Whole fruit preferred. No more than 0.5 cup (4 oz.) per day 100% juice.	Whole fruit preferred. No more than 0.5-0.75 cup (4-6 oz.) per day 100% juice.	Amounts listed for ages 12 months to 5 years are upper limits (not minimum requirements) that may be consumed only if fruit intake recommendations cannot be met with whole fruit.

a The age subgroups provided in the expert panel's recommendations use whole numbers for the purposes of simplicity and are not intended to overlap. For example, a given beverage recommendation for ages 0-6 months, 6-12 months, 12-24 months, and 2-5 years is intended to refer to 0-5.9 months of age, 6-11.9 months of age, 12-23.9 months of age, and 24-60.0 months of age.

b The expert panel did not address breast milk or infant formula, as recommendations in these areas vary by the infant's age, weight, and developmental milestones, and are generally well understood and widely accepted.

		0-6 months	6-12 months	12-24 months	2-5 years	Notes
Beverages Not Recommended as Part of a Healthy Diet	Plant milks/Non-dairy beverages	Not recommended	Not recommended	Not recommended for exclusive consumption in place of dairy milk; consume only when medically indicated (e.g., cow's milk allergy or intolerance) or to meet specific dietary preferences (e.g., vegan)	Consume only when medically indicated (e.g., allergy or intolerance) or to meet specific dietary preferences (e.g., vegan)	Consumption of these beverages as a full replacement for dairy milk should be undertaken in consultation with a health care provider so that adequate intake of key nutrients commonly obtained from dairy milk can be considered in dietary planning.
	Flavored milk	Not recommended	Not recommended	Not recommended	Not recommended	Added sugars intake should be avoided in children <2 years old and minimized in children 2-5 years old to avoid contributing to early establishment of a preference for sweet taste as well as potential negative impacts on nutrient intake and diet quality.
	Toddler milk	Not recommended	Not recommended	Not recommended	Not recommended	These products offer no unique nutritional value beyond what a nutritionally adequate diet provides and may contribute added sugars to the diet and undermine sustained breastfeeding.
	Sugar-sweetened beverages (SSB)	Not recommended	Not recommended	Not recommended	Not recommended	Strong evidence demonstrates the adverse health effects of SSB, which include, but are not limited to, soft drinks/soda, fruit drinks, fruit-flavored drinks, fruitades, sports drinks, energy drinks, sweetened waters, and sweetened coffee and tea beverages.
	Beverages with low-calorie sweeteners (LCS)	Not recommended	Not recommended	Not recommended	Not recommended	This recommendation is based on expert opinion given that early childhood is a critical developmental period, and there is a lack of evidence regarding the long-term health impact(s) of LCS consumption in young children.
	Caffeinated beverages	Not recommended	Not recommended	Not recommended	Not recommended	Caffeinated beverages are not appropriate for young children.

Notes: All amounts listed are per day, unless otherwise noted; 1 cup = 8 fluid ounces.

BEVERAGES RECOMMENDED AS PART OF A HEALTHY DIET IN EARLY CHILDHOOD

Plain Drinking Water and Overall Hydration

Water is the single largest component of the human body and is essential for life, but there is no single daily total water requirement for a given person. Individual water needs can vary greatly, even on a day-to-day basis, because of differences in physical activity, climate, and to a lesser extent, dietary factors.[c] In addition, the human body is generally able to compensate for some degree of over- and under-hydration in the short term. Because normal hydration can be maintained over a wide range of water intakes and evidence was not available to set a Recommended Dietary Allowance (RDA), the Dietary Reference Intakes (DRIs) for water, established in 2005, are comprised only of Adequate Intake (AI) reference values. AIs are a recommended average daily intake level based on observed or experimentally determined estimates of intake by a group (or groups) of apparently healthy people that are assumed to be adequate.[19]

The AIs for water are based on the median total water intake (from foods and beverages) from NHANES 1988-1994. Thus, the AI reference values for water in young children provide both a total daily water amount, as well as the proportion that is assumed to come from only fluids/beverages (i.e., not counting the water content of foods). For young children, the percentage of total daily fluids consumed from foods was determined to be approximately 25% for 7 to 12-month-olds and 29% for children ages 1 to 3 years and 4 to 8 years; leaving about 70-75% of total daily fluid needs coming from beverages (including drinking water). The resulting AI reference values for total water for young children are presented in Table 2.

Table 2: Adequate Intakes for Water[d]

Age Group	AI for total water (per day)	Amount of AI included as beverages	Notes
0-6 months	0.7 L	0.7 L assumed to be from human milk	The AI is derived based on data regarding human milk consumption for this age group; infants exclusively fed human milk do not require supplemental water.
7-12 months	0.8 L	0.6 L (≈ 3 cups) assumed to be mostly from human milk	The AI is derived based on data regarding human milk consumption for this age group.
1-3 years	1.3 L	0.9 L (≈ 4 cups)	The AI is set based on the median total water intake using data from NHANES III (1988-1994) and rounding to the nearest 0.1 L.
4-5 years	1.7 L	1.2 L (≈ 5 cups)	The AI is set based on the median total water intake using data from NHANES III (1988-1994) and rounding to the nearest 0.1 L. The expert panel was charged to focus only on children up to age 5, but notes that this adequate intake reference value is for children ages 4 to 8 years.

Source: Institute of Medicine. 2005. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, DC: The National Academies Press.

c For example, water requirements cannot be considered in isolation from macronutrient and electrolyte consumption because these nutrients are critical to water balance.

d Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz

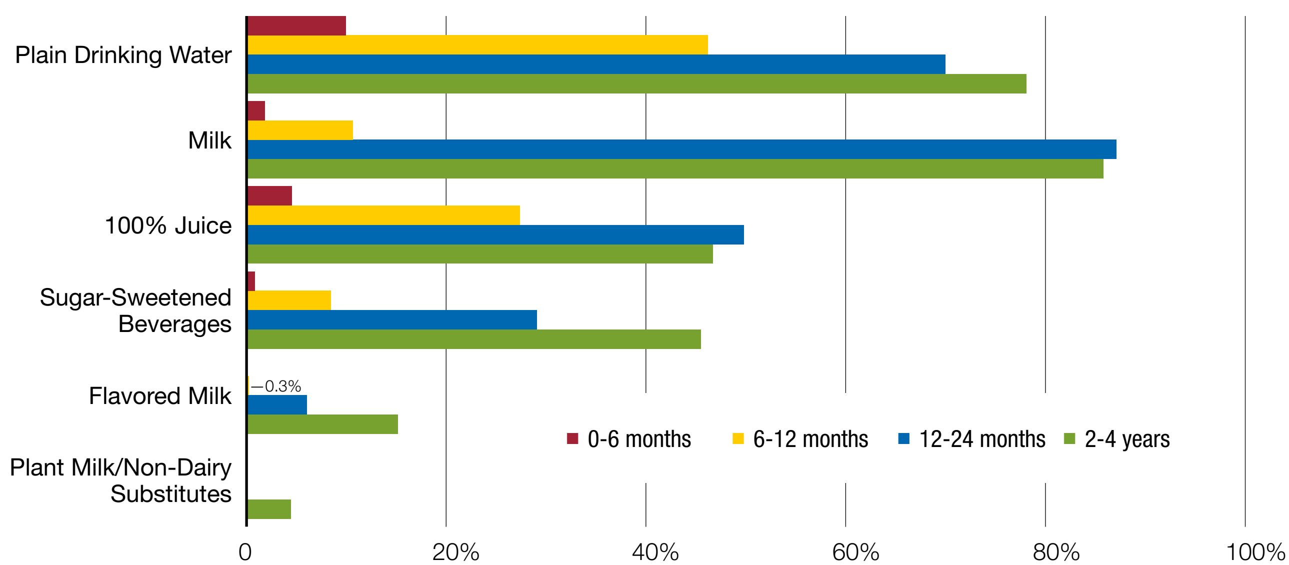
The AI for total water is for the purpose of hydration and is set to prevent deleterious, primarily acute, effects of dehydration, which include metabolic and functional abnormalities. No Tolerable Upper Intake Level (UL) was set for water because no adverse effects have been reported with chronic high intakes of water in healthy people consuming a normal diet, as long as fluid intake is approximately proportional to losses.[20] There may be extenuating circumstances that could put an individual at risk for excess water intake. For example, water intoxication can occur in infants if too much water is used to prepare infant formula or if water is substituted for breast milk or infant formula.[21,22]

With the exception of the DRIs and a 2017 HER report on feeding infants and toddlers, there is a gap in both research and in existing quantitative recommendations regarding recommended drinking water intake for young children. General guidance is consistent in encouraging young children to drink plain, unflavored, fluoridated water, particularly for beverages consumed outside of meals and snacks. For infants 0 to 6 months of age, only human milk or infant formula are recommended to meet fluid and nutrient needs. The AAP has noted that if human milk or formula intake is adequate, healthy infants do not need additional water except perhaps when the environmental temperature is extremely high.[23] When an infant starts solid foods (generally around age 6 months), HER has suggested to begin offering a small amount (e.g., approximately 4 to 8 ounces total per day) of plain drinking water in an open, sippy, or strawed cup.[18] This practice is intended to introduce the infant to the flavor and mouthfeel of water, as well as to foster cup-drinking skills, which take time to develop, rather than to serve as a source of hydration for the infant. The USDA Child and Adult Care Food Program requires potable drinking water to be offered to children throughout the day and available to children upon their request throughout the day. Regarding water safety, the AAP recommends that if a family drinks well water, it should be tested for nitrates;[24] recommendations for inspection, testing, and remediation for wells providing drinking water for children have also been issued by AAP.[25]

Consumption

The expert panel reviewed several data sources to obtain as complete a picture as possible regarding current beverage consumption among 0 to 5-year-olds, including the most recent Feeding Infants and Toddlers Study (FITS) and several iterations of the NHANES. FITS is the largest dietary intake study of infants, toddlers, and preschoolers in the US, capturing data on young children from ages 0 to 47.9 months. Selected prevalence data from the 2016 study, which reports the percentage of young children up to 4 years old (i.e., 47.9 months) consuming various beverages, is summarized in Figure 1.

Figure 1: Prevalence of Beverage Consumption among Children Ages 0 to 4 Years, FITS 2016[15,16]



Notes:

FITS 2016 collected data on children up to 4 years of age, reported in age groupings of birth to age 5.9 months, 6-11.9 months, 12-23.9 months, and 24-47.9 months.

Milk includes flavored and unflavored cow, goat, and plant milk/non-dairy beverages, but the percentages of goat and plant milk were low. Consumption data for plant milk/non-dairy substitutes are available only for children ages 2 to 4 years in FITS 2016.

Consumption data for toddler milk are not available.

Consumption data for beverages with LCS are not available from FITS 2016, but NHANES data are presented in this report's section on beverages with LCS.

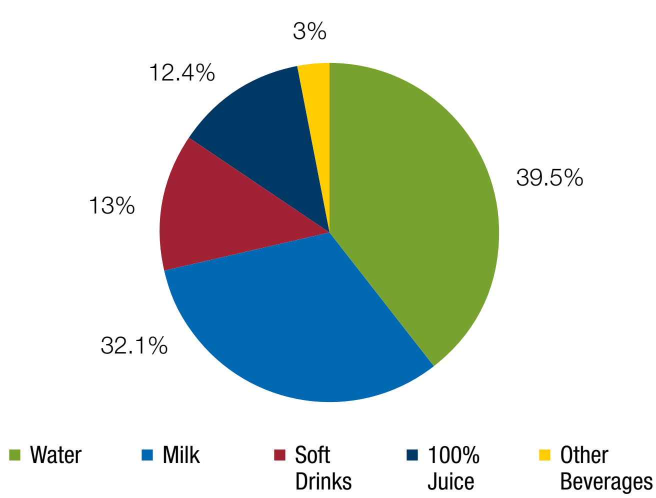
The percentage of young children that reported consuming plain drinking water on the day of the FITS 24-hour dietary recall survey is:[15]

- **0-6 months:** 10.0%
- **6-12 months:** 46.2%
- **12-24 months:** 70.0%
- **2-4 years:** 78.1%

Because FITS does not capture data from children older than 4 years, the panel looked to NHANES, a program of studies designed to assess health and nutritional status of adults and children in the U.S., for information on the percentage of 4 to 5-year-olds consuming water. According to NHANES 2011-2014, 79.2% of 4 to 5-year-olds consumed water (includes tap, bottled, flavored, carbonated, enhanced, fortified, and baby water) on the day of the survey.[26]

Data from NHANES is also available regarding the contribution of beverage types to total fluids for 2 to 5-year-olds (Figure 2). Based on NHANES 2013-2016, water accounted for the greatest proportion of beverage intake (39.5%) among children ages 2 to 5 years. Water and milk together made up approximately 71% of these children's beverage consumption; the remainder was from soft drinks, 100% juice, and other beverages.[27]

Figure 2: Contribution of Beverage Types to Total Beverage Consumption among Children Ages 2 to 5 Years: United States, 2013-2016[27]



Notes: Percentages are based on total grams of reported beverage intake. Other beverages include: coffee, tea, sports and energy drinks, and other miscellaneous beverages.

According to the most recent NHANES data from 2015-2016, 83% of 2 to 5-year-olds consumed water (tap, bottled, flavored, carbonated and enhanced/fortified water) on any given day, and among consumers, mean daily intake was 2 cups (16 fluid ounces) for water and about 4 cups (31 fluid ounces) for all beverages.[28]

The consumption data summarized here from both FITS and NHANES demonstrates room for improvement in current beverage consumption patterns for 0 to 5-year-olds in the U.S.

Analysis of Total Water Intake in NHANES 2011-2016

To examine if median total water intakes from more recent NHANES data were consistent with the data from NHANES 1988-1994 that were used to establish the AIs for total water, the expert panel requested an analysis of NHANES 2011-2016. The median total water intake reported in NHANES 2011-2016 was calculated for ages 6 to 12 months, ages 12 to 24 months, and ages 2 to 5 years. It was also calculated for ages 1 to 3 and ages 4 to 8 to facilitate comparison to the current AIs.

The median total water intakes for 6 to 12-month-olds and 12 to 24-month-olds in NHANES 2011-2016 were similar to mean total water intakes reported for these age groups in an analysis of NHANES 2005-2012.[29] In a comparison of the median total water intake in NHANES 2011-2016 with the AI reference values, the results were similar for children ages 1 to 3 years (1189 ml vs. 1300 ml, respectively), but not for children ages 4 to 8 years (1307 ml vs. 1700 ml, respectively). The differences could reflect differing methodological approaches or temporal changes in beverage intake. However, the median total water intakes in NHANES 2011-2016 for children ages 4 to 8 years (1307 ml) were more similar to the mean total water intakes reported for this age group based on an analysis of NHANES 2005-2010 (1447 ml)[30] and NHANES 2007-2010 (1405 ml for females and 1427 ml for males).[31] Based on these estimates, the expert panel considered a range of 1300-1700 ml to reflect total water intake needs among children ages 4 to 8 years. More detail about the analysis of young children's total water intakes in NHANES 2011-2016 is available in *Appendix A*.

In addition to comparing the AIs with more recent estimates of median and mean total water intakes for young children, the expert panel examined more recent data on the proportion of total water intake that came from foods versus beverages. For children ages 6 to 12 months, approximately 21% came from foods and 79% from beverages.[29] For children ages 12 to 24 months, approximately 24% of total water intake came from foods and 76% came from beverages.[29] For children ages 4 to 8 years, approximately 30% of total water intake came from foods and 70% came from beverages.[30] These percentages are similar

to those reflected in the AIs; thus the expert panel determined the AIs were sufficient for their purposes of establishing water recommendations for 0 to 5-year-olds.

Health Impact Literature Review

The expert panel searched for relevant literature to explore whether any adverse outcomes are associated with young children's plain drinking water consumption (namely, displacement of nutrient-dense foods and beverages); whether there is an optimum amount of fluid that young children should consume daily, or an optimum amount of fluid that should come from plain drinking water; and what beverages, and in what amounts, should ideally contribute to young children's total fluid intakes. The panel followed the search strategy outlined in the Methodology section. The literature search did not return any relevant results, but 2 articles on these topics were hand pulled.

Summary of Literature Review Key Findings for Water

There is a lack of research exploring optimum daily fluid amounts in young children, as well as a lack of quantitative guidance for plain drinking water consumption in this population. There are few studies in children that explore dietary regulation as it relates to drinking water intake. In the studies available, young children's plain water intake did not displace food intake at a subsequent meal, but when caloric beverages were consumed, young children compensated for those calories by consuming fewer calories during or shortly after consuming the beverage. Additional research could clarify age brackets in which energy regulation may vary.

Fluid Displacement of Foods

- A 2012 review conducted by a non-profit group identified 1 study including children ages 0 to 5 years.[32] Conducted in 36 preschoolers in Sweden, it tested the effects of consumption of 1.8 ounces of either milk or water prior to consuming a lunch meal. Consuming milk with meals increased energy intake compared to water with meals, and milk displaced solid food more than water (meal intake was reduced by ~10% when consumed with milk vs. water).[33]

- A 2010 systematic review (funded by the bottled water industry) included 2 studies covering children ages 0 to 5 years.[34] One was the same non-profit-funded Swedish study identified in the 2012 review described above, and the other (partially industry-funded) found that preschoolers (n = 24) consumed significantly fewer snack calories after a fruit drink compared to water regardless of delay (0, 30, and 60 minutes) in serving the snack post-beverage consumption. Percent compensation was statistically equivalent to 100% in all cases (i.e., children reduced snack calories to perfectly offset their beverage calories). They consumed significantly fewer snack calories when diet fruit drinks, compared to water, were served 30 minutes before the snack, but not with a longer delay (60 minutes) or no delay. This pattern was repeated in a second similar experiment (n = 20).[35] Compared to the similar adult studies reported in the systematic review, children had a greater ability to compensate for calorie intake through beverages.

Expert Recommendations

- **0-6 months:** No supplemental drinking water is needed.
- **6-12 months:** Offer a total of 1/2 to 1 cup (4-8 ounces) per day of plain, fluoridated drinking water in a cup during meal times.
- **1-3 years (12-36 months):** 1 to 4 cups (8-32 ounces) per day of plain, fluoridated drinking water, with the specific amount to be determined based on the amount of plain milk consumed.
- **4-5 years (37-60 months):** 1.5 to 5 cups (12-40 ounces) per day of plain, fluoridated drinking water, with the specific amount to be determined based on the amount of plain milk consumed.

Rationale

Water is essential for life, yet there is no single daily requirement of total water or fluid for a given person. The human body is generally able to compensate for some degree of over- and under-hydration in the short term, and thus, normal hydration can be maintained over a range of water intakes. Plus, individual fluid needs vary on a day-to-day basis due to differences in physical activity, climate, and other foods and beverages consumed.[20] While this high intra- and inter-individual variation in water intake needs makes it challenging to establish an upper or lower bound of intake for toddlers and preschoolers, the expert panel proposed a prudent range of recommended plain drinking water for children ages 1 to 5 years estimated to be adequate for normal hydration. The upper and lower bounds of this range are dependent on the AI (namely, the proportion included as beverages) and the NHANES 2011-2016 analysis results (detailed in *Appendix A*), as well as the amounts of plain, pasteurized milk (the only other beverage unconditionally recommended by the expert panel) and perhaps 100% fruit juice consumed throughout the day.

For children ages 6 to 12 months who are eating solid foods, the panel determined that a small amount (e.g., approximately ½ to 1 cup, or 4 to 8 ounces total per day) of plain drinking water may be offered in an open, sippy, or strawed cup. This drinking water is not intended to replace any amount of breast milk or infant formula, and practically speaking, it is unlikely that much of this drinking water will be ingested as many infants ages 6 to 12 months are still developing cup-drinking skills. This practice is suggested to help familiarize the infant with plain water. Based on the available data regarding the development of taste preferences, early introduction of water may help children become accustomed to its taste; however, more data is needed to further evaluate this practice for young children. Drinking water should be tested to confirm that it is free of contaminants, especially for this young population.[36]

For children ages 1 to 3 years, approximately 4 cups (32 fluid ounces) of beverages are included in total water intakes, according to the DRIs (which assume that 70 percent of total water is consumed from beverages). The other beverage unconditionally recommended by the expert panel, plain, pasteurized milk, may be consumed in daily amounts of 2 to 3 cups (children ages 1 to 2 years), and up to 2 cups (children ages 2 to 3 years).[e] Therefore, if children consumed the full amount of milk recommended at these ages, the remaining fluid needs to be fulfilled by plain drinking water would be approximately 1 cup for 1 to 2-year-olds and 2 cups for 2 to 3-year-olds. If less milk is consumed, the remaining fluid needs to be fulfilled by plain drinking water would increase. For example, if no milk is consumed, then 4 cups of plain drinking water would be recommended. If 100% fruit juice is consumed, this additional fluid should also be factored into the amount of plain drinking water to consume. If plain drinking water were the only fluid consumed to meet total fluid needs for 1 to 3-year-old children, careful dietary planning would be essential to promote adequate nutrient intake from foods.

For children ages 4 to 5 years, approximately 4 to 5 cups (32 to 40 fluid ounces) of beverages are included in total water intakes, based on the range indicated by the DRIs and the expert panel's analysis of NHANES 2011-2016. This assumes that 70 percent of total water intake is contributed from beverages. The recommended intake of dairy foods at these ages is 2.5 cups (of which milk could technically contribute any proportion). Therefore, if these children consumed this amount of milk, the remaining fluid needs to be fulfilled by plain drinking water would be approximately 1.5 to 2.5 cups. If less milk is consumed, the remaining fluid needs to be fulfilled by plain drinking water would increase, and could be as high as 5 cups if no milk is consumed. As noted above, careful dietary planning would be required to ensure adequate nutrient intake if plain drinking water were the only fluid used to meet total water needs in this age group.

These examples are summarized in Table 3, and further detailed in *Appendix B*.

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e If plant milks/non-dairy beverages are consumed in place of plain cow's milk in the instance of a cow's milk allergy, lactose intolerance, or vegan or certain vegetarian dietary preferences, the same daily consumption amounts apply for both ages 1 to 3 years and 4 to 5 years.

Table 3: Suggested Plain Drinking Water Intakes for Young Children, Cups* Per Day

Age Group	1-2 years (12-24 months)	2-3 years (24-36 months)	4-5 years
Approximate amount of total water intakes included as beverages (cups)**	4	4	4-5
Recommended amount of plain, pasteurized milk (cups per day)	2-3	Up to 2	Up to 2.5
Amount of beverages to be contributed by plain drinking water if no plain, pasteurized milk is consumed (cups)	4	4	4-5
Amount of beverages to be contributed by plain drinking water if maximum amount of plain, pasteurized milk is consumed (cups)	1	2	1.5-2.5

**1 cup = 8 fluid ounces.*

***Calculated as 70% of the AI for total water (and for ages 4 to 5 years, a range based on 70% of the AI for total water and 70% of the median value for total water intake for ages 4 to 8 years, as calculated in the NHANES 2011-2016 analysis).*

The illustrations in [Appendix B](#) are intended to clarify that foods contribute about 25-30% of total water intake.

Related to plain drinking water, the expert panel notes:

- Carbonated water has been shown to decrease microhardness of the tooth enamel,[37] however, mineral ions, such as calcium ions, can alleviate these destructive effects.[38] There is a lack of evidence to inform a quantitative recommendation about carbonated water consumption.

- Plain drinking water is a beneficial and inexpensive strategy for reducing dental caries; therefore, children are encouraged to consume plain water that is fluoridated according to recommended optimal levels.[39] The fluoride content of bottled water varies greatly; the vast majority of bottled waters do not contain optimal levels of fluoride, and some do not contain any fluoride.[40]

Plain, Pasteurized Milk

The dairy food group is an important component of most young children's diets as dairy products are important sources of calcium, phosphorous, vitamin A, vitamin D, B vitamins, and protein. According to the DGAs, the dairy food group includes milk, yogurt, cheese, and fortified soy beverages. The Dietary Guidelines for Americans (DGAs) recommend daily amounts of dairy based on age rather than recommended daily calorie ranges: 2 cups per day for children ages 2 to 3 years and 2.5 cups per day for children ages 4 to 8 years.[4]

While the DGAs currently do not provide recommendations for children younger than 2 years, a 2017 HER expert panel on feeding infants and toddlers recommended up to 2 cups of milk per day for children ages 1 to 2 years.[18] AAP recommends 2 to 3 cups per day (16 to 24 ounces) of whole milk up until the age of 2 years, but reduced-fat (2%) or low-fat (1%) milk may be considered in consultation with a pediatrician, especially in the presence of excessive weight gain or family history of obesity, dyslipidemia, or other cardiovascular disease (CVD).[41,42] It is important to note that both this HER expert panel and the AAP recommend that children younger than 12 months avoid consuming milk due to risks for intestinal bleeding in their developing gastrointestinal tracts and because it is not well-suited for meeting infants' nutritional requirements.[41] Children younger than 12 months often get the nutrients found in dairy products through formula, breast milk, and complementary foods (for infants ages approximately 6 to 12 months), such as yogurt or cheese.

The DGAs recommend that individuals who are unable or choose not to consume dairy products should be sure to consume foods and beverages that provide the nutrients generally obtained from dairy, including protein, calcium, potassium, magnesium, vitamin D, and vitamin A. Consulting a registered dietitian nutritionist or a pediatrician is recommended in these instances to ensure young children are getting enough of these nutrients in the absence of dairy foods, as these nutrients are essential for proper growth and development.

Consumption

Data from FITS 2016 document the percent of young children consuming milk on the day of the 24-hour dietary recall survey:[15] For their data collection, FITS defines "milk" as including flavored and unflavored cow's milk and plant milks/non-dairy beverages.

- **0-6 months:** 1.9%
- **6-12 months:** 10.7%
- **12-24 months:** 87.1%
- **2-4 years:** 85.8%

Some data suggest that among 18 to 24-month-olds, there are racial/ethnic disparities in the varieties of milk consumed.[43] Among children ages 2 to 4 years, fewer black children consume cow's milk than their white and Hispanic counterparts.[16] The FITS study only includes children up to 4 years (47.9 months) old, but data from NHANES 2011-2014 show that 82.7% of children ages 4 to 5 years consume milk. Like FITS, the NHANES definition includes milk, flavored milk, and milk substitutes. Unlike FITS, the NHANES definition also includes milk shakes and other dairy drinks;[26] unfortunately, disaggregated data are not available to determine the contribution from milks versus these other dairy drinks.

Based on 2015-2016 NHANES data, 65% of 2 to 5-year-old children consumed milk (excludes milk or milk substitutes added to coffee, tea, and/or foods, such as cereal) on any given day. Among milk consumers, mean daily intake was 1.5 cups (12 fluid ounces).[28]

Based on NHANES 2007-2010 data, more than 60% of boys and girls ages 1 to 3 years consumed 2 or more cups of dairy products per day, with most of this dairy intake in the form of fluid milk.[31] About 30% of boys and girls ages 4 to 8 years consumed 2.5 or more cups of dairy products per day.[31] These data indicate that the majority of young children (ages 1 to 3 years) in the U.S. consume recommended amounts of dairy products, but among older children (ages 4 to 8 years), only about 1/3 consume recommended amounts of dairy.

Health Impact Literature Review

The expert panel did not conduct a literature search on the heath impact of plain, pasteurized milk, as existing recommendations for young children's milk consumption are highly consistent.

Expert Recommendations

- **0-12 months:** Children under 12 months should not consume milk.

- **12-24 months:** At 12 months, plain pasteurized whole milk may be introduced. 2 to 3 cups per day (16-24 ounces) of whole milk is recommended until 2 years of age, but reduced-fat (2%) or low-fat (1%) milk may be considered, in consultation with a pediatrician, especially in the presence of excessive weight gain or family history of obesity, dyslipidemia, or other CVD.

- **2-5 years:** At 2 years of age (24 months), children should transition to plain, pasteurized fat-free (skim) or low-fat (1%) milk. Total daily milk intake may be up to 2 cups per day (16 ounces) for ages 2-3 years and up to 2.5 cups per day (20 ounces) for children ages 4 to 5 years.

Rationale

Plain cow's milk is a common, familiar beverage in U.S. diets, and its availability, affordability, and nutrient density make it a good choice for healthy, growing children. An analysis, funded by the dairy industry, indicated that milk was the number one food source of 9 essential nutrients for children 2 to 18 years of age based on data from NHANES 2003-2006: protein, calcium, potassium, phosphorus, vitamins A, D, B12, riboflavin, and niacin (as niacin equivalents).[44] A more recent analysis, using FITS 2016 data, indicated that milks (flavored and unflavored cow, goat, and plant-based) were the number one source of energy, saturated fat, calcium, vitamin A, D, and zinc for both 12 to 24-month-olds and 2 to 4-year-olds.[15]

Therefore, the expert panel concurs with existing recommendations from the DGAs, AAP, and the HER expert panel on Infant and Toddler Feeding regarding plain, pasteurized milk.

The expert panel also notes:

- For children older than 12 months, 1/2 cup (4 fluid ounces) of milk may be offered at each meal or as part of a snack. A child's nutrient intake from other foods will help determine the appropriate total daily amount of milk to offer, however, caregivers should be sure that total amounts consumed align with the recommended ranges for each age group.

- By age 2, children's diets have generally shifted to include a greater proportion of nutrient intake from table foods. Recommended total dairy foods intake is 2 cups per day for children ages 2 to 3 years and 2.5 cups per day for children ages 4 to 5 years. Any proportion of these amounts may come from fluid milk. (For example, 4 to 6 ounces of plain or low-sugar yogurt (<23 grams of total sugars) may be offered in place of 4 to 6 fluid ounces of milk).

- Only plain, pasteurized milk should be consumed, as this reduces the risk of foodborne illness from animal products.[4]

- Caregivers may choose to serve organic milk, however, there is no evidence that doing so provides a consistent nutritional advantage. There are no documented, clinically relevant nutritional differences between organic and conventional milk.[45]

The expert panel recognizes that there has been recent research and discussion regarding the role of dairy fat in healthy dietary patterns.[46] Related to milk intake in young children, some have suggested that fat-free or low-fat milk (instead of whole milk) be offered when milk is introduced at 12 months, while others have suggested that whole milk be given through early childhood (instead of transitioning to fat-free or low-fat milk at 24 months). However, due to an apparent lack of definitive evidence justifying a departure from existing recommendations, the panel chose to be consistent with current guidance that recommends whole milk for children ages 12 to 24 months and fat-free (skim) or low-fat (1%) milk for children ages 2 years (24 months) and older. The panel reiterates the need for future research in this area and further review of the current evidence supporting this guidance.

BEVERAGES TO LIMIT AS PART OF A HEALTHY DIET IN EARLY CHILDHOOD

100% Juice[f]

The fruit food group, as defined by the DGAs, includes both whole fruit (referred to simply as "fruit" from here forward) and 100% fruit juice. 100% fruit juice can be part of a healthy eating pattern, but adhering to recommended portion sizes is critical. 100% fruit juice is lower in dietary fiber—an under-consumed nutrient among children ages 2 to 5 years—than fruit, and can contribute extra calories when consumed in excess.[47,4]

The DGAs recommend 1 to 1.5 cups of fruit per day for young children ages 2 to 8 years. These recommendations are based on dietary patterns of 1,000 to 1,400 calories per day, with most 2-year-olds being at the lower end of this range and most 8-year-olds falling at the upper end.[4] Children's total daily calorie needs increase with age; correspondingly, the amount of fruit needed to meet daily nutrient needs also increases with age. Generally, 1 cup of fruit per day is appropriate for children ages 2 to 3 years, while 1.5 cups is more appropriate for children ages 4 to 5 years. The DGAs and the AAP have indicated that although fruits should be encouraged, 100% fruit juice may be used to satisfy up to half of young children's recommended daily fruit intake (up to 4 ounces for children ages 2-3 years, and 6 ounces for children ages 4-5 years).[48] These recommendations have been widely adopted.

Consumption

Based on 2015-2016 NHANES data for children ages 2 to 5 years, average daily intake of total fruit (including both fruit and 100% juice) was 1.23 cups for boys and 1.19 cups for girls. Less than half of these daily intakes were consumed in the form of 100% fruit juice: boys consumed 0.49 cups of 100% juice (40% of their total fruit intake) and girls consumed 0.42 cups of 100% juice (35% of their total fruit intake).[49] Also, according to NHANES 2015-2016, 40% of 2 to 5-year-olds consumed 100% juice on any given day; and among juice consumers, mean daily intake was 10 fluid ounces.[28]

According to data from FITS 2016, 100% juice consumption is higher in older children—both in terms of the percent of children consuming juice and the amount of juice consumed.[15]

FITS 2016 measured the percentages of young children consuming 100% juice (on the day of the survey):

- **0-6 months:** 4.6%
- **6-12 months:** 27.4%
- **12-24 months:** 49.8%
- **2-4 years:** 46.7%

Similarly, approximately 49% of 4 to 5-years-olds in the United States consumed 100% juice (defined as fruit and vegetable juice) on the day for which dietary intake was collected according to 2011-2014 NHANES data.[26]

FITS 2016 also found racial and ethnic disparities in juice consumption. Among 12 to 24-month-olds, Hispanic (55%) and black (56%) children were significantly more likely than white (37%) children to consume 100% juice.[50] Consumption patterns are similar in 2 to 4-year-olds, where Hispanic (45%) and black (47%) children were more likely than white (39%) children to consume 100% juice, but these differences did not reach statistical significance.[16]

Based on available data, vegetable juice comprises a small proportion of intake when juice consumption includes both fruit and vegetable juice intake. For example, an analysis of 0 to 24-month-olds reported that only 0.4% of children in the sample consumed vegetable juice when 100% juice intake was assessed as both 100% fruit and vegetable juices.[29]

Health Impact Literature Review

The expert panel reviewed relevant literature to explore the impact of consuming 100% juice during early childhood (ages 0 to 5 years) on: nutrient intake and dietary patterns; health outcomes including body weight, dental caries, and diabetes; and (sweet) taste preference development. The panel also explored whether different varieties of 100% juice (e.g. orange, apple, grape juice) vary in their relationships with these outcomes. The panel followed the search strategy outlined in the Methodology section, except 2017 was used as the start date for individual articles examining body weight, dental caries, and diabetes due to a recent systematic review examining 100% fruit juice consumption and these outcomes using literature published through February 2017.[51]

f Throughout this report, "100% juice" refers to 100% fruit juice unless otherwise noted.

Summary of Literature Review Key Findings for 100% Juice

One hundred percent fruit juice may be an important contributor to achieving adequate fruit intake in young children, particularly in certain populations for whom access to and affordability of fruit is limited. In addition, the available evidence suggests that when consumed in recommended amounts, 100% fruit juice does not appear to promote excess weight gain in young children but may, based on limited data, influence consumption of fruit juice and SSB later in childhood.[52] Data on the relationship between 100% juice consumption during early childhood and dental caries is limited, but suggests a positive association with tooth decay. Frequent, continuous consumption of juice (e.g., outside of meals and snacks) prolongs the teeth's exposure to sugars, increasing risk of caries. The expert panel did not identify any data on the relationship of early childhood consumption of 100% juice with diabetes in early childhood. More research is needed to better characterize any relationships between 100% fruit juice intake and these outcomes in young children. In addition, the expert panel did not identify sufficient evidence to justify a recommendation to favor consumption of 1 or more specific varieties of juice.

Nutrient Intake and Dietary Patterns

- A systematic review, partially funded by the juice industry, concluded that "limited evidence" from 8 observational studies (6 of which included children in the 0 to 5-year-old age range) suggests that children consuming 100% fruit juice have higher intake and adequacy of dietary fiber, vitamin C, magnesium, and potassium, compared to non-consumers. The authors cautioned that differences in study designs and methodology preclude causal determination of 100% fruit juice as the sole influences of nutrient intake/ adequacy of shortfall nutrients.[53]
- A few studies published since this systematic review's literature search cut-off date provided additional information on outcomes related to nutrient intake.
    - A non-profit-funded cross-sectional study using data from NHANES 2005-2012 indicated that 100% juice provided the greatest source of vitamin C and the second highest source of sugar, energy, and carbohydrate intake for children ages 12 to 24 months.[29]
    - Another study, which reported industry funding, suggested that it may be a challenge to achieve recommended fruit intakes without a substantial increase in diet costs. It conducted modeling, based on 4 to 18-year-olds from NHANES 2009–2010, to demonstrate that combining fruit with 100% fruit juice capped at AAP standards may be a way to meet fruit recommendations within cost constraints.[54]
    - Finally, a small trial of predominantly white, higher socioeconomic status 4-year-old children (funding source not reported) observed that providing 100% fruit juice (compared to providing water) as part of a snack led to 67% greater energy intake, and children did not appear to compensate for the juice calories by reducing consumption of the snack food.[55]
- Related to dietary patterns, a government- and university-funded prospective cohort study reported an association of 100% juice consumption early in life with greater likelihood of consuming juice and sugar-sweetened beverages at older ages, although additional confounding may be present.[52]

Body Weight

- According to a government-funded 2017 meta-analysis that pooled 8 prospective cohort studies among children ages 1 to 18 years (the mean baseline age was between 1 and 5 years old in 4 of the studies), there was no clinically important change in weight or BMI associated with each 1-serving increment/day (6 to 8 ounces) of 100% fruit juice in children of all ages. Subgroup analyses indicated a statistically significant increase in BMI z-score for each additional serving (6 to 8 ounces) of 100% fruit juice/day in children ages 1 to 6 years.[56] However, considered as a percentage of total body weight, the changes in weight observed among young children (1 to 6 years) were small (<1% increase in total body weight over 1 year) and were deemed unlikely to be clinically important in normal-weight individuals.[51]

- The 2017 meta-analysis noted that although the pooled estimate of weight gain in young children was likely not clinically important, individual studies showed clinically important weight gain in children younger than 2 years old. This suggests that age may modify the association of 100% fruit juice consumption and change in BMI z-score in children, with those ≤2 years old being more susceptible to weight gain from consuming 1 serving/day of 100% juice.

Dental Caries

The available evidence, which is limited to a meta-analysis of mostly cross-sectional studies conducted in children ages 8 to 19 years (which is outside of the expert panel's age range of interest), suggests that 100% fruit juice consumption may be positively associated with tooth decay in children.[57] In addition, prolonged exposure of the teeth to the sugars in 100% fruit juice promotes the development of dental caries. Such exposure occurs, for example, when children are allowed to carry a bottle, portable cup, or other easily-transported container of juice throughout the day.[48]

Diabetes

The expert panel did not identify any studies on the relationship between 100% juice intake and diabetes risk in children. Evidence in adults suggests there is not a strong link between 100% juice consumption and type 2 diabetes risk, but further research in children is needed.[51]

Taste Preferences

The expert panel did not identify any relevant studies designed to examine 100% juice intake and impact on taste preferences. However, the expert panel notes that infants are born with a biological preference for sweet tastes, and early life is an important period for the development of flavor and food preferences.[58,59] Thus, it may be possible that minimizing children's exposure to sweet-tasting exposures during their early years could help reduce their preference for sweetened food and beverages at older ages.

Expert Recommendations

- **0-6 months:** Juice is not recommended.
- **6-12 months:** Juice is not recommended.
- **1-3 years (12-36 months):** No more than 4 ounces of 100% juice per day.
- **4-5 years (37-60 months):** No more than 4 to 6 ounces of 100% juice per day.[g]

Rationale

The expert panel concluded that it is ideal for young children to achieve fruit intake recommendations primarily by eating whole fruits without added sugars or LCS. However, a combination of fruit plus 100% fruit juice is preferred to the alternative of falling short of fruit intake goals.

Therefore, if fruit intake recommendations cannot be satisfied with fruit, the expert panel supports the AAP and DGA recommendations. The expert panel also extends these recommendations to include blends of 100% fruit and vegetable juice.

The expert panel emphasizes that the recommended amounts are considered upper limits for daily servings of 100% fruit juice, not minimum requirements.

The expert panel also provides the following related recommendations and notes:

- It is strongly encouraged that 100% juices should be pasteurized in order to reduce the risk of foodborne illness.
- Frequent exposure to sources of dietary sugars and acids promotes the development of dental caries. If 100% juice is consumed, it should not be given in a bottle or an easily transportable covered cup (e.g., sippy cup) that facilitates continuous consumption throughout the day. If consumed, 100% juice should be part of a meal or snack, not sipped throughout the day.
- Many varieties of 100% juice are available. Nutrient content differs among varieties, and some may be fortified with vitamins and minerals. Additional research can help clarify any health advantages that may be associated with consuming certain varieties. Regardless of the variety, portion size is key.
- For 100% juice blends containing fruit and vegetable juices, choose varieties with no more than 70 milligrams of sodium per portion.[60]
- There are also juice products in the marketplace that are comprised of 100% juice that is diluted with other liquids, such as purified water or coconut water. In general, the proportion of these products that are 100% juice is not clearly labeled on the package. The expert panel suggests that consumers purchase products that are comprised only of 100% juice and dilute them with water at home if they desire (noting that the proportion of 100% juice in the final beverage should adhere to the portion sizes outlined above).
- Juice products with added sugars are not 100% juice and are classified as SSB. They may have names such as juice drink, juice cocktail, juice beverage, fruitade, fruit drink, or fruit punch. These products can be identified by the presence of added sugars in the ingredient list, and the label may list the proportion of the beverage that is comprised of juice, such as "contains 25% juice." The expert panel advises that these products are not recommended for children ages 0 to 5 years (see section on SSB).

g The AAP's guidance of 4 to 6 ounces/day applies to children ages 4 to 6 years, but ages 4 to 5 years is listed here because the expert panel's scope of work is concerned with children up to 5 years old. This upper limit is expressed as range of 4 to 6 ounces because daily fruit intake recommendations for 4 to 5-year-olds may be 1.0 or 1.5 cups depending on their calorie intake, and the upper limit for 100% juice is equal to half of the daily fruit intake recommendation.

BEVERAGES NOT RECOMMENDED AS PART OF A HEALTHY DIET IN EARLY CHILDHOOD

Plant Milks/Non-Dairy Beverages

Plant milks are growing in popularity among consumers, but few understand that they are not nutritionally equivalent to cow's milk. They have widely differing nutritional profiles, reflecting the variety of plant products from which they are derived (e.g., rice, nuts/seeds, coconut, oats, peas, or blends of these ingredients). Many plant milks come in both sweetened and unsweetened varieties, with sweetened varieties generally contain added sugars. With the exception of soy milk, the DGAs do not include these beverages as part of the dairy group because their overall nutritional content is not similar to dairy foods, which are a key contributor of calcium, vitamin D, phosphorus, vitamin A, riboflavin, vitamin B-12, potassium, and choline in U.S. food patterns.[31]

There is little existing guidance for young children's consumption of plant beverages. AAP and HER state that plant milks are not to be substituted for human milk or infant formula during the first year of life. For children ages 1 to 5 years, a few entities specify that any plant milks consumed should be nutritionally equivalent to dairy milk, and the Child and Adult Care Food Program (CACFP) notes that these alternatives can be served in place of cow's milk to children with medical or special dietary needs. Soy beverages, if appropriately fortified, are eligible in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Consumption

According to FITS 2016 data, approximately 4.5% of children ages 2 to 4 years consumed plant milks on the day of survey.[16] Consumption data indicate that these numbers have increased over time. Unfortunately, no FITS data is available on plant milks/non-dairy substitutes for children younger than 2 years, and NHANES includes plant milks under the "milks" category, so disaggregated data for this beverage category is also not available for 4 to 5-year-olds.

Sales data indicate that plant milks are becoming more popular, though these data do not provide demographic details about their consumers. Non-dairy milk sales grew 61% from 2012 to 2017,[61] and according to data from the 52-week period ending April 21, 2019, sales of plant-based milks grew 6% and comprised 13% of the entire milk category.[62]

Health Impact Literature Review

The expert panel reviewed relevant literature to explore the impact of consuming plant milk during early childhood (ages 0 to 5 years) on: nutrient intake and dietary patterns; and health outcomes including body weight, bone density, CVD, and diabetes. The panel followed the search strategy outlined in the Methodology section.

Summary of Literature Review Key Findings for Plant Milks/ Non-Dairy Beverages

Based on the 3 published analyses of the nutrient content of plant milks compared with cow's milk, the nutrition profiles of plant milks vary widely. Although plant milks may be fortified to attain similar nutrient levels as cow's milk, it is not known whether the bioavailability of these added nutrients is comparable to that of their naturally-occurring counterparts in cow's milk. There is a lack of research on diet quality and health outcomes associated with young children's plant milk consumption, but the 2 studies identified on this topic indicated negative health impacts.

Nutrient Intake and Dietary Patterns

The expert panel identified 3 published analyses of the nutrient content of plant milks compared with cow's milk.

- An analysis (funding source not reported) compared cow's milk with 8 common nondairy beverages (almond milk, cashew milk, coconut milk, hazelnut milk, hemp milk, oat milk, rice milk, and soy milk).[63] The authors observed that cow's milk has higher protein content and quality[h] compared with all of the nondairy beverages analyzed, with the exception of soy milk. They also noted that although most of the plant milks were fortified with calcium and vitamin D (in equal or even greater amounts than those found in cow's milk), there was a lack of evidence to indicate the bioavailability (i.e., absorbability) of the nutrients added through fortification in these products. Finally, they observed that—unlike the detailed information available in the USDA National Nutrient Database for Standard Reference about the quantity of several micronutrients in cow's milk—similar data for most of the nondairy beverages was not available, which further complicated the comparison of their nutritional profiles with that of cow's milk. They concluded that cow's milk should not be removed from the diets of young children unless there is a medical indication, and that nondairy milk

h Based on the Digestible Indispensable Amino Acid Score, which scores the digestibility of amino acids in the small intestine and is a measure of both protein content and absorption.

beverages should not be considered adequate nutritional substitutes for cow's milk until nutrient quality and bioavailability are established.

- A second analysis concurred, concluding that if the goal is to provide a beverage nutritionally similar to cow's milk for growing children, then these nondairy beverages (with the exception of soy milk) are not nutritionally similar to cow's milk and are not a good substitute.[64]

- A third analysis (funding source not reported) reviewed numerous plant milks available in Spain, and concluded that they are inappropriate alternatives to breast milk, infant formula, or cow's milk in the first years of life for the same reasons identified by the analyses described above. It also noted that nutrients such as zinc, magnesium, and iron are bound by the phytates present in seeds, so the bioavailability may be reduced in seed-based plant milks. Finally, it specified that fortification should occur after processing, as the processing treatments used to prepare plant milks could cause loss of nutrients.[65]

Similarly, the 2015 DGA Committee noted that most milk alternatives are fortified with similar amounts of calcium as are found in dairy milk, but that the absorption of calcium is less efficient from plant beverages. It also noted that vitamin D and potassium amounts vary across these milk alternatives, and that to obtain a comparable amount of calcium (compared to 1 cup of dairy milk), the required portion size for most plant milks results in higher energy intake.[31]

The expert panel found 2 studies indicating negative impacts of plant milk intake.

- A government- and non-profit-funded cross-sectional study conducted in children ages 1 to 6 years in Canada identified an association between plant milk beverage consumption and lower vitamin D levels. Children who drank only plant milk were at higher risk of having insufficient vitamin D levels (i.e., below 50 nmol/L) than children who drank only cow's milk.[66]

- A second study (funding source not reported) reviewed literature on nutritional diseases associated with consumption of plant milks in infants and young children, and identified 30 clinical cases of nutritional disease (such as metabolic acidosis, kwashiorkor, and rickets) associated with young children's nearly exclusive consumption of soy, rice, or almond beverages. In most of the cases, plant beverages were introduced during the first year of life, but there were a number of cases in which the beverage was introduced during the second year of life.[65]

Body Weight, CVD, Diabetes, and Bone Density

The expert panel did not identify any relevant studies on the relationship between plant milk consumption and body weight, CVD, diabetes, or bone density.

Expert Recommendations

- **0-12 months:** Plant milks/non-dairy beverages are not recommended.

- **1-5 years (12-60 months):** Unsweetened plant milks/non-dairy beverages are not recommended for exclusive consumption in place of dairy milk (with the exception of soy milk); consume only when medically indicated or to meet specific dietary preferences.

Rationale

During the first year of life, plant milks should not be used as a substitute for human milk or infant formula (when human milk or formula provide a significant portion of daily energy intake). Use of alternative fluids as a major component of the diet during this period has been associated with protein energy malnutrition and growth faltering.[41]

Between 1 and 5 years of age, plant milks may be particularly useful for children with allergies or intolerances to cow's milk (about 2.5% of children under 3 years old are allergic to milk[67]), or to accommodate vegan or certain vegetarian dietary preferences. If plant-based beverages are consumed as a full or partial replacement to cow's milk, careful attention should be given to the selection of other dietary choices in order to provide the nutrients that would otherwise be consumed through cow's milk. Accordingly, the choice to consume a plant milk should be undertaken in consultation with a health care provider, such as a pediatrician and/or registered dietitian nutritionist, who can advise on dietary planning. Should plant-based beverages be necessary, the expert panel recommends consuming only unsweetened varieties in order to avoid additional added sugar in the diet.

There may also be price tradeoffs if plant milks are consumed in place of cow's milk. Cup for cup, plant milks tend to be more expensive than cow's milk. *Appendix C* provides a comparison of the nutrient profiles of a variety of plant-based milks to cow's milk, as well as a comparison of cost per serving.

Flavored Milk

Based on existing recommendations, the expert panel observed that flavored milk was the beverage for which guidance was most inconsistent. The CACFP specifies that unflavored milk only be served to children ages 1 to 5 years,[68] 2 previous HER expert panels recommended only unflavored milk for children ages 1 to 5,[18,60] and the AAP notes a preference for unflavored milk.[69,70] The DGAs state that some sweetened milk and yogurt products may be included in a healthy eating pattern if consumed within daily limits for added sugars and total calories. While flavored milk is eligible in WIC, a 2015 analysis found that it is offered in only 6% of states.[71]

Consumption

According to FITS 2016, approximately 6% of children ages 12 to 24 months consumed flavored milk on the day of the survey, whereas approximately 15% of 2 to 4-years-olds consumed flavored milk.[15] Although the percentage of young children consuming flavored milk is relatively small, the expert panel explored the potential health impacts of flavored milks given they are a source of added sugars in young children's diets.

Health Impact Literature Review

The expert panel reviewed relevant literature to explore the impact of consuming flavored milk during early childhood (ages 0 to 5 years) on: nutrient intake and dietary patterns; health outcomes including body weight, bone density, CVD, and diabetes; and (sweet) taste preference development. The panel followed the search strategy outlined in the Methodology section, except 2016 was used as the start date for individual articles examining body weight. This is because a systematic review previously examined flavored milk consumption among children ages 1 to 18 years and weight-related outcomes using literature published through June 2016.[72]

Summary of Literature Review Key Findings for Flavored Cow's Milk

Relatively few peer-reviewed studies examine the relationship of flavored milk consumption with young children's nutrient intake, dietary patterns, body weight, and other health outcomes. The 2 recent systematic reviews that examined studies on the relationship between flavored milk consumption and diet quality outcomes included a total of 9 studies that involved 0 to 5-year-old children. Taken together, these studies suggest that young children's flavored milk consumption has both favorable associations (e.g., increased milk intake, contribution of positive nutrients such as calcium and vitamin D) and unfavorable associations (e.g., increased intake of calories, saturated fat, and added sugars). While studies of older children report mixed and inconclusive results on flavored milk and body weight, there is a lack of evidence on this relationship in young children, although 2 cross-sectional studies reviewed by the expert panel suggested that flavored milk was not associated with weight status. It would be beneficial to have more research (particularly non-industry-sponsored studies) on young children's flavored milk consumption to examine these and other relevant health outcomes.

Nutrient Intake and Dietary Patterns

A non-profit-funded systematic review examined studies on the relationship between flavored milk consumption and diet quality outcomes in children,[72] and included 3 studies encompassing children ages 0 to 5 years.

- In 2 non-industry-funded experimental crossover studies of children ages 18 to 66 months (1 with 40 participants and the other with 135 participants) in a preschool setting, more calories were consumed when flavored milk rather than plain milk was offered with a meal.[73,74]
- In an experimental crossover study of 24 children ages 18 to 66 months in the home setting (funding source not

reported), caloric intake at meals was not significantly higher when flavored milk rather than plain milk was offered with meals.[75]

A food and beverage industry-funded systematic review included 9 studies encompassing children ages 0 to 5 years, 3 of which were also included in the non-profit-funded systematic review and reported above.[76]

- Four cross-sectional studies (2 in children ages 2 to 18 years,[77,78] 1 in children ages 2 to 16 years,[79] 1 in children ages 2.5 to 6.5 years[80]) showed that flavored milk provided similar amounts of calcium as plain milk among flavored milk consumers (1 study reporting), and flavored milk consumers drank more milk overall (2 studies reporting) and had higher total energy and daily sugar intakes (2 studies reporting); flavored milk contributed to a higher percentage of energy and added sugars intake than did plain milk based on cross-sectional population-wide data (1 study reporting).

- In 2 additional studies, preschoolers were offered either plain milk or chocolate milk with their lunch meals. These studies indicated that although children consumed more flavored milk than plain milk at the lunch meals, consumption of other foods did not differ between the plain milk and the chocolate milk groups.[81] Also, the increase in chocolate milk intake, along with no change in other foods consumed, resulted in a net increase in energy intake at the lunch meal.[82]

In addition to the 2 systematic reviews on this topic, the expert panel identified 2 individual articles:

- A partially industry-funded cross-sectional analysis of NHANES 2001-2012 data identified no significant differences in diet quality by flavored milk consumption.[83] This study suggested both favorable and unfavorable nutritional outcomes for flavored milk consumers vs. non-consumers. For example, 2 to 3-year-olds drinking flavored milk drank more milk overall and had higher mean calcium, vitamin D, and potassium intakes. They also consumed significantly more saturated fat. This was the only age group where higher mean intake of added sugars and magnesium was also observed.

- An earlier cross-sectional analysis of NHANES 2003-2006 data assessed the contribution of flavored and plain milk to diets of 2 to 18-year-olds.[78]

Body Weight

- The non-profit-funded systematic review also examined research on flavored milk intake and weight outcomes, reporting mixed and inconclusive results. It examined 3 studies on weight outcomes, but none included any children ages 0 to 5 years.[72]

- Separately, 2 cross-sectional studies reported on flavored milk and weight in children ages 0 to 5 years:

    - A non-profit-funded study of 2 to 4-year-old, predominantly Hispanic WIC participants reported that neither plain nor flavored milk were associated with overweight or obesity prevalence.[84]

    - A university-funded study of 2 to 18-year-old NHANES 2009-2014 participants reported that consumption of added sugars in dairy foods or dairy beverages was not associated with weight status.[85]

CVD, Diabetes, Bone Density, and Taste Preferences

The expert panel did not identify any relevant studies on the relationship between flavored milk consumption and CVD, diabetes, bone density, or taste preferences.

Expert Recommendations

- **0-12 months:** Do not consume milk (flavored or plain).

- **1-5 years (12-60 months):** Consume only plain, pasteurized milk;[i] flavored milk is not recommended.

Rationale

Flavored milk contains caloric sweeteners, and the expert panel concurs with the American Heart Association's recommendation to avoid added sugars for children less than 2 years old. For older children (ages 2 to 5 years), the expert panel considered it appropriate to recommend avoiding flavored milk in order to minimize intake of added sugars and to avoid contributing to early establishment of a preference for sweet taste as well as potential negative impacts on nutrient intake and diet quality.[58,86] The expert panel recommends that after cow's milk is introduced at 1 year of age, only plain, pasteurized milk be consumed by young children.

This recommendation is consistent with CACFP regulations for children ages 1 to 5 years, and with the National Academies of Sciences, Engineering, and Medicine recommendation that only unflavored milk be permitted in WIC food packages.[87]

i Please see the section on plain, pasteurized milk for specific guidance.

Toddler Milk

Many toddler milks have added caloric sweeteners as most are primarily composed of powdered milk, corn syrup solids or other added caloric sweeteners, and vegetable oil. They also tend to have more sodium and less protein than whole cow's milk.[2]

Most U.S. health and nutrition organizations do not make recommendations about toddler milk, although the AAP has noted that follow-up or weaning formulas offer no clear advantage for infants consuming sufficient amounts of iron- and vitamin-containing solid food.[88] The World Health Organization (WHO) has called toddler milk unnecessary and unsuitable as a breast milk substitute[89] and suggests that these products undermine sustained breastfeeding up to 2 years and beyond.[90]

Consumption

The expert panel did not identify any estimates of absolute consumption or consumption prevalence of toddler milks, but observed that manufacturers have marketed these products in Europe for many years and have expanded their marketing to the United States more recently. For example, manufacturers spent $16.8 million promoting toddler milk in the U.S. in 2015 (an increase from $3.9 million in 2012), compared with $9.7 million on infant formula.[2] In a leading company's 2014 annual report, it noted a significant increase in the popularity of its growing-up milk in North America,[91] and its 2015 annual report referenced continued expansion of its growing-up milk business in North America.[92]

Health Impact Literature Review

The expert panel reviewed relevant literature to explore the impact of consuming toddler milks during early childhood (ages 0 to 5 years) on nutrient intake and dietary patterns. The panel followed the search strategy outlined in the Methodology section.

Summary of Literature Review Key Findings for Toddler Milk

Expert recommendations for the compositional requirements for toddler milk have been issued for a global context and by participants with financial relationships that may pose a conflict of interest. Limited data from developed countries outside the United States suggest that toddler milks can contribute to intakes of vitamin D, iron, and essential fatty acids; however, national survey data suggest that dietary intake of most of these nutrients is adequate among infants and toddlers in the U.S.

Nutrient Intake and Dietary Patterns

- A government-funded cross-sectional study of 1,329 high-socioeconomic status children ages 2 to 5 years in New Zealand found that those who drank toddler milk (6% of the sample) had zero risk of low vitamin D status.[93]

- A government-funded cross-sectional study of 500 children ages 1 to 4 years in Ireland reported that toddler milk contributed to 26%, 19%, 16%, and 18% of vitamin D intakes for 1, 2, 3, and 4-year-old children, respectively. They also contributed to 12% of iron intakes in 1-year-olds.[94]

- A government-funded modeling simulation on 12 to 18-month-old children in the UK suggested that replacement of habitual cow's milk intake by a matching volume or 300 ml of young child formula could improve intakes of essential fatty acids, vitamin D, and iron.[95]

In addition to the studies summarized above, the expert panel identified 3 papers that provided recommendations for the compositional requirements for follow-up formulas, 1 for infants ages 6 to 12 months[96] and 2 for young children 1 to 3 years.[97,98]

- There was consensus among the 3 papers that there is no necessity for the routine use of follow-up formulas in young children, but that such products—if of appropriate composition—could be used as part of a strategy to increase intake of iron, vitamin D, and omega-3 polyunsaturated fatty acids and decrease intake of protein compared with unfortified cow's milk.

- The expert panel notes that these 3 papers considered a global context, in which nutrient deficiencies are of greater concern than in the United States, and also that several of the paper's authors reported relevant industry financial relationships.

Related to this topic, the expert panel also identified a cross-sectional study of U.S. children ages 6 to 23 months, which, based on NHANES 2009-2012 data, demonstrated that estimated usual intakes for most nutrients met or exceeded requirements. It noted that most toddlers were at risk for inadequate vitamin D and E intakes and had diets low in fiber and potassium.[99] An analysis of FITS 2016 by WIC participation status concluded that the diets of infants (<12 months) were nutritionally adequate in general. WIC participants had better intakes of iron (ages 6-24 months), zinc, and potassium (ages 6-12 months), saturated fat (ages 2-4 years), and vitamin D (all ages). Most children, regardless of WIC participation status, met the calcium and zinc guidelines, but

large proportions had intakes not meeting the recommendations for iron (ages 6-12 months), vitamin D, potassium, fiber, saturated fat, and sodium.[100]

Expert Recommendations

- **0-12 months:** Avoid supplementation with “transition” or “weaning” formulas; nutrient needs should be met primarily through human milk and/or infant formula.
- **1-5 years (12–60 months):** Toddler milk is not recommended; nutrient needs should be met primarily through nutritionally adequate dietary patterns.

Rationale

The expert panel concluded that although there is no evidence to indicate that toddler milk is harmful, these products offer no unique nutritional value beyond what could be achieved through a nutritionally adequate diet; furthermore, they may contribute added sugars to the diet. Toddler milk is also more expensive than an equivalent volume of cow’s milk.[101] *Appendix D* provides information about the nutritional content and cost of selected toddler milks.

Infants and young children should first aim to meet nutrient needs primarily through human milk and/or infant formula, and then increasingly through healthy foods and beverages as they transition to solid foods. If nutrient-rich food intake appears to be inadequate, other strategies to increase food acceptance should be tried first, before resorting to toddler milks, such as repeated exposures to healthy foods.

Sugar-Sweetened Beverages (SSB)

Two prior HER expert panels have released recommendations on SSB in early childhood.[60,18] Both panels determined that SSB should not be consumed in early childhood due to associations with lower diet quality, development of unhealthy taste preferences, and other adverse health outcomes. The AHA has also recommended that children younger than 2 years avoid added sugars because there is minimal room for nutrient-free calories in the habitual diets of very young children. For children older than 2 years, AHA recommends limiting total added sugar intake to a maximum of 6 teaspoons per day.[102] The DGAs, which include recommendations for individuals ages 2 years and older, recommend that no more than 10% of total daily calories come from added sugars.[4] The AAP and the AHA have also put forth policy strategies to reduce sugary drink consumption in children and adolescents.[103]

Consumption

Most children consume more than the recommended amount of added sugar, and the number one source of added sugar in the diets of young children is SSB.[104]

According to data from FITS 2016, SSB consumption is considerably higher in older age groups.[15] The percentages of young children (ages 0 to 4 years) consuming an SSB (fruit-flavored drinks, soft drinks, sports drinks, and sweetened tea and coffee) on the day of the 24-hour recall survey were:

- **0-6 months:** 0.9%
- **6-12 months:** 8.5%
- **12-24 months:** 29.1%
- **2-4 years:** 45.5%

Among children 0 to 5 years, fruit-flavored drinks are by far the most commonly consumed SSB. According to NHANES 2015-2016, 44% of 2 to 5-year-old children consumed sweetened beverages (soft drinks, fruit drinks, and sports/energy drinks with more than 40 kcal per reference amount customarily consumed) on any given day. Among those consumers of sweetened beverages, mean daily intake was 9 fluid ounces.[28]

There are considerable racial/ethnic differences in SSB intake. For example, among children 1-4 years, black children are more likely to consume SSB than their white and Hispanic peers.[50,16]

Health Impact Literature Review

The expert panel did not conduct a literature search on the heath impact of sugar-sweetened beverages, as this topic has been researched and described previously.[105,106,107] For example, a 2018 review of the evidence demonstrated that in both cross-sectional and longitudinal studies, there is an association between SSB consumption and overweight or obesity, insulin resistance, and dental caries.[108] Some, but not all of these studies, were conducted in children 0 to 5 years old. While no research has been conducted on the impact of SSB consumption on flavor preferences in early childhood, it may be possible that consumption of SSB could contribute to a continued preference for sweet-tasting foods and beverages later in life due to the inherent predisposition for sweet tastes during this period, and the tracking of early life dietary habits into older ages.

Expert Recommendations

- **0-5 years:** SSB are not recommended, including but not limited to, soft drinks/soda, fruit drinks, fruit-flavored drinks, fruitades, sports drinks, energy drinks, sweetened waters, and sweetened coffee and tea beverages.

Rationale

Based on the strength of the evidence demonstrating the adverse health effects of SSB consumption, as described by previous HER expert panels and a joint policy statement from the AAP and AHA, the expert panel concluded that young children should avoid consumption of SSB.

The expert panel considered the SSB definitions used by various entities, including key national and international medical, public health, and nutrition organizations. It also considered how SSB were defined in beverage taxation policies in 3 jurisdictions (Cook County, IL, the city of Philadelphia, PA, and the city of Berkeley, CA). Ultimately, the expert panel chose to use the definition of SSB from the 2015-2020 Dietary Guidelines for Americans, which it adapted slightly to include additional examples (fruit drinks and fruit-flavored drinks) and to clarify that this report's definition of SSB does not include beverages sweetened with LCS, 100% juice, or flavored milks.

Beverages with Low-Calorie Sweeteners (LCS)

The expert panel recognizes that there are nuances to the various terms used to refer to low- and no-calorie sweeteners and chose to use "low-calorie sweeteners" (LCS) in this report and the accompanying consensus statement.

LCS are commonly used as sugar substitutes or sugar alternatives because they are anywhere from 100 to 20,000 times sweeter than sugar (the multiplier of sweetness intensity varies by sweetener) but contribute only a few to no calories when added to foods and beverages.[1] FDA has approved 6 such sweeteners as food additives: acesulfame-potassium, advantame, aspartame, neotame, saccharin, and sucralose. Based on the available scientific evidence, the FDA has concluded that these sweeteners meet the FDA's safety standard of reasonable certainty of no harm under their intended conditions of use (i.e., the types of food products in which they are used and the amounts in which they are added to these products).[109] The FDA has received Generally Recognized As Safe (GRAS) notices for the use of 2 additional LCS. These include steviol glycosides, a natural substance from the leaves of the stevia plant, and monk fruit extract. The FDA has not questioned the GRAS determination of these sweeteners under their intended conditions of use.[1]

FDA approval to use LCS takes into account an acceptable daily intake (ADI), which is measured in milligrams per kilogram of body weight, per day. The ADI is the amount of a substance that is considered safe to eat every day over the course of one's lifetime.[1] A 100-fold safety factor is incorporated into the ADI in that the ADI cannot exceed 1/100th of the maximum amount that has been demonstrated to be without harm in experimental animals.[110] The FDA has determined that the estimated daily intake of the LCS permitted for use would not typically exceed the ADI.[109] An exception is monk fruit extract, for which an ADI has not yet been specified.[1]

There is little existing guidance for young children's consumption of beverages containing LCS. A 2018 AHA science advisory noted the dearth of evidence on the potential adverse effects of beverages with LCS relative to potential benefits, and concluded that on the basis of the available evidence, "at this time, it is prudent to advise against prolonged consumption of LCS beverages by children."[111] The 2015 Dietary Guidelines Advisory Committee report recommended that "added sugars should be reduced in the diet and not replaced with LCS, but rather with healthy options, such as water in place of sugar-sweetened beverages."[31]

Consumption

Estimates of LCS intake are typically derived through self-report (or for young children, parent/caregiver proxy report) of products that contain LCS. This is because quantitative

Table 4: Changes in Time: % of 2 to 5-year-olds consuming any Food or Beverage with LCS

	NHANES 1999-2000	NHANES 2007-2008	NHANES 2009-2012
Food or Bev w/LCS	7.0%	11.9%	21.5%
Bev (only) w/LCS	4.1%	9.4%	13.3%

data on the amount of LCS used in beverages and foods are limited and not easily accessible. Although LCS must be included in product ingredient lists, manufacturers are not required to disclose the amounts used in products (with the exception of saccharin[112]), nor to release the information to federal agencies.[113]

The expert panel identified 4 analyses of NHANES data that examined the percentage of young children ages 0 to 5 years who consume beverages with LCS.

- An analysis of NHANES 2005-2012 data that examined diet beverages (defined as diet soft drinks, diet sports drinks and diet energy drinks) or flavored or enhanced water (defined as flavored or carbonated water and enhanced or fortified water; this category included waters sweetened with LCS) produced the following estimates:[29]
    - **0-6 months:** No consumers of either beverage category
    - **6-12 months:** 0.3% for diet beverages, 0.5% for flavored or enhanced water
    - **12-24 months:** 3.0% for diet beverages, 2.0% for flavored or enhanced water
- An analysis of NHANES 2011-2014 that examined diet beverages (defined as diet soft drinks, diet sport drinks, diet energy drinks, other diet drinks) produced the following estimates:[26]
    - **0-12 months:** 0.0%
    - **12-24 months:** 2.1%
    - **2-3 years:** 3.5%
    - **4-5 years:** 5.1%

  This analysis also examined flavored water, but the percentages reported above do not include the flavored water estimates because that beverage was part of a larger water group that included tap, bottled, flavored, carbonated, enhanced, fortified, and baby water.

Analyses of NHANES data from 1999-2000, 2007-2008, and 2009-2012 indicate that the percentage of children ages 2 to 5 years who consumed any food or beverage with LCS, has increased over time. Similarly, the percentage of 2 to 5-year-old children who consumed beverages with LCS during those NHANES cycles also increased (see Table 4). Similar increases in LCS consumption from all sources and from beverages alone were also observed among older children and adults.[114,115] When use of LCS was evaluated as a proportion of total beverage intake (among both consumers and non-consumers of LCS), consumption of beverages with LCS comprised 1% of the total beverage intake reported in children ages 2 to 18 years in NHANES 2009-2012.[115]

According to NHANES 2015-2016, only 3% of 2 to 5-year-olds consumed diet beverages (defined as diet soft drinks, diet sport/energy drinks and other diet drinks that are low- and no-calorie sweetened). Mean daily intake amounts were not available for consumers of these beverages because of small sample size of reporters.[28] It is important to note that the percent of 2 to 5-year-olds reported consuming beverages with LCS was much lower in 2015-2016 as compared to previous years. This may be due to the fact that the 2015-2016 consumption numbers are based only on 1 day of dietary recall, whereas the previous years were based on 2. More data is needed to determine whether this decrease is actually a change in consumption patterns over time, or simply due to methodological differences between study years.

Health Impact Literature Review

The design and conduct of studies examining the relationship of LCS and health outcomes is inherently complex. Furthermore, in many studies, participant-reported LCS intake lacks specificity and many of the food composition databases also lack accurate LCS values, making it difficult to track actual intake.[116] A challenge of establishing causality between LCS consumption and health outcomes is that LCS intake is likely to be an indicator of other variables. For example, parents and caregivers of young children may offer LCS beverages out of concerns about their child's weight gain.[117]

With this complexity in mind, the expert panel reviewed relevant literature to explore the impact of consuming beverages with LCS during early childhood (ages 0 to 5 years) on: nutrient intake and dietary patterns; health outcomes including body weight, CVD, and diabetes; and (sweet) taste preference development. The panel followed the search strategy outlined in the Methodology section, except 2017 was used as the start date for individual articles examining CVD. This is because an AHA Science Advisory previously examined LCS consumption and CVD using literature published through 2017.[118]

Summary of Literature Review Key Findings for Beverages with LCS

The findings on the health impacts—including nutrient intake, dietary patterns, and weight- and chronic disease-related outcomes—of consumption of beverages with LCS are mixed and inconsistent for children. Evidence on these outcomes among children ages 0 to 5 years is particularly scarce. Much of the research published to date focuses on adults, and much of the human data is limited to a focus on using diet soft drinks in place of regular soft drinks. Therefore, the expert panel applied its collective expertise and judgment to develop recommendations regarding young children's consumption of beverages with LCS.

Nutrient Intake and Dietary Patterns

- A government-funded cross-sectional study of children ages 4 to 18 years (with an average age of 10 to 11 years, which is outside of the expert panel's age range of interest) in the UK found that male consumers of artificially-sweetened beverages (ASB) had increased sugar intake from solid foods, while female ASB consumers did not differ from non-consumers of sweetened beverages. On the days that ASBs were consumed, sugar intake was 1% lower compared with those in non-consumption days.[119]

- A cross-sectional study of children ages 2 to 18 years in Australia (funding source not reported) observed no differences in sugar or energy intake between LCS consumers and non-consumers.[120]

- 3 partially industry-funded experimental studies of artificial sweeteners and food intake, conducted in children ages 2 to 5 years, demonstrated that caloric compensation (i.e., compensating for previously consumed calories at subsequent meals) is more complete in children than in adults. The degree of caloric compensation was influenced by factors such as the amount of time that elapsed between consumption of the pre-meal food/beverage and the actual meal, as well as the age of the child and other experimental circumstances.[121,35,122]

Weight- and Chronic-Disease Related Outcomes

There is limited evidence on LCS and weight-related outcomes among children ages 0 to 5 years. The expert panel identified 1 trial,[123] 3 prospective cohort studies,[124,125,126] and 3 cross-sectional studies[84,119,14] that examined weight- or body composition-related outcomes in study populations that included children ages 0 to 5 years. There is marked heterogeneity in the methods and in the participant characteristics among these studies, as well as mixed and inconclusive results—this makes it challenging to draw conclusions. This is an important gap in knowledge as it precludes the ability to confidently characterize the impact of consumption of beverages with LCS on weight and diet-related chronic disease outcomes in young children.

Expert Recommendations

- **0-5 years:** Beverages with LCS are not recommended.

Rationale

Given that early childhood is a critical developmental period, and that there is a lack of evidence regarding the long-term health impacts of LCS consumption in young children, it is the opinion of this expert panel that children ages 0 to 5 years should not consume beverages with LCS.

The lack of existing guidance for young children's LCS beverage consumption reflects the lack of evidence to characterize the association—whether positive, neutral, or negative—of intake of beverages with LCS with nutrient intake and dietary patterns, metabolic outcomes, or other health or developmental outcomes (beyond body weight) in this population. Likewise, little research has examined LCS intake and sweet taste preferences among young children. Additionally, in a pilot study that assessed parental attitudes toward LCS, a majority of parents had negative attitudes toward providing LCS to their children. However, they did not recognize the presence of LCS in products that they purchase for their families, due in part to how these products were labeled.[127]

Although the FDA has determined that there is reasonable certainty of no harm from consuming LCS within the ADI, this does not imply that the exposures of LCS are clinically or metabolically insignificant, and the effects of chronic consumption are unknown. Furthermore, young children have smaller body sizes, rapid growth trajectories, and developing organ systems, and the use of LCS in the food supply, as well as the prevalence of its consumption among young children, appears to be increasing.

Consumer education should stress that promotion of a certain LCS as "real" or "natural" does not necessarily indicate an advantage related to safety or nutritional value compared with other LCS.[116]

Caffeinated Beverages

There are currently no quantitative recommendations for young children's caffeine intake, but the AAP and HER have recommended that children do not consume caffeine.[128,18] Compared to adults, there is less certainty about the safe level of caffeine intake in children and adolescents.

Consumption

Caffeine intakes are difficult to gauge because caffeine content is not required to be disclosed on nutrition labels, but average caffeine intakes reported for young children are low.[47] Based on NHANES 2015-2016, 10% of 2 to 5-year-olds consumed coffee/tea (however, this includes regular and decaffeinated coffee or tea with additions such as milk, cream and/or sweeteners, and coffee and tea drinks, including ready-to-drink) on any given day. Mean daily intake amounts were not available for consumers of these beverages because of the small sample size of reporters.[28]

Health Impact Literature Review

The expert panel did not conduct a literature search on the heath impact of caffeinated beverages, as existing guidance is consistent in cautioning against caffeine intake in young children.

Expert Recommendation

0-5 years: Do not consume caffeinated beverages.

Rationale

It is the opinion of this expert panel that caffeinated beverages should not be consumed by children ages 0 to 5 years due to potential for adverse effects.[31,128,60]

OTHER CONSIDERATIONS

The expert panel considered mode of beverage consumption as an ancillary issue as it developed recommendations on what young children should be drinking as part of a healthy diet.

Mode of Beverage Consumption

Frequent consumption of between-meal snacks and beverages containing sugars, whether added or naturally-occurring, increases the risk of dental caries due to prolonged contact between sugars in the consumed food or liquid and cariogenic bacteria on the teeth.[129] To reduce the risk of developing caries during early childhood, the expert panel reiterates the guidance from the AAPD and the AAP, including:

- Avoid frequent consumption of milk and juice from a sippy or other training cup.[129]
- Use a cup if offering milk and juice to young children, but do not allow them to carry the cup throughout the day.[48,130]
- Wean young children from a bottle by 1 year of age and do not put young children to bed with a bottle.[129,131]

RESEARCH RECOMMENDATIONS

A consistent theme that prevailed throughout the expert panel's information-gathering efforts was that research and evidence on the health impacts of consuming most beverages during the first 5 years of life—with the exception of human milk and infant formula, which were not focus areas for this effort—is limited, and longitudinal studies are particularly scarce. Additionally, there is a dearth of research on beverage consumption patterns and behaviors and their associated health outcomes among racial/ethnic minority groups in the United States. During the panel's deliberations a number of specific knowledge gaps were identified that could be explored through future research among children ages 0 to 5 years, as an entire group and by demographic characteristics such as race/ethnicity and income. These include:

- Conduct more longitudinal research and intervention studies to examine the health impacts associated with consumption of different beverages in infancy and early childhood.
- Continue to monitor young children's beverage consumption, and consider adding new beverage categories as products enter the marketplace and grow in popularity, such as fermented beverages, naturally flavored waters and teas, and other innovative products in order to assess consumption prevalence and to explore the potential impact on dietary quality and health outcomes of these products.
- Conduct studies to inform strategies to reduce SSB consumption and provide and promote consumption of water and any other culturally appropriate, healthy substitutes for SSB.
- Conduct studies to better characterize the impact of 100% juice consumption (including specific varieties of 100% juice) on taste preference development, dietary patterns later in life, body weight, and chronic disease outcomes.
- Conduct an assessment of the evidence supporting the current recommendations to consume whole cow's milk during the second year of life and transition to low-fat milk at age 2 years.
- Conduct studies to better characterize the impact of flavored milk consumption on overall intake of milk, calories, added sugars, and other nutrients of public health concern; body weight; and chronic disease outcomes.
- Conduct studies to better characterize the impact of plant milks on nutrient intake, diet quality, and other relevant health outcomes, and compare results between exclusive and non-exclusive consumers of these beverages.
- Conduct studies to assess the bioavailability of nutrients added to plant milks through fortification.
- Conduct studies to better characterize the impact of LCS consumption on nutrient intake and dietary patterns, body weight, and chronic disease outcomes, particularly in young children.
- Conduct research to explore dietary regulation as it relates to plain drinking water intake and to clarify age brackets in which energy compensation may vary.
- Conduct research and/or analyze existing data to inform quantitative guidance on an optimum daily fluid intake in various age subgroups of young children.

POLICY AND PRACTICE IMPLICATIONS

The expert panel's beverage recommendations are expected to inform policy, environmental, and systems efforts to improve young children's health. Examples of policy and practice applications include:

- Standards for children's restaurant meals, such as default beverages to be offered;
- Nutrition standards for marketing beverages to young children;
- Federal nutrition assistance programs that affect young children, such as Supplemental Nutrition Assistance Program (SNAP), WIC, and CACFP;
- The 2020-2025 DGAs, which will include recommendations for children from ages 0 to 24 months;
- Beverage taxation policies;
- Toddler milk labeling practices (particularly given previous research suggesting that toddler drink labels may confuse consumers about their nutrition and health benefits);[3] and
- Educational guidance provided to parents and caregivers by health care providers.

The expert panel hopes that its simple, straightforward recommendations will spur the development of innovative advertising and marketing strategies to promote young children's consumption of recommended beverages.

CONCLUSIONS

Healthy beverage habits during early childhood are critical to the achievement of adequate hydration and nutrition to support optimal growth and development. Despite extensive efforts to develop guidance and recommendations for young children's beverage intake, and to improve beverage intake patterns in this age group, intakes continue to diverge from recommendations and are marked by disparities, particularly among racial/ethnic groups. The beverage recommendations put forward by this expert panel are based on the best available evidence, combined with sound expert judgment, and provide consistent messages that can be used by a variety of stakeholders to improve the beverage intake patterns of young children.

This expert panel uncovered a number of areas that require additional rigorous research in order to inform future dietary guidance on what young children ages 0 to 5 years should be drinking as part of a healthy diet. In particular, researchers and funders should focus on longitudinal studies and intervention research to assess the health impacts associated with consumption of different beverages, such as effects on nutrient intake and dietary patterns and quality, body weight, and chronic disease-related outcomes. In addition, efforts will be needed to translate these consensus recommendations into practice, including policy, systems, and environmental efforts. The recommendations are a strong basis for public health practitioners, health care providers, and advocates to develop tailored strategies and materials for a variety of audiences and stakeholders including parents and caregivers, policymakers, industry, and early care and education providers.

Consistent information from authoritative health entities on what young children should be drinking are needed now more than ever, as parents and caregivers navigate an increasingly crowded, diverse beverage landscape. It is imperative to capitalize on early childhood as a critical window of opportunity during which dietary patterns are both impressionable and capable of setting the stage for lifelong eating behaviors. The level of collaboration and consistency among major national health and nutrition organizations that is represented in these recommendations is noteworthy and has the capacity to evoke meaningful change to improve beverage consumption patterns and ultimately the health and well-being of young children in the United States.

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About Healthy Eating Research

Healthy Eating Research (HER) is a national program of the Robert Wood Johnson Foundation. Technical assistance and direction are provided by Duke University under the direction of Mary Story PhD, RD, program director, and Megan Lott, MPH, RDN, deputy director. HER supports research to identify, analyze, and evaluate environmental and policy strategies that can promote healthy eating among children and prevent childhood obesity. Special emphasis is given to research projects that benefit children and adolescents and their families, especially among lower-income and racial and ethnic minority population groups that are at highest risk for poor health and well-being and nutrition-related health disparities. For more information, visit www.healthyeatingresearch.org or follow HER on Twitter at @HEResearch.

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APPENDIX A:
METHODOLOGY: SUPPLEMENTAL INFORMATION

This appendix includes additional information regarding the literature reviews conducted by the expert panel's 4 working groups, as well as the analysis of total water intake in NHANES 2011-2016.

Expert Panel Working Group Literature Reviews

Research Questions and Search String Details

100% Juice

- What are the health impacts, including nutrient intake and dietary patterns, and health outcomes including body weight, dental caries, and diabetes, associated with consuming 100% juice during ages 0 to 5 years?
- What is the impact of 100% juice consumption on sweet taste preference development?
- Do different varieties of 100% juice have different impacts on flavor preferences or other behavioral outcomes? The search strings did not address this; the working group did other searches to try to identify relevant articles.

Milks

- What is the impact of consumption of toddler milk, drinkable yogurts,[a] plant milks/non-dairy beverages, and flavored milk in early childhood on diet quality?
- What is the impact of consumption of toddler milk on diet quality in early childhood (up to age 5)?
- What is the impact of consumption of drinkable yogurts on diet quality in early childhood (up to age 5)?
- What is the impact of consumption of plant milks/non-dairy beverages on diet quality in early childhood (up to age 5)?
- What is the impact of consumption of flavored milk on diet quality in early childhood (up to age 5)?
- What is the impact of consumption of flavored milk and plant milks/non-dairy beverages in early childhood on body weight/obesity, bone density, CVD, and diabetes?
- What is the impact of flavored milk consumption on taste preference development?

Beverages with Low Calorie Sweeteners

- What is the health impact (including nutrient intake and dietary patterns, and health outcomes including body weight, CVD, and diabetes) associated with consuming beverages with non-nutritive sweeteners during ages 0 to 5 years?
- Does consumption of beverages with non-nutritive sweeteners impact taste preference development and/or future dietary patterns?

Water and Hydration

- What is the optimal amount of fluid that children ages 0 to 5 years should consume daily?
- What beverages should contribute to the total fluid intake, and in what amounts? Is there an ideal proportion (or a minimum or maximum amount), for purposes of optimizing hydration and nutritional status, that should come from plain water?
- Are there adverse outcomes associated with consuming plain water among children, ages approximately 6 months to 5 years? Is there evidence to suggest that water displaces other, more nutrient-dense options such as milk?

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a The expert panel did not identify any studies on drinkable yogurts.

Inclusion Criteria

To be included in the review, studies needed to: be in the English language; be published in a peer-reviewed journal; take place in the United States or other developed country; have healthy, non-institutionalized subjects (i.e., no chronic conditions or diseases); evaluate consumption of the beverage of interest as a primary exposure; evaluate beverage consumption during the 0 to 5-year-old age period (articles were included if they evaluated exposure over an age range that overlapped with 0 to 5 years, such as 3 to 7 years); and evaluate 1 or more of the outcomes of interest specified for each beverage. The outcomes of interest for each beverage are detailed in the "Evidence-Based Recommendations" section of this report.

Search Strategy

For each research question, the working groups followed a consistent search strategy informed by the methodology used by the 2015 Dietary Guidelines for Americans Advisory Committee. The working groups' strategy involved a search for reviews (narrative reviews, systematic reviews, and meta-analyses) published from 2008-present in PubMed and the Cochrane Systematic Review Database, as well as a search for single studies published from 2014-present or from the end date of the most recently published systematic review on the topic. The year 2014 was selected because this was the end date that was considered for literature on 2 to 5-year-olds for the development of the 2015-2020 DGAs. For research on 0 to 2-year-olds, the year 2016 was selected because this was the end date of the literature reviewed for the HER infant and toddler feeding report released in 2017. The consultant and HER staff executed the literature searches, identified articles that met the inclusion criteria, extracted relevant data from included articles, and synthesized the findings.

List of Included Studies

See *Appendix E* for a full list of included studies with funding sources noted.

Analysis of Total Water Intake in NHANES 2011-2016

To examine if median total water intakes from more recent NHANES data were consistent with the data from NHANES 1988-1994 that were used to establish the Adequate Intakes (AI),[b] the expert panel requested an analysis of NHANES 2011-2016 data. The median total water intake from NHANES 2011-2016 was calculated for ages 6 to 12 months, ages 12 to 24 months, and ages 2 to 5 years. It was also calculated for ages 1 to 3 years and ages 4 to 8 years to facilitate comparison to data used to establish the AI.

The median total water intakes for 6 to 12-month-olds and 12 to 24-month-olds in NHANES 2011-2016 were similar to total water intakes reported for these age groups in an analysis of NHANES 2005-2012 data.[c] In a comparison of the median total water intake in NHANES 2011-2016 with the AI reference values, the results were similar for children ages 1 to 3 years (1189 ml vs. 1300 ml), but not for children ages 4 to 8 years (1307 ml vs. 1700 ml). This dissimilarity could reflect differing methodological approaches[d] or temporal changes in beverage intake. Nonetheless, the expert panel found it helpful to have reference points for young children's total water intakes.

Results are shown in Table 1.

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b Institute of Medicine. 2005. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, DC: The National Academies Press.

c Grimes CA, Szymlek-Gay EA, Nicklas TA. Beverage Consumption among U.S. Children Aged 0–24 Months: National Health and Nutrition Examination Survey (NHANES). Nutrients 2017, 9, 264.

d The footnote of the DRI Appendix Table D-1 states "The intake distributions for infants 2–6 and 7–12 months and children 1–3 years of age are unadjusted. Means and percentiles for these groups were computed using SAS PROC UNIVARIATE. For all other groups, data were adjusted using the Iowa State University method to provide estimates of usual intake. Means, standard errors, and percentiles were obtained using C-Side." The analysis of NHANES 2011-2016 data did not use the Iowa State University method or C-Side to apply adjustments. This differing approach could explain why the estimate for 4-8 year olds is more inconsistent than the estimate for 1-3 year olds.

Table 1: Total Moisture Intake among Children in NHANES 2011-2016, by Age

Age Group	Sample Size	Total Moisture[1] (grams)[2]	AI[3] (1 ml = 1 g water)
6-12 months	n=547 (including 128 breast fed infants)[4]	938 grams (SE=18)	7-12 months: 800 ml[5]
	n=419 (breastfed infants were excluded from analysis)	1019 grams (SE=26)	
12-24 months	n=587 (breastfed infants were excluded from analysis)	1180 grams (SE=26)	
2-5 years	n=1712 (breastfed infants were excluded from analysis)	1215 grams (SE=23)	
1-3 years	n=1292 (breastfed infants were excluded from analysis)	1189 grams (SE=27)	1300 ml[6]
4-8 years	n=2100 (breastfed infants were excluded from analysis)	1307 grams (SE=21)	1700 ml[6]

1 *Includes all water sources in diet (i.e., drinking water, as well as water in foods and beverages) by using "total moisture" variable already created in NHANES.*

2 *1 gram of water is equivalent to 1 milliliter. 1 ounce of water is equivalent to 29.57 grams.*

3 *These Adequate Intake values were developed based on NHANES III survey data from 1988-1994, and are included here for ease of comparison to the most recent NHANES data from 2011-2016 analyzed by the expert panel.*

4 *All 128 breastfed infants were assigned a value of 938 grams of moisture. This is the estimated total beverage intake for 6-12 month old's reported in Grimes et al., 2017. Note: this would over-estimate water from beverages (since it assumes 100% of beverage is moisture/water), but overall likely under-estimates total water since it doesn't include water from food. Caution should be taken when using this estimate as assigning over 20% of sample the same value will affect the interpretability of the median.*

5 *Based on estimated water intake from human milk and from complementary foods and other beverages, rounded to the nearest 0.1 L.*

6 *Based on total water intake from NHANES III (1988-1994), rounded to the nearest 0.1 L.*

It is not clear if the NHANES survey data from 1988-1994 that were used to calculate the AI had a total moisture (grams) variable that was used in this more recent analysis.

Any effort to simulate an updated AI value based the median total water intake observed in recent national dietary survey data should be appropriately rigorous in how it accounts for breastfed children and both food and beverage sources of water intake. Furthermore, it should also be noted that a reference value based on median intakes assumes that the general population is adequately hydrated, but young children's hydration status is not well understood.

APPENDIX B:
EXAMPLE SCENARIOS OF DAILY FLUID BREAKDOWNS BY AGE

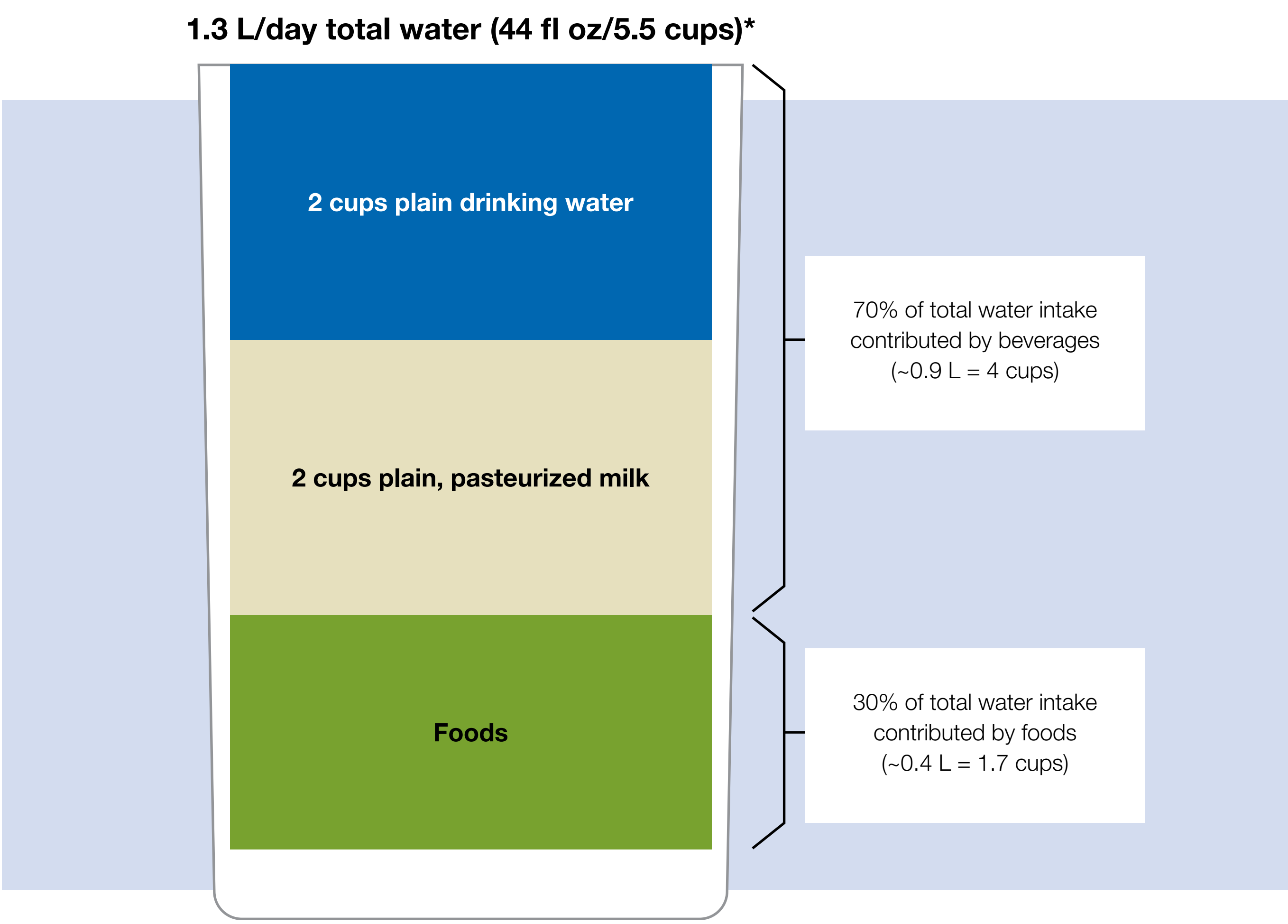
Daily Fluid Breakdown, Ages 1-3 Years, Scenario 1

Expert panel recommendations for plain, pasteurized milk:

- Up to 2-3 cups of whole milk for 1 to 2-year-olds
- Up to 2 cups of skim or low-fat milk for 2 to 3-year-olds

If the upper limits of milk are consumed, the remaining fluid needs to be fulfilled by drinking water would be approximately 1 cup for 1 to 2-year-olds and 2 cups for 2 to 3-year-olds.

If less milk is consumed, the remaining fluid needs to be fulfilled by drinking water would increase, and could be as high as 4 cups if no milk is consumed.



*Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz

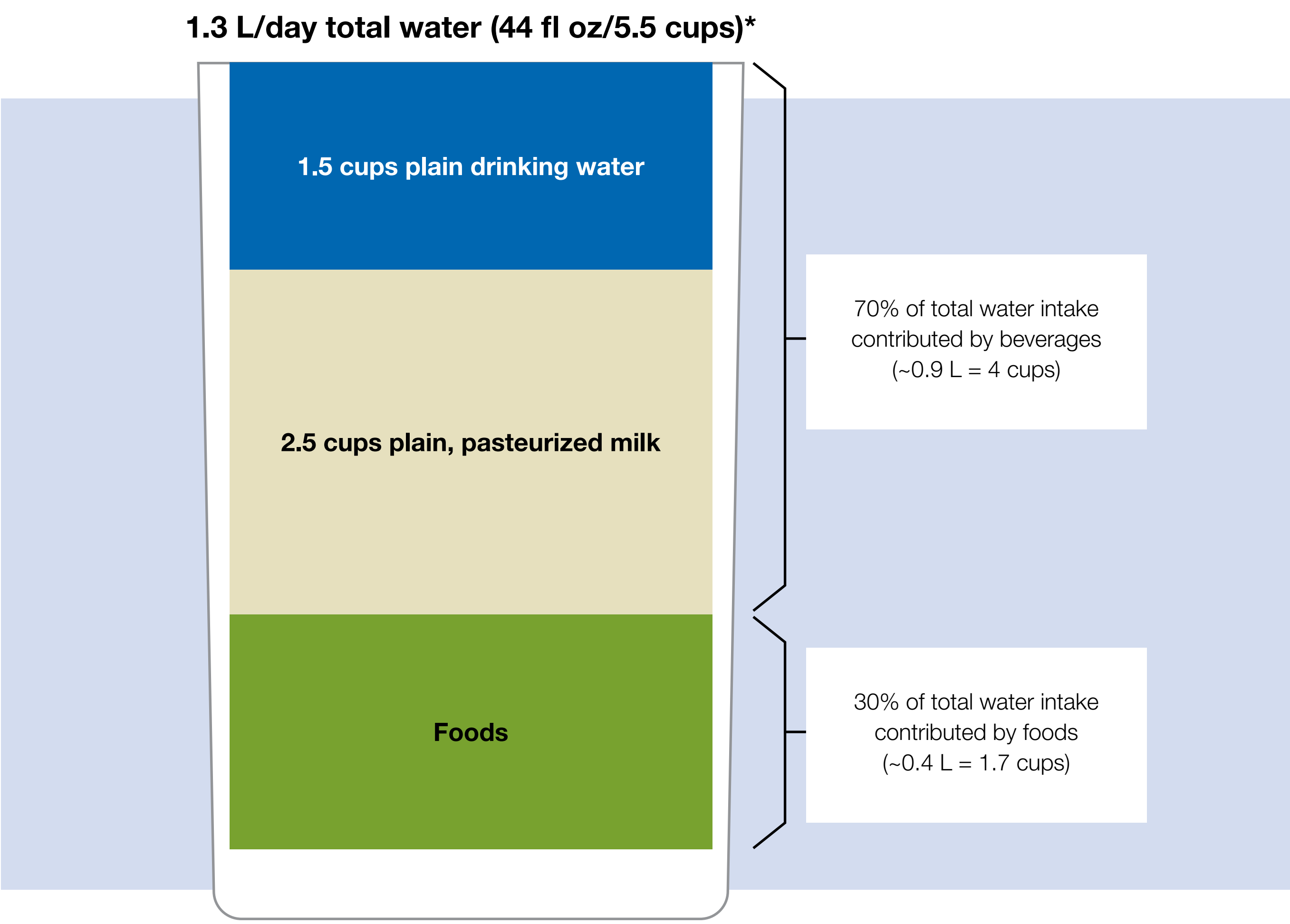
Daily Fluid Breakdown, Ages 1-3 Years, Scenario 2

Expert panel recommendations for plain, pasteurized milk:

- Up to 2-3 cups of whole milk for 1 to 2-year-olds
- Up to 2 cups of skim or low-fat milk for 2 to 3-year-olds

If the upper limits of milk are consumed, the remaining fluid needs to be fulfilled by drinking water would be approximately 1 cup for 1 to 2-year-olds and 2 cups for 2 to 3-year-olds.

If less milk is consumed, the remaining fluid needs to be fulfilled by drinking water would increase, and could be as high as 4 cups if no milk is consumed.



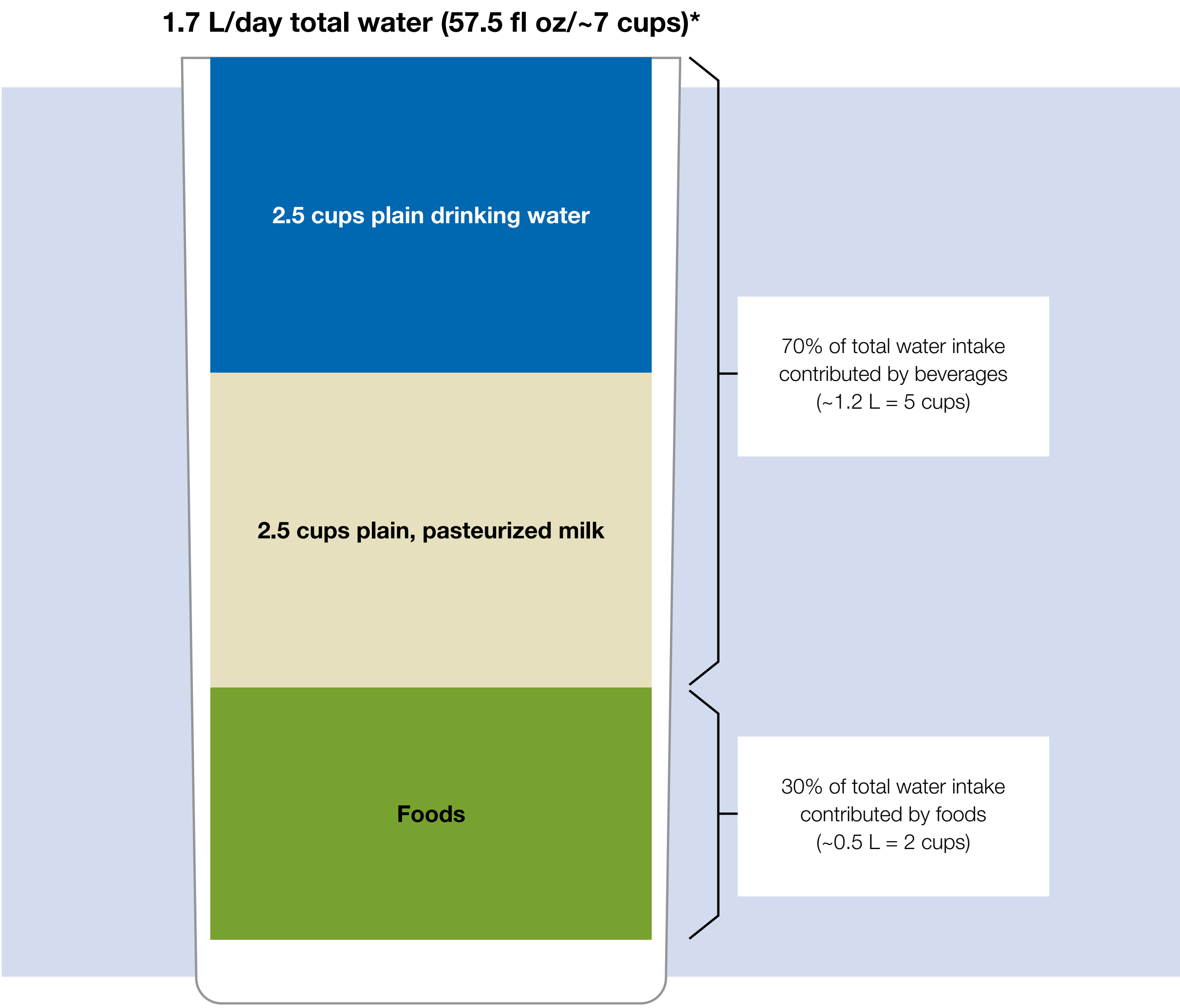
*Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz

Daily Fluid Breakdown, Ages 4-5 Years, Scenario 1

Expert panel recommendations for plain, pasteurized milk: 2.5 cups for 4 to 5-year-olds.

If the upper limits of milk are consumed, the remaining fluid needs to be fulfilled by drinking water would be approximately 2.5 cups.

If less milk is consumed, the remaining fluid needs to be fulfilled by drinking water would increase, and could be as high as 5 cups if no milk is consumed.



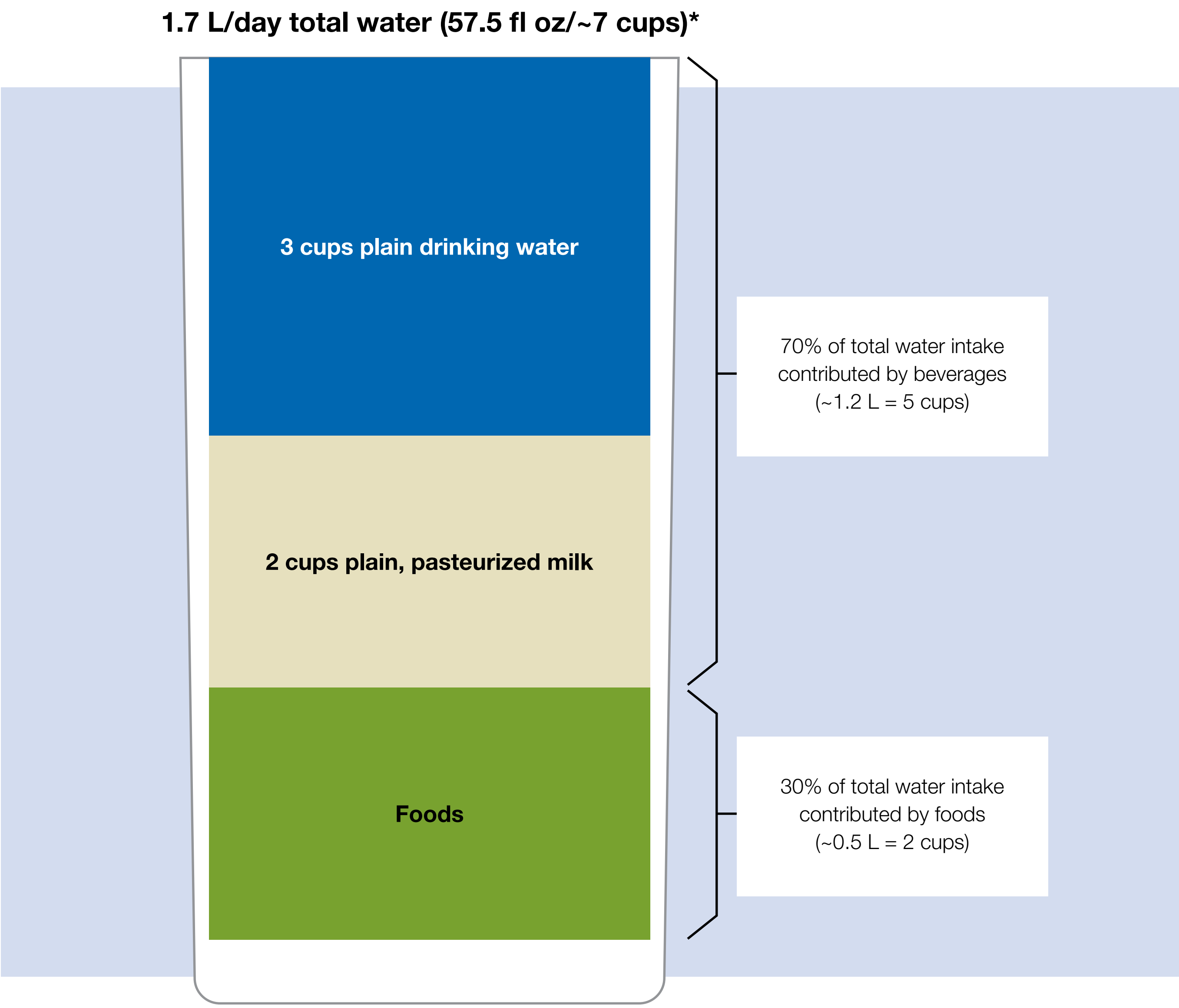
*Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz

Daily Fluid Breakdown, Ages 4-5 Years, Scenario 2

Expert panel recommendations for plain, pasteurized milk: 2.5 cups for 4 to 5-year-olds.

If the upper limits of milk are consumed, the remaining fluid needs to be fulfilled by drinking water would be approximately 2.5 cups.

If less milk is consumed, the remaining fluid needs to be fulfilled by drinking water would increase, and could be as high as 5 cups if no milk is consumed.



*Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz

APPENDIX C: NUTRITIONAL COMPARISON OF PLAIN, PASTEURIZED COW'S MILK TO PLANT MILKS/NON-DAIRY BEVERAGES

Price	Cow's (whole)	Almond	Cashew	Coconut	Hazelnut	Hemp	Oat	Rice	Soy	Pea	Flax
Price ($/100 g)	0.15	0.24	-	0.35	-	-	0.28	0.19	0.18	-	-
Price ($/8 fl oz)	0.29	0.47	-	0.69	-	-	0.56	0.38	0.37	-	-
Price ($/gallon)	4.68	7.58	-	11.04	-	-	8.98	6.11	5.88	-	-

Nutritional Composition for 8 fl oz

Nutrient	Unit	Cow's (whole)	Almond	Cashew	Coconut	Hazelnut	Hemp	Oat	Rice	Soy	Pea	Flax
Energy	kcal	149	60	60	80	110	80	130	120	99.6	70	25
Protein	g	7.69	1	<1	1	3.5	2	4	1	7	8	0
Total Lipid (Fat)	g	7.98	2.5	2.5	5	2	7	2.5	2.5	4	4.6	2.5
Carbohydrate	g	12.8	8	9	7	19	8	24	23	8	0	1
Total Dietary Fiber	g	0	1	0	0	1	0	2	0	1.5	0	0
Total Sugar	g	12.32	7	7	6	14	0	19	10	6	0	0
Calcium	mg	276	450	450	450	300	300	350	20	450	450	450
Iron	mg	0.07	0.7	1.2	0.7	0.1	0.36	0.6	0.2	1.1	2.7	0
Magnesium	mg	24	16	1.3	16	-	33	-	-	38.9	0	-
Phosphorus	mg	205	20	-	20	-	-	-	-	-	-	15
Potassium	mg	322	-	30	35	-	-	-	-	299	450	-
Sodium	mg	105	150	170	30	-	20	-	86	119	130	110
Zinc	mg	0.9	1.5	0.94	1.5	-	-	-	-	0.6	-	-
Vitamin C	mg	0	0	0	0	0	0	0	1.2	0	0	0
Thiamin	mg	0.112	-	-	-	-	-	-	-	-	-	-
Riboflavin	mg	0.412	0.4	0.3	0.4	0.3	0.27	0.3	-	0.5	-	-
Niacin	mg	0.217	-	-	-	-	-	-	-	-	-	-
Vitamin B6	mg	0.088	-	-	-	-	-	-	-	-	-	-
Folate	µg	12	-	-	-	-	-	-	-	24.3	-	-
Vitamin B12	µg	1.1	3	1	3	-	-	-	-	-	-	1.5
Vitamin A	IU	395	500	-	500	-	0		0	501	100	100
Vitamin D	IU	124	150	150	150	150	150	150	0	180	120	100
Vitamin K	µg	0.7	-	-	-	-	-	-	-	-	-	-
Vitamin E	mg	0.15	-	-	-	-	-	-	-	-	-	-
Total Saturated FA	g	4.55	0	0	4.5	0	0.5	0	0.1	0.5	0.5	0
Total Monounsaturated Fatty Acids	g	1.98	-	-	-	-	-	-	-	-	3	0
Total Polyunsaturated Fatty Acids	g	0.476	-	-	-	-	-	-	-	-	1	1.5
Cholesterol	mg	24	0	0	0	0	0	0	1.3	0	0	0

**100 g = 1/2 C*

Nutritional Composition from: A Comparison of the Nutritional Value of Cow's Milk ad Nondairy Beverages by S. Singhal, R.D. Baker, and S.S. Baker

Price Data from: https://www.cnpp.usda.gov/data

Almond Milk Price Data from the California Almond Board

Oat Milk Price Data from Silk Milk as the Suggested National Price

Pea Milk Nutritional Composition from Ripple Foods Original Unsweetened Pea Milk

Flax Milk Nutritional Composition from Good Karma Foods Unsweetened Flax Milk

APPENDIX D: NUTRITIONAL COMPARISON OF PLAIN, PASTEURIZED COW'S MILK TO TODDLER MILK

Price	Cow's (whole)	EnfaGrow Toddler Transitions	EnfaGrow Toddler Next Step	Gerber Good Start Grow Stage 3	Nido 1+	Similac Go & Grow	Happy Tot Grow & Shine
Price ($/100 g)	0.15	0.63	0.50	0.59	0.22	0.50	0.71
Price ($/8 fl oz)	0.29	1.26	1.01	1.17	0.44	1.00	1.41
Price ($/gallon)	4.68	20.21	16.13	18.76	7.09	16.00	22.60

Nutritional Composition for 8 fl oz

Nutrient	Unit	Cow's (whole)	EnfaGrow Toddler Transitions	EnfaGrow Toddler Next Step	Gerber Good Start Grow Stage 3	Nido 1+	Similac Go & Grow	Happy Tot Grow & Shine
Energy	kcal	149	160	160	149	160	150	179
Protein	g	7.69	4.16	6	4.57	6	4	5.12
Total Lipid (Fat)	g	7.98	8.48	6	5.71	7	8	8.96
Carbohydrate	g	12.8	17.28	20	18.3	18	16	17.92
Total Dietary Fiber	g	0	0	<1	0	1	<1	0
Total Sugar	g	12.32	2.8	11	11.43	15	15	17.92
Total Saturated FA	g	4.55	12.6	2.5	0.57	2.5	0	0

**100 g = 1/2 C*

Milk Nutritional Composition from: A Comparison of the Nutritional Value of Cow's Milk ad Nondairy Beverages by S. Singhal, R.D. Baker, and S.S. Baker

Toddler Milk Nutrition Composition & Price from Manufactuer

Nutrition Composition Supplemented by Baby Food Facts by Uconn Rudd Center for Food Policy & Obesity

APPENDIX E: STUDIES, WITH FUNDING SOURCES, INCLUDED IN LITERATURE REVIEWS

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Ahluwalia N, Herrick KA, Rossen LM et al. Usual nutrient intakes of US infants and toddlers generally meet or exceed Dietary Reference Intakes: findings from NHANES 2009-2012. Am J Clin Nutr. 2016; 104(4):1167-1174. https://www.ncbi.nlm.nih.gov/pubmed/27629049.	N/A	N/A	N/A
Auerbach BJ, Dibey S, Vallila-Buchman P, Kratz M, Krieger J. Review of 100% Fruit Juice and Chronic Health Conditions: Implications for Sugar-Sweetened Beverage Policy. Adv Nutr. 2018; 9:78-85. https://www.ncbi.nlm.nih.gov/pubmed/29659683.	Ruth L Kirschstein National Research Service of the National Institutes of Health	N/A	N/A
Auerbach BJ, Wolf F, Hikida A et al. Fruit juice and change in BMI: A meta-analysis. Pediatrics. 2017; 139(4):e20162454. https://www.ncbi.nlm.nih.gov/pubmed/28336576.	Ruth L Kirschstein National Research Service of the National Institutes of Health	N/A	N/A
Beauchamp GK, Mennella JA. Early flavor learning and its impact on later feeding behavior. J Pediatr Gastroenterol Nutr. 2009; 48 Suppl 1:S25-30. https://www.ncbi.nlm.nih.gov/pubmed/19214055.	N/A	N/A	N/A
Birch LL, Anzman-Frasca S. Learning to Prefer the Familiar in Obesogenic Environments. Nestle Nutr Workshop Ser Pediatr Program. 2011; 68:187-196. https://www.ncbi.nlm.nih.gov/pubmed/22044900.	Nestle Nutrition Institute	N/A	N/A
Birch LL, Deysher M. Calorie compensation and sensory specific satiety: Evidence for self-regulation of food intake by young children. Appetite. 1986; 7(4):323-331. https://www.sciencedirect.com/science/article/pii/S0195666386800010.	National Dairy Council, the Dart-Kraft Corporation, the National Institute of Child Health and Human Development, and a Hatch Grant administered through the University of Illinois Agricultural Experiment Station	N/A	N/A
Birch LL, Deysher M. Conditioned and unconditioned caloric compensation: evidence for self-regulation of food intake in young children. Learn Motiv. 1985; 16(3):341-355. https://www.sciencedirect.com/science/article/pii/0023969085900207.	National Dairy Council, Dart Kraft Corporation, and a USDA Hatch grant administered by the Illinois Agricultural Experiment Station	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Birch LL, McPhee L, Sullivan S. Children's food intake following drinks sweetened with sucrose or aspartame: time course effects. Physiol Behav. 1989; 45(2):387-95. https://www.ncbi.nlm.nih.gov/pubmed/2756027.	National Institute of Health and the Dart-Kraft Corporation	N/A	N/A
Brown RJ, De Banate MA, Rother KI. Artificial Sweeteners: a systematic review of metabolic effects in youth. Int J Pediatr Obes. 2010; 5:305-312. https://www.ncbi.nlm.nih.gov/pubmed/20078374.	National Institute of Diabetes, Digestive, and Kidney Diseases	N/A	N/A
Byrd-Bredbenner C, Ferruzzi MG, Fulgoni III VL, Murray R, Pivonka E, Wallace TC.. Satisfying America's Fruit Gap: Summary of an Expert Roundtable on the Role of 100% Fruit Juice. J Food Sci. 2017; 82(7): 1523-1534. https://www.ncbi.nlm.nih.gov/pubmed/28585690.	Welch's	All authors received an honorarium for their participation in the roundtable, which was hosted by Welch's and faciliated by FoodMinds LLC.	MGF is a member of the Advisory Boards for Alliance for Potato Research and Education, Sensient Technologies, and Welch's. MGF is consultant for General Mills and Unilever and has research funded, in part, by General Mills, Welch's, Pepsico Global, and Alliance for Potato Research and Education. VLF III is the Senior Vice President of Nutrition Impact LLC, and provides consulting and database analyses for various food and beverage companies and related entities. RM is a member of the Speaker's Bureau for the National Dairy Council and Abbott Nutrition, and a consultant for Dannon Co., Sabra Dipping Co., Egg Nutrition Board, Hass Avocado Board, and National Cattlemen's Beef Association. EP is the CEO of Produce for Better Health, which receives contributions from more than 350 members of the fruit/vegetable industry, including $10,000 annually from Welch's. TCW is the Principal Consultant at Think Healthy Group, LLC, which performs consulting and clinical research for various food, beverage, and dietary supplement companies.
Cairncross CT, Stonehouse W, Conlon CA et al. Predictors of vitamin D status in New Zealand preschool children. Matern Child Nutr. 2017; 13(3). https://www.ncbi.nlm.nih.gov/pubmed/27460693.	Health Research Council of New Zealand	N/A	N/A
Crowe-White K, O'Neil CE, Parrott JS et al. Impact of 100% Fruit Juice Consumption on Diet and Weight Status of Children: An Evidence-based Review. Crit Rev Food Sci Nutr. 2016; 56(5):871-884. https://www.ncbi.nlm.nih.gov/pubmed/26091353	Pepsico Inc. and Academy of Nutrition and Dietetics	CEO received partial support from the USDA Hatch Project.	CEO participates in a working group that has received current and past funding from the Juice Products Association. PZ and TW are currently employed at the Academy of Nutrition and Dietetics.
Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. Nutr Rev. 2010; 68(9):505-521. https://www.ncbi.nlm.nih.gov/pubmed/20796216	Nestlé Waters, Issy-les-Moulineaux, France and NIH	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Davis JN, Koleilat M, Shearrer GE, Whaley SE. Association of Infant Feeding and Dietary Intake on Obesity Prevalence in Low-Income Toddlers. Obesity. 2014; 22(4):1103-1111. https://www.ncbi.nlm.nih.gov/pubmed/24123802	First 5 LA	JND was also funded by start-ups.	N/A
De Ruyter JC, Olthof MR, Seidell JC, Katan MB. A Trial of Sugar-free or Sugar-Sweetened Beverages and Body Weight in Children. N Engl J Med. 2012; 367(15): 1397-1406. https://www.nejm.org/doi/pdf/10.1056/NEJMoa1203034.	Netherlands Organization for Health Research and Development, the Netherlands Heart Foundation, and the Royal Netherlands Academy of Arts and Sciences	N/A	N/A
Eussen SRBM, Pean J, Olivier L, Delaere F, Lluch A. Theoretical impact of replacing whole cow's milk by young-child formula on nutrient intakes of UK young children: Results of a simulation study. Ann Nutr Metab. 2015; 67(4): 247-256. https://www.karger.com/Article/Fulltext/440682	DNSIYC & UK Department of Health	N/A	All authors are employees of Danone Nutricia Research.
Fayet F, Ridges LA, Wright JK, Petocz P. Australian children who drink milk (plain or flavored) have higher milk and micronutrient intakes but similar body mass index to those who do not drink milk. Nutr Res. 2013; 33(2):95-102. https://www.ncbi.nlm.nih.gov/pubmed/23399659.	Nestlé Australia Ltd	N/A	LAR & JKW are employees of Nestle Australia Ltd.
Fayet-Moore F. Effect of flavored milk vs plain milk on total milk intake and nutrient provision in children. Nutr Rev. 2016; 74(1):1-17. https://www.ncbi.nlm.nih.gov/pubmed/26534904.	Nestlé Australia Ltd	N/A	N/A
Fidler Mis N, Braegger C, Bronsky J et al. Sugar in Infants, Children and Adolescents: A Position Paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. J Pediatr Gastroenterol. 2017; 65(6):681-696. https://www.ncbi.nlm.nih.gov/pubmed/28922262.	European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition	N/A	N/A
Fitch C, Keim KS, Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: Use of Nutritive and Nonnutritive Sweeteners. J Acad Nutr Diet. 2012; 112(5):739-758. https://www.ncbi.nlm.nih.gov/pubmed/22709780.	Academy of Nutrition and Dietetics	N/A	N/A
Gardner C, Wylie-Rosett J, Gidding SS et al. Nonnutritive sweeteners: current use and health perspectives: a scientific statement from the American Heart Association and the American Diabetes Association. Circulation. 2012; 126(4):509-19. https://www.ncbi.nlm.nih.gov/pubmed/22777177.	American Heart Association and American Diabetes Association	JWR has a research grant from Kraft. RKJ has a research grant from Dairy Management Inc, New England Dairy Promotion Board, and Vermont Dairy Promotion Council.	JWR has received honoraria from unilever. RKJ is on the advisory board for Dairy Management Inc. National Research Scientific Advisory Committee and Milk Processor Education Program Medical Advisory Board. CE has a research grant from NIH.

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Gibson S, Francis L, Newens K, Livingstone B. Association between free sugars and nutrient intakes among children and adolescents in the UK. Br J Nutr. 2016; 116(7):1265-1274. https://www.ncbi.nlm.nih.gov/pubmed/27641637.	Sugar Nutrition UK	N/A	SG is Director of Sig-Nurture Ltd, an independent research consultancy to the food industry, government, and not-for-profit and trade organisations. Sig-Nurture Ltd. has received grants and consulting fees in the past 36 months from food, beverage and ingredients manufacturers and trade organisations with an interest in sugar-containing foods and/or sugar replacements. LF and KN are an employees of Sig-Nurture Ltd. BL is Emerita Professor of Nutrition at Ulster University and has received grants in the past 36 months from Danone and Sugar Nutrition UK.
Grech A, Kam CO, Gemming L, Rangan A. Diet quality and sociodemographic factors associated with non-nutritive sweetener use in the Australian population. Nutrients. 2018; 10(7):E833. https://www.ncbi.nlm.nih.gov/pubmed/29954097.	N/A	N/A	N/A
Grimes CA, Szymlek-Gay EA, Campbell KJ, Nicklas TA. Food sources of total energy and nutrients among U.S. infants and toddlers: National Health and Nutrition Examination Survey 2005–2012. Nutrients. 2015; 7(8):6797–6836. https://www.ncbi.nlm.nih.gov/pubmed/26287236.	National Heart Foundation of Australia	CAG is supported by a National Heart Foundation of Australia Postdoctoral Fellowship and received funding by the National Heart Foundation of Australia to support travel to the U.S. to complete this work.	N/A
Hagg A, Jacobson T, Nordlund G, Rossner S. Effects of milk or water on lunch intake in preschool children. Appetite. 1998; 31(1):83–92. https://www.sciencedirect.com/science/article/pii/S0195666397901525.	Swedish Dairy Association	N/A	N/A
Hasnain SR, Singer MR, Bradlee ML, Moore LL. Beverage intake in early childhood and change in body fat from preschool to adolescence. Child Obes. 2014; 10:42–49. https://www.ncbi.nlm.nih.gov/pubmed/24450382.	National Heart, Lung, and Blood Institute and the National Dairy Council	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Hojsak I, Bronsky J, Campoy C et al. Young child forumla: A position paper by the ESPGHAN committee on nutrition. J Pediatr Gastroenterol Nutr. 2018; 66(1): 177-185. https://www.ncbi.nlm.nih.gov/pubmed/29095351.	European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition	N/A	JB has received honoraria for lectures and travel support from Nutricia and Nestle. CC received research funding from ORDESA Laboratories. SA and MD received lecture fees from Nestle´ and Semper. MF received honoria for lectures (Nestle´ Nutrition Institute) and editing book on growth (Danone). NE received speaker fees and research funding from manufacturers of infant milk formula (Nestle and Danone Baby Nutrition) for studies in preterm infants. AL received lecture fees from Nestle´ and Mead Johnson Nutrition.
Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. Obes Rev. 2013; 14(8):606-19. https://www.ncbi.nlm.nih.gov/pubmed/23763695.	National Institute of Health	California Walnut Commission	N/A
Huybrechts I, Lin Y, De Keyzer W et al. Dietary sources and sociodemographic and economic factors affecting vitamin D and calcium intakes in Flemish preschoolers. Eur J Clin Nutr. 2011; 65(9):1039-47. https://www.ncbi.nlm.nih.gov/pubmed/21559036.	Belgian Nutrition Information Center (NICE)	N/A	N/A
Johnson RK, Lichtenstein AH, Anderson CAM et al. Low-Calorie Sweetened Beverages and Cardiometabolic Health: A Science Advisory From the American Heart Association. Circulation. 2018; 138:e126-e140. https://www.ahajournals.org/doi/pdf/10.1161/CIR.0000000000000569.	American Heart Association	JPD has a research grant from CPAC and Heart and Stroke Foundation, CHIR, Fondation de l'IUCPQ, FRQS, Heart & Stroke Foundation of Canada. SSG has a research grant and research support from NIH. DM has a research grant from Medtronic, Dexcom, Bigfood Biomedical, Roche, Insulet Corporation.	SSG is the Cardiology Division Head at Nemours Foundation. DM is on the advisory board for Insulet Corporation, Abbott Diabetes Care, Helmsley Charitable Trust.
Kehoe L, Walton J, McNulty BA, Nugent AP, Flynn A. Dietary strategies for achieving adequate vitamin D and iron intakes in young children in Ireland. J Hum Nutr Diet. 2017; 30(4):405–416. https://www.ncbi.nlm.nih.gov/pubmed/27990698.	Irish Department of Agriculture, Food, and the Marine	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Koletzko B, Bhutta ZA, Cai W et al. Compositional requirements of follow-up formula for use in infancy: Recommendations of an international expert group coordinated by the Early Nutrition Academy. Ann Nutr Metab. 2013; 62(1):44-54. https://www.ncbi.nlm.nih.gov/pubmed/23258234.	Government of New Zealand, the ENA, and the European Commission.	N/A	ZAB has received support as a member of the Nestlé Nutrition Institute advisory board advising on nutrition priorities and educational activities. WC has received support from Danone, Mead Johnson Nutritionals, and Nestlé Nutrition. SC received support from Biocodex, Danone, Nestlé Nutrition, and Pfizer Nutrition. MEG acknowledges support from Abbott Nutrition, Danone, Mead Johnson Nutrition, Nestlé Nutrition, and Pfizer Nutrition. GJF received an author's honorarium from Nestlé Nutrition. EAG received support from Nestlé Nutrition. The University of Amsterdam and the Free University, Amsterdam, and its employee JBvG have or have had scientific and educational collaborations with Abbott Nutrition Danone, Hipp, Mead Johnson Nutrition, and Nestlé Nutrition. SHQ received support from Danone. The University of Munich Medical Centre and its employee BKo have or have had scientific and educational collaborations with manufacturers of FUF, primarily as part of re-search collaborations funded by the European Commission and the German government, from Abbott Nutrition, Dairy Goat Cooperative, Danone, Fonterra, Hipp, Mead Johnson Nutrition, Nestlé Nutrition, and Pfizer Nutrition, and receive grant support from the European Commission, the European Research Coun-cil, and the German Federal Government. MM and the Women's and Children's Health Research Institute and the University of Adelaide have received support from the National Health and Medical Research Council (NHMRC), Clover Corporation, Dairy Goat Cooperative, Danone, Fonterra, Nestlé Nutrition, and Mead Johnson Nutrition. AW has received financial support from Danone, Mead Johnson Nutrition, and Nestlé Nutrition. JBcG and BKo are members of their respective National Breastfeeding Committees, and all authors declare to be strongly biased in favour of breastfeeding.
Lamb MM, Fredericksen B, Seifert JA, Kroehl M, Rewers M, Norris JM. Sugar intake is associated with progression from islet autoimmunity to type 1 diabetes: the Diabetes Autoimmunity Study in the Young. Diabetologia. 2015; 58(9):2027–2034. https://www.ncbi.nlm.nih.gov/pubmed/26048237.	National Institutes of Health and the Diabetes Endocrine Research Center, Clinical Investigation, & Bioinformatics Core	N/A	N/A
Lee GJ, Birken CS, Parkin PC et al. Consumption of non-cow's milk beverages and serum vitamin D levels in early childhood. CMAJ. 2014; 186(17):1287-1293.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4234713/.	TARGet Kids! Collaboration	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Lee GJ, Birken CS, Parkin PC et al. Goat's milk, plant-based milk, cow's milk, and serum 25-hydroxyvitamin D levels in early childhood [Letter to the editor]. Epidemiology; 2016; 27(4), e29-e31. https://www.ncbi.nlm.nih.gov/pubmed/27046131	TARGet Kids! Collaboration	N/A	N/A
Li XE, Drake M. Sensory Perception, Nutritional Role, and Challenges of Flavored Milk for Children and Adults. J Food Sci. 2015; 80(4):R665-R670. https://www.ncbi.nlm.nih.gov/pubmed/25810331	Dairy Research Institute	N/A	N/A
Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. Am J Clin Nutr. 2013; 98(4):1084-1102. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3778861/.	National Institute of Health	N/A	N/A
Marshall TA, Curtis AM, Cavanaugh JE, VanBuren JM, Warren JJ, Levy SM. Description of Children and Adolescent Beverage and Anthropometric Measures According to Adolescent Beverage Patterns. Nutrients. 2018; 10(8): E958. https://www.ncbi.nlm.nih.gov/pubmed/30044405.	National Institutes of Health, The Roy J Carver Charitable Trust, and The Delta Dental of Iowa Foundation	N/A	N/A
Murphy MM, Douglass JS, Johnson RK, Spence LA. Drinking flavored or plain milk is postively associated with nutrient intake and is not associated with adverse effects on weight status in US children and adolescents. J Am Diet Assoc. 2008; 108(4):631-9. https://www.ncbi.nlm.nih.gov/pubmed/18375219.	National Dairy Council	N/A	N/A
Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota. J Am Diet Assoc. 2004; 104(17): 1086-94. https://www.ncbi.nlm.nih.gov/pubmed/15215766.	USDA, National Institutes of Health Harvard Education Program in Cancer Prevention Control, and the Boston Obesity Nutrition Research Center	N/A	N/A
Nicklas TA, O'Neil C, Fulgoni 3rd V. Flavored Milk Consumers Drank More Milk and Had a Higher Prevalence of Meeting Calcium Recommendations Than Nonconsumers. J Sch Health. 2017; 87(9):650-657. https://www.ncbi.nlm.nih.gov/pubmed/28766321.	USDA/ARS, National Dairy Council, USDA Hatch Project	N/A	N/A
Nicklas TA, O'Neil CE, Fulgoni 3rd VL. The nutritional role of flavored and white milk in the diets of children. J Sch Health. 2013; 83(10):728-733. https://www.ncbi.nlm.nih.gov/pubmed/24020687.	N/A	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Norton EM, Poole SA, Raynor HA. Impact of fruit juice and beverage portion size on snack intake in preschoolers. Appetite. 2015; 95:334-340. https://www.ncbi.nlm.nih.gov/pubmed/26232137.	N/A	N/A	N/A
O'Connor TM, Yang SJ, Nicklas TA. Beverage intake among preschool children and its effect on weight status. Pediatrics. 2006; 118(4):e1010-8. https://www.ncbi.nlm.nih.gov/pubmed/17015497.	USDA/ARS Children's Nutrition Research Center and Department of Pediatrics Baylor College of Medicine	N/A	TAN is a member of the speaker's bureau for the National Dairy Council, a member of the speaker's bureau for the National Cattleman's and Beef Association, a member of the advisory board for Cadbury Schweppes, a member of the advisory board for the Grain Food Foundation, a member of the advisory board for Splenda, a member of the International Food Information Media Dialogue Expert Council, and a member of the US Potato Board's Scientific Advisory Panel.
O'Neil CE, Nicklas TA, Fulgoni 3rd VL. Consumption of apples is associated with a better diet quality and reduced risk of obesity in children: National Health and Nutrition Examination Survey (NHANES) 2003–2010. Nutr J. 2015; 14:48. https://www.ncbi.nlm.nih.gov/pubmed/25971247.	USDA/ARS, USDA Hatch Project, Dr. Pepper/ Snapple	N/A	N/A
Paglia L, Scaglioni S, Torchia V et al. Familial and dietary risk factors in Early Childhood Caries. Eur J Paediatr Dent. 2016; 17(2):93-9. https://www.ncbi.nlm.nih.gov/pubmed/27377105.	N/A	N/A	N/A
Patel AI, Moghadam SD, Freedman M, Hazari A, Fang ML, Allen IE. The association of flavored milk consumption with milk and energy intake, and obesity: A systematic review. Prev Med. 2018; 111:151-162. https://www.ncbi.nlm.nih.gov/pubmed/29501475.	Healthy Food America	N/A	N/A
Pietrobell A, Agosti M, the MeNu Group. Nutrition in the first 1000 Days: Ten practices to minimize obesity emerging from published Science. Int J Environ Res Public Health. 2017; 14(12):E1491. https://www.ncbi.nlm.nih.gov/pubmed/29194402.	N/A	N/A	N/A
Przyrembel H, Agostoni C. Growing up milk: A necessity or marketing? World Rev Nutr Diet. 2013; 108: 49-55. https://www.ncbi.nlm.nih.gov/pubmed/24029786.	N/A	N/A	N/A
Rehm CD, Drewnowski A. Dietary and economic effects of eliminating shortfall in fruit intake on nutrient intakes and diet cost. BMC Pediatr. 2016; 16:83. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937591/.	Juice Products Association	N/A	AD has received grants, honoraria, and consulting fees from numerous food and beverage companies and other commercial and nonprofit entities with interests in nutritive and non-nutritive sweeteners. The University of Washington has received grants, donations, and contracts from both the public and the private sector.

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Reid AE, Bhupendrasinh CF, Rabbani R et al. Early Exposure to Nonnutritive Sweeteners and Long-Term Metabolic Health: A systematic review. Pediatrics. 2016; 137(3): e20153603. https://www.ncbi.nlm.nih.gov/pubmed/26917671.	N/A	RZ is the recipient of a New Investigator Award from the Candian Institutes of Health Research (CIHR). JM receives salary support from CIHR.	N/A
Ritchie L, Rausa J, Patel A, Braff-Guajardo E, Hecht K. Providing Water With Meals is Not a Concern for Young Children: Summary of the Literature and Best Practice Recommendations. California Food Policy Advocates; 2012. https://cfpa.net/ChildNutrition/ChildNutrition_CFPAPublications/WaterWithMealsYoungChildren-2012.pdf	Healthy Eating Research, Robert Wood Johnson Foundation	N/A	N/A
Schuster MJ, Wang X, Hawkins T, Painter JE. Comparison of the nutrient content of cow's milk and nondairy milk alternatives: What's the Difference? Food and Nutrition. 2018; 53(4): 153-159.	N/A	N/A	JEP has received speaking honoraria from the National Soybean Research Lab, the Wonderful Company, state Dairy Council affiliates, and the Almond Board of California. JEP has also received research funding from the Wonderful Company and the Soybean Checkoff Board and served on an advisory board for White Wave Silk Brands and the National Dairy Council.
Seferidi P, Millett C, Laverty AA. Sweetened beverage intake in association to energy and sugar consumption and cardiometabolic markers in children. Pediatr Obes. 2018; 13(4):195-203. https://www.ncbi.nlm.nih.gov/pubmed/28112866.	National Institute of Health Research	CM received a Research Professorship award from the National Institute of Health Research, which funded this independent research.	N/A
Singhal S, Baker RD, Baker SS. A Comparison of the Nutritional Value of Cow's Milk and Nondairy Beverages. J Pediatr Gastroenterol Nutr. 2017; 64(5):799-805. https://www.ncbi.nlm.nih.gov/pubmed/27540708.	N/A	N/A	N/A
Sonneville KR, Long MW, Rifas-Shiman, SL, Kleinman K, Gillman MW, Taveras EM. Juice and Water Intake in Infancy and Later Beverage Intake and Adiposity: Could Juice be a Gateway Drink? Obesity. 2015; 23:170-176. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4276519/.	Centers for Disease Control and Prevention, U.S. National Institutes of Helath, Harvard Medical School, and the Harvard Pilgrim Health Care Foundation	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Suthutvoravut U, Abiodun PO, Chomtho S et al. Composition of follow-up formula for young children aged 12-36 Months: Recommendations of an international expert group coordinated by the Nutrition Association of Thailand and the Early Nutrition Academy. Ann Nutr Metab. 2015; 67(2): 119-132. https://www.ncbi.nlm.nih.gov/pubmed/26360877.	New Zealand Ministry for Primary Industries and the Commission of the European Communities	N/A	US has had scientific and educational collaborations with Nestlé Nutrition, Mead Johnson Nutrition and Dumex. POA received an honorarium for chairing a scientific session from Wyeth Nutrition. SC has had scientific and educational collaborations with Nestlé Nutrition and Mead Johnson Nutrition. NC has had scientific and educational collaborations with Nestlé Nutrition, Mead Johnson Nutrition and Dumex. SC has had scientific and educational collaborations with Biocodex, Danone, Nestlé Nutrition and Pfizer Nutrition. PSWD's research group (The Children's Nutrition Research Centre) has received support from Nestlé Nutrition, Bayer, Nutricia, Pfizer Nutrition, Aspen, Danone Nutrition, Abbott Nutrition and the Infant Nutrition Council. JBG received research grants and speaker fees from various formula companies and is actively supporting breastfeeding and is a member of the National Breastfeeding Council and the National Nutrition Council in the Netherlands. ERN received a publication honorarium from AstraZeneca. AS has participated in a clinical research with limited support from Nutricia. WW is a member of the Nestlé Nutrition Council, Nestec Ltd. PW has had scientific and educational collaborations with Dumex. The Ludwig-Maximilians-University of Munich and its employee BK have received support from Abbott Nutrition, Beneo, Danone, Fonterra, Hipp, Mead Johnson Nutrition and Nestlé Nutrition for scientific and educational activities, predominantly as part of publically funded research project with support of the European Commission or German governmental research support. BK is a member of the National Breastfeeding Committee and tends to be biased toward breastfeeding
Sylvetsky AC, Conway EM, Malhotra S, Rother KI. Development of Sweet Taste Perception: Implications for Artificial Sweetener Use. Endocr Dev. 2017; 32:87-89. https://www.ncbi.nlm.nih.gov/pubmed/28873386.	N/A	N/A	N/A
Sylvetsky AC, Rother KI, Brown RB. Artificial Sweetener Use Among Children: Epidemiology, Recommendations, Metabolic Outcomes and Future Directions. Pediatr Clin North Am. 2011; 58(6):1467–1480. https://www.ncbi.nlm.nih.gov/pubmed/22093863	Intramural Research Program of the National Institutes of Health and the National Institute of Diabetes, Digestive, and Kidney Diseases	N/A	N/A
Vitoria I. The nutritional limitations of plant-based beverages in infancy and toddlerhood. Nutr Hosp. 2017; 34(5): 1205-1214. https://www.ncbi.nlm.nih.gov/pubmed/29130721.	N/A	N/A	N/A

Citations	Funding Disclosures	Financial Relationships of the Authors	Conflicts of Interest
Warren JJ, Van Buren JM, Levy SM et al. Dental caries clusters among adolescents. Community Dent Oral Epidemiol. 2017; 45(6):538–544. https://www.ncbi.nlm.nih.gov/pubmed/28671327.	National Institute of Health, the Roy J Carver Charitable Trust, and Delta Dental of Iowa Foundation	N/A	N/A
Welsh JA, Wang Y, Figueroa J, Brumme C. Sugar intake by type (added vs. naturally occuring) and physical form (liquid vs. solid) and its varying association with children's body weight, NHANES 2009-2014. Pediatr Obes. 2018; 13(4):213-221. https://www.ncbi.nlm.nih.gov/pubmed/29318755.	N/A	N/A	N/A
Wilson JF. Does type of milk beverage affect lunchtime eating patterns and food choice by preschool children? Appetite. 1994; 23(1):90-2. https://www.sciencedirect.com/science/article/pii/S0195666384710385?via%3Dihub.	N/A	N/A	N/A
Wilson JF. Lunch eating behavior of preschool children: Effects of age, gender, and type of beverage served. Physiol Behav. 2000; 70(1-2):27-33. https://www.sciencedirect.com/science/article/pii/S0031938400002304.	National Institute of Health	N/A	N/A
Wilson JF. Preschool children maintain intake of other foods at a meal including sugared chocolate milk. Appetite. 1991; 16(1):61-67. https://www.sciencedirect.com/science/article/pii/0195666391901126.	Wittenberg University Research Fund	N/A	N/A
Wilson JF. Preschooler's mid-afternoon snack intake is not affected by lunchtime food consumption. Appetite. 1999; 33(3):319-327.	National Institute of Health	N/A	N/A
Wilson JF, Sinisko SA. Lunchtime food consumption of preschool children over a 2-year period. Appetite. 1995; 25(3):297.	N/A	N/A	N/A

APPENDIX F: EXPERT PANEL MEMBERS

Stephen R. Daniels, MD, PhD is the Chairman of the Department of Pediatrics, Pediatrician-in-Chief, and L. Joseph Butterfield Chair in Pediatrics at Children's Hospital Colorado with the University of Colorado School of Medicine. Dr. Daniels earned his medical degree from the University of Chicago in 1977 and his Masters in Public Health from Harvard University in 1979. He completed his residency in Pediatrics and his fellowship in Pediatric Cardiology at the Cincinnati Children's Hospital Medical Center, in 1981 and 1984, respectively. In 1989 he received his doctorate in Epidemiology from the University of North Carolina. Dr. Daniels held numerous academic and clinical appointments at the University of Cincinnati College of Medicine and the Cincinnati Children's Hospital.

Lori Bechard, PhD, MEd, RDN is currently an Adjunct Instructor at Rutgers University and an Academic Consultant and Lecturer at Northeastern University. Dr. Bechard earned her Bachelor of Science in Dietetics from the University of Vermont in 1989, her Master of Education in Nutrition Education from Framingham State College in 1995, and her Doctor of Philosophy in Health Sciences from Rutgers University School of Health Related Professions in 2014. Dr. Bechard is an esteemed member of the staff of Boston Children's Hospital serving as the Clinical Research Manager of Pediatric Critical Care Nutrition and a Research Associate in Anesthesia at Harvard Medical School. She is a renowned nutrition researcher and clinician with expertise in the areas of clinical research methodology, pediatric critical care, oncology, energy expenditure, and body composition in children.

Emily A. Callahan, MPH, RD is owner of EAC Health and Nutrition, LLC where she specializes in health and nutrition research, policy, communications, and education. Emily earned an MPH in Nutrition and a certificate in Interdisciplinary Health Communication at the University of North Carolina at Chapel Hill, and a BS in Dietetics (summa cum laude) from Miami University in Ohio. Her core services include research, science writing and editing, and content creation for consumer, health professional, academic, and policymaker audiences. Previously, Emily managed a national nutrition initiative at the American Heart Association and was a Program Officer at the National Academies of Sciences, Engineering, and Medicine (Food and Nutrition Board). A Registered Dietitian for 10 years, Emily has counseled patients and delivered numerous in-person and web-based health and nutrition presentations. She has also authored or contributed to peer-reviewed scientific publications, reports, white papers, continuing medical education courses, nutrition education curricula, and more.

Paul S. Casamassimo, DDS, MS currently serves as Professor Emeritus in Pediatric Dentistry at The Ohio State University College of Dentistry. Dr. Casamassimo earned his dental degree from Georgetown University in 1974 and his Masters in Pediatric Dentistry from the University of Iowa in 1976. He also has been a part of numerous research publications with research interests in oral health disparities for children, oral health care for persons with disabilities, policy issues related to the oral health care system for children in the U.S., oral-systemic relationships, and the morbidity of pain related to early childhood caries.

David Krol, MD, MPH, FAAP, a pediatrician, serves as Medical Director of the New Jersey Institute for Food, Nutrition, and Health and the New Jersey Healthy Kids Initiative at Rutgers University. Dr. Krol earned his MD from Yale University School of Medicine and completed pediatrics residency at Rainbow Babies and Children's Hospital. David received his MPH from the Columbia Mailman School of Public Health. He is passionate about improving the physical, mental, and social health and well-being of all infants, children, adolescents, and young adults. A recognized leader in children's oral health, David has served on many expert panels, advisory groups, and task forces including the 2018 Surgeon General's Working Meeting on Oral Health. He is currently chair of the American Academy of Pediatrics Section on Oral Health. David received a BA from the University of Toledo.

Alison Steiber, PhD, RDN is a Registered Dietitian Nutritionist and the Chief Science Officer at the Academy of Nutrition and Dietetics. Dr. Steiber completed her Dietetic Internship and received her Masters of Science in Dietetics at the University of Kansas Medical Center and her Doctorate in Human Nutrition from Michigan State University. As Chief Science Officer, Dr. Steiber leads the 14-person Research, International, and Scientific Affairs team in both research efforts, including: conducting nutrition related research, systematic reviews, position statements, and Evidence Based Nutrition Practice Guidelines, and oversees the Dietitian Outcomes Registry. Additionally, Dr. Steiber oversees the Academy's international efforts, standardized language development and resources, and the research fellowship program. Dr. Steiber holds an adjunct faculty position at Case Western Reserve University and prior to the Academy was Director of the Coordinated Dietetic Internship. She is an author on dozens of scientific research papers and represents the Academy at key research, scientific and/or policy conferences.

Natalie Muth, MD, MPH, RD, FAAP, FACSM is a pediatrician at Children's Primary Care Medical Group in Carlsbad, CA and is an adjunct assistant professor at UCLA Fielding School of Public Health. She earned her Masters of Public Health degree in Nutrition from the University of North Carolina at Chapel Hill in 2004 and her medical degree from the University of North Carolina at Chapel Hill in 2008. She completed her pediatrics residency in the UCLA Pediatrics Community Health and Advocacy Track in 2012. She is a dual board-certified pediatrician and obesity medicine specialist, registered dietitian, and board-certified specialist in sports dietetics. Dr. Muth is recognized for her expertise in nutrition, fitness, health coaching, and childhood obesity prevention and treatment. She is a strong advocate for integration of clinic and community resources to optimize community health. Additionally, she is the author of 5 books and over 120 articles, book chapters, and peer-reviewed journal articles, and is a spokesperson for the American Academy of Pediatrics.

Jenny Ison Stigers, DMD is currently the editor of the American Academy of Pediatric Dentistry (AAPD) Reference Manual, an annual publication of oral health policies, best practices, and clinical practice guidelines. Dr. Stigers is a graduate of Morehead State University and obtained her dental degree from the University of Kentucky (UK). She completed a two-year General Practice Residency at UK and then a residency in pediatric dentistry at Indiana University and the James Whitcomb Riley Hospital for Children in Indianapolis. Dr. Stigers became certified by the American Board of Pediatric Dentistry (ABPD). She was elected as director of ABPD in 2008 and served as president 2012-2013. She chaired the AAPD's Task Force on Strengthening the Science in AAPD's Guidelines and Journals. She was the recipient of AAPD's Leadership Award in 2004 and selected as Pediatric Dentist of the Year in 2008.

Marie-Pierre St-Onge, PhD, CCSH, FAHA is Center Director for the American Heart Association-funded Go Red for Women Strategically Focused Research Center, aimed at determining the causality of the relation between sleep and cardiovascular disease and the specific role that sleep plays in the health of women throughout the life cycle. Dr. St-Onge earned Bachelor's, Master's, and PhD degrees in Human Nutrition at McGill University. Dr. St-Onge conducts innovative, cutting-edge clinical research to address questions relating to the role of circadian rhythms, including sleep duration and timing as well as meal timing and eating patterns, on cardio-metabolic risk. Dr. St-Onge has been NIH-funded since 2008. She has strong expertise in the conduct of controlled inpatient and outpatient studies of sleep and dietary manipulations. She is a pioneer in this field, having Chaired the first scientific statement endorsed by the AHA on this topic. She is a strong supporter of the American Heart Association and has served on numerous committees of the Council on Lifestyle and Cardiometabolic Health over the past 15 years, currently serving on the Nutrition Committee.

Laurie Whitsel, PhD, FAHA is currently the Vice President of Policy Research and Translation for the American Heart Association, helping to translate science into policy at a national level in the areas of cardiovascular disease, stroke prevention, and health promotion. Dr. Whitsel received her doctorate in Nutrition Science from Syracuse University. She has been integrally involved in national policy around worksite wellness, published several peer-reviewed articles, and collaborated with leading experts to develop policy guidance. She also serves on the Board of Directors for the Health Enhancement Research Organization and the National Coalition for Promoting Physical Activity.