POLICY STATEMENT Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

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Fruit Juice in Infants, Children, and Adolescents: Current Recommendations

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Historically, fruit juice was recommended by pediatricians as a source of vitamin C and as an extra source of water for healthy infants and young children as their diets expanded to include solid foods with higher renal solute load. It was also sometimes recommended for children with constipation. Fruit juice is marketed as a healthy, natural source of vitamins and, in some instances, calcium. Because juice tastes good, children readily accept it. Although juice consumption has some benefits, it also has potential detrimental effects. High sugar content in juice contributes to increased calorie consumption and the risk of dental caries. In addition, the lack of protein and fiber in juice can predispose to inappropriate weight gain (too much or too little). Pediatricians need to be knowledgeable about juice to inform parents and patients on its appropriate uses.

Between 2008 and 2013, sales of juice and juice drinks have declined, likely as a result of competing beverages and increasing consumption of healthier food options, specifically fruit and vegetables. Drinks containing tropical fruit, teas, sports and energy drinks, and other combinations ("hybrids") present an array of newer and more fashionable options. Children and adolescents continue to be the highest consumers of juice and juice drinks. Healthier beverage options are gaining popularity, including lower-calorie, unsweetened beverages, as well as those with perceived benefits from ingredients such as herbs and spices. Unfortunately, data revealed that children 2 to 18 years of age consume nearly half of their fruit intake as juice, which lacks dietary fiber and predisposes to excessive caloric intake. This proportion has decreased in recent years.[1]

abstract

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The guidance in this statement does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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DEFINITIONS

To be labeled as a fruit juice, the US Food and Drug Administration mandates that a product be 100% fruit juice. For juices reconstituted from concentrate, the label must state that the product is reconstituted from concentrate. Any beverage that is less than 100% fruit juice must list the percentage of the product that is fruit juice, and the beverage must include a descriptive term, such as "drink," "beverage," or "cocktail." In general, juice drinks contain between 10% and 99% juice and added sweeteners, flavors, and sometimes fortifiers, such as vitamin C or calcium. These ingredients must be listed on the label according to Food and Drug Administration regulations.

COMPOSITION OF FRUIT JUICE

Water is the predominant component of fruit juice. Carbohydrates, including sucrose, fructose, glucose, and sorbitol, are the next most prevalent nutrients in juice. The carbohydrate concentration varies from 11 g % (0.44 kcal/mL) to >16 g % (0.64 kcal/mL). Human milk and standard infant formulas have a carbohydrate concentration of 7 g %.

Juice contains a small amount of protein and minerals. Some juices have naturally occurring high contents of potassium, vitamin A, and vitamin C. In addition, some juices and juice drinks are fortified with vitamin C. Juices fortified with calcium have approximately the same calcium content as milk but lack some other nutrients present in milk, such as magnesium and a substantial amount of protein. Many such calcium-fortified juices also are fortified with vitamin D. The vitamin C and flavonoids in juice may have beneficial long-term health effects, such as decreasing the risk of cancer and heart disease.[2,3]
Drinks that contain ascorbic acid consumed simultaneously with food can increase iron absorption by twofold,[4,5] which may be important for children who consume diets with low iron bioavailability.

Juice contains no fat or cholesterol, and unless the pulp is included, it contains no fiber. The fluoride concentration of juice and juice drinks varies. One study found that fluoride ion concentrations in juice ranged from 0.02 to 2.8 ppm.[6] The fluoride content of concentrated juice varies with the fluoride content of the water used to reconstitute the juice.

Some manufacturers specifically produce juice for infants. These juices do not contain sulfites or added sugars and are more expensive than regular fruit juice.

Other forms of fruit juices are frequently consumed. Parents often use dilute juices to treat constipation or to provide supplementary fluids to infants and children. Up to one-third of adolescents consume sport drinks, and approximately 10% to 15% consume energy drinks.[7] Pediatricians should inquire about the use of these products as they assess the nutritional intake of their patients.

PHARMACOLOGIC CONSIDERATIONS ASSOCIATED WITH FRUIT JUICE INGESTION

Juices from many fruit (eg, grapefruit, blueberry, pomegranate, apple) contain flavonoids (eg, naringin, naringenin, hesperidin, hesperetin, phloridzin, phloretin, quercetin, and kaempferol), which can decrease the activity of several enzymes and transport proteins important in drug disposition.[8–12] Although the ingestion of grapefruit juice has been shown to reduce the activity of intestinal cytochrome P450 3A4 (CYP3A4) and produce potential drug-nutrient interactions (eg, increased bioavailability) of drugs that are CYP3A4 substrates (eg, cyclosporine, tacrolimus, atorvastatin, felodipine, fexofenadine, specific antiretroviral agents), recent evidence suggests that grapefruit juice can also inhibit organic acid transporter activity.[9] In addition to grapefruit juice, flavonoids present in oranges and apples have also been shown to reduce the activity of the organic acid transporter OATP2B1.[8] Although the grapefruit juice–CYP3A4 substrate interaction and the potential for producing significant nutrient-drug interactions is the most well characterized, it should be noted that, in addition to inhibiting CYP3A4 activity, cranberry, pomegranate, and blueberry juice can inhibit the activity of CYP2C9,[10,12] a cytochrome P450 isoform that catalyzes the biotransformation of therapeutic drugs such as ibuprofen, flurbiprofen, warfarin, phenytoin, fluvastatin, and amitriptyline.
The clinical significance of any of the aforementioned juice-drug interactions is extremely difficult to predict on the basis of a history of coingestion. Substantial variability in the duration and magnitude of resultant interactions is a function of multiple factors, including the following: (1) constitutive expression of the effected enzyme or transport protein, (2) significant genetic polymorphism in the enzyme (eg, CYP2C9) or transporter, (3) the relative flavonoid composition and potency among different juices, and (4) the amount of juice ingested and its duration of ingestion (eg, consumption of 1 to 2 L/day of cranberry juice in an adult may be required to produce a significant interaction with warfarin).[10] In evaluating the potential juice-drug interactions, the coadministration of fruit juice and a drug for which metabolism or transport could be affected by a flavonoid should not be considered immediately as a contraindication for treatment. The amount and type of juice being ingested,[9] specific information characterizing a given interaction, and whether the drug(s) being taken has a low (eg, antiretrovirals, calcineurin inhibitors, calcium

channel blockers, warfarin) or high therapeutic index must be considered in the evaluation of a potential interaction. Consultation between the physician and pharmacist can be beneficial in considering the potential clinical significance of a juice-drug interaction.

ABSORPTION OF CARBOHYDRATE FROM JUICE

The 4 major sugars in juice are sucrose, glucose, fructose, and sorbitol. Sucrose is a disaccharide that is hydrolyzed into 2 component monosaccharides, glucose and fructose, by sucrase present in the small bowel epithelium. Glucose is then absorbed rapidly via an active-carrier–mediated process in the brush border of the small bowel. Fructose is absorbed by a facilitated transport mechanism via a carrier but not against a concentration gradient. In addition, fructose may be absorbed by a disaccharidase-related transport system, because the absorption of fructose is more efficient in the presence of glucose, with maximal absorption occurring when fructose and glucose are present in equimolar concentrations.[13] Clinical studies have shown this process, with more apparent malabsorption when fructose concentration exceeds that of glucose (eg, apple and pear juice) than when the 2 sugars are present in equal concentrations (eg, white grape juice).[14,15] However, when provided in appropriate amounts (10 mL/kg body weight), these different juices are absorbed equally as well.[16] Sorbitol, found in small amounts in pears, apples, cherries, apricots, and plums and in sugar-free foods (eg, candy, gum, drinks, ice cream) and some liquid medications, is absorbed via passive diffusion at slow rates, resulting in much of the ingested sorbitol being unabsorbed.[17]

Carbohydrate that is not absorbed in the small intestine is fermented by bacteria in the colon. This bacterial fermentation results in the production of hydrogen, carbon dioxide, methane, and the short-chain fatty acids acetic, propionic, and butyric. Some of these gases and fatty acids are reabsorbed through the colonic epithelium, and in this way, a portion of the malabsorbed carbohydrate can be scavenged.[18] Nonabsorbed carbohydrate presents an osmotic load to the gastrointestinal tract, which causes diarrhea.[19]

Toddlers' diarrhea is a well-known and benign condition that often responds by simply removing excess juice from the diet of 1- to 4-year-olds. However, malabsorption of carbohydrate in juice, especially when consumed in excessive amounts, can result in chronic diarrhea, flatulence, bloating, and abdominal pain.[20–26] Fructose and sorbitol have been implicated most commonly,[14,15,27–30] but the ratios of specific carbohydrates may also be important.[31] The malabsorption of carbohydrate that can result from large intakes of juice is the basis for some health care providers to recommend juice for the treatment of constipation, particularly in infants. The North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition constipation guideline suggests taking advantage of the sorbitol and other carbohydrates contained in some juices, such as prune, pear, and apple juices, to help increase the frequency and water content of stools for infants with constipation.[32]

STRATEGIES REGARDING JUICE IN THE *DIETARY GUIDELINES FOR AMERICANS*

A basic premise of the *Dietary Guidelines for Americans*, the most recent version of which was published in 2015, is to focus on nutrient-dense foods.[1] Fruit is 1 of the key focus foods in the dietary guidelines.[1] Fruit, along with vegetables, is recommended to provide necessary vitamins and minerals, reduce the risk of cardiovascular disease, potentially protect against cancer, and curb excessive caloric intake. For example, children consuming approximately 1000 kcal/day (depending on size, 1–4 years old) should have ~1 cup of fruit per day, whereas those consuming approximately 2000 kcal/day (depending on size, 10–18 years old) should consume ~2 cups of fruit per day. Although whole fruit is to be encouraged, up to half of the servings can be provided in the form of 100% fruit juice (not fruit drinks). A 6-ounce glass of fruit juice equals 1 fruit serving. Fruit juice offers no nutritional advantage over whole fruit. A disadvantage of fruit juice is that it lacks the fiber of whole fruit. Kilocalorie for kilocalorie, fruit juice can be consumed more quickly than whole fruit. Reliance on fruit juice instead of whole fruit to provide the recommended daily intake of fruit does not promote eating behaviors associated with the consumption of whole fruit. Because recent studies suggest that pure orange juice consumption has health benefits in adults, further research is needed to determine whether children and adolescents may derive similar benefits.[33,34]

Pediatricians play a central role in children's health and nutrition by providing guidance to pediatric patients and their parents. Pediatricians can also advocate for changes in public policy, especially in schools, where improved fruit and vegetable intake has been associated with policies promoting healthier dietary choices.[35] Open assessment and recommendations for appropriate dietary habits, including consuming whole fruit rather than fruit juice, can help encourage parental support of healthy rates of weight gain.[36] Although other risk factors associated with obesity may be important to consider, a

recent study suggests that special attention may be indicated for infants and children of women who are overweight before bearing children.[37]

MICROBIAL SAFETY OF JUICE

Parents need to be informed that unpasteurized juice products may contain pathogens, such as *Escherichia coli, Salmonella* species, and *Cryptosporidium* species, which may be harmful to children. These organisms are associated with serious diseases, such as hemolytic-uremic syndrome.[38–40] If parents choose to give their children unpasteurized juice products, they should do so with caution and be advised that this is an unsafe practice. Commercially prepared unpasteurized juice must contain a warning on the label that the product may contain harmful bacteria.[41] This guidance does not apply to certain modes of sale (eg, "juice or cider that is freshly squeezed and sold by the glass, such as at apple orchards, at farmers' markets, at roadside stands, or in some juice bars" [http://www.fda.gov/Food/ResourcesForYou/Consumers/ucm110526.htm]), but families should remain vigilant when providing unpasteurized juice products to children. Pasteurized fruit juices are free of microorganisms and are safe for infants, children, and adolescents.

INFANTS

The American Academy of Pediatrics (AAP) recommends that human milk be the only nutrient fed to infants untilapproximately 6 months of age.[42] For mothers who cannot breastfeed or who choose not to breastfeed, a prepared infant formula can be used as a complete source of nutrition. No additional nutrients are needed. There is no nutritional indication to give fruit juice to infants younger than 6 months. Offering juice before solid foods are introduced into the diet could risk having juice replace human milk or infant formula in the diet, which can result in reduced intakes of protein, fat, vitamins, and minerals such as iron, calcium, and zinc.[43] Malnutrition and short stature in children have been associated with excessive consumption of juice.[44,45]

It is optimal to completely avoid the use of juice in infants before 1 year of age. When juice is medically indicated for an infant older than 6 months, it is prudent to give the juice to the infant in a cup. Dental caries have also been associated with juice consumption.[46] Prolonged exposure of the teeth to the sugars in juice is a major contributing factor to dental caries. Recommendations from the AAP and American Academy of Pediatric Dentistry state that juice should be offered to toddlers in a cup, not a bottle, and that infants not be put to bed with a bottle in their mouth.[47,48] The practice of allowing children to carry a bottle, easily transportable covered cup, open cup, or box of juice around throughout the day leads to excessive exposure of the teeth to carbohydrate, which promotes the development of dental caries.[49]

Infants can be encouraged to consume whole fruit that is mashed or pureed. After 1 year of age, fruit juice may be used as part of a meal or snack. It should not be sipped throughout the day or used as a means to calm an upset child. Because infants consume <1600 kcal/day, 4 ounces of juice per day, representing half of the recommended daily serving of fruit, is more than adequate.

The AAP practice parameter on the management of acute gastroenteritis in young children (published in 1996 and subsequently retired in 2001) recommended that only oral electrolyte solutions be used to rehydrate infants and young children and that a normal diet be continued throughout an episode of gastroenteritis.[50] Surveys show that many health care providers do not follow the recommended procedures for the management of diarrhea.[51] The high carbohydrate content of juice (11–16 g %), compared with oral electrolyte solutions (2.5–3 g %), may exceed the intestine's ability to absorb carbohydrate, resulting in carbohydrate malabsorption. Carbohydrate malabsorption causes osmotic diarrhea, increasing the severity of the diarrhea already present.[52] Fruit juice is low in electrolytes. The sodium concentration is 1 to 3 mEq/L. The stool sodium concentration in children with acute diarrhea is 20 to 40 mEq/L. Oral electrolyte solutions contain 40 to 45 mEq sodium/L. As a replacement for fluid losses, juice may predispose infants to development of hyponatremia.

Concern has been raised that infants exposed to orange juice had an increased likelihood of developing an allergy to it. The development of a perioral rash in some infants after being fed freshly squeezed citrus juice is most likely attributable to the chemical irritant effects of acid.[53] Diarrhea and other gastrointestinal symptoms observed in some infants were most likely attributable to carbohydrate malabsorption. Although allergies to fruit may develop early in life, they are uncommon.[54]

TODDLERS AND YOUNG CHILDREN (1–6 YEARS OF AGE)

Most issues relevant to juice intake for infants are also relevant for toddlers and young children. Fruit juice and fruit drinks are easily overconsumed by toddlers and young children because they taste good. In addition, they are conveniently packaged or can be placed in a bottle or transportable covered cup and carried around during the day.

Because juice is viewed as nutritious, limits on consumption are not usually set by parents. Toddlers and young children can be encouraged to consume whole fruit instead of juice. Like soda, it can contribute to energy imbalance. Pediatricians should support policies that seek to reduce the consumption of fruit juice and promote the consumption of whole fruit by toddlers and young children already exposed to juices. This support should include policies of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), provided that those policies do not have negative nutritional consequences (ie, inadequate total calories, absence of any fruit in the diet) for children without access to fresh fruit. In addition, high intakes of juice can contribute to diarrhea, overnutrition or undernutrition, and the development of dental caries. The dilution of juice with water does not necessarily decrease the dental health risks.

OLDER CHILDREN AND ADOLESCENTS (7–18 YEARS OF AGE)

Juice consumption presents fewer nutritional issues for older children and adolescents, because they consume less of these beverages. Nevertheless, juice intake should be limited to 8 ounces/day, half of the recommended daily fruit servings. It is important to encourage the consumption of the whole fruit for the benefit of fiber intake and a longer time to consume the same kilocalories.

Excessive juice consumption and the resultant increase in energy intake may contribute to the development of obesity. One study found a link between juice intake in excess of 12 ounces/day and obesity.[45] Other studies, however, found that children who consumed greater amounts of juice were taller and a had lower BMI than those who consumed less juice[55] or found no relationship between juice intake and growth variables.[56] A more recent study suggested that varying intakes of 100% juice were not associated with obesity.[57] More research is required to better define this relationship.

CONCLUSIONS

1. Fruit juice offers no nutritional benefits for infants younger than 1 year.
2. Fruit juice offers no nutritional benefits over whole fruit for infants and children and has no essential role in healthy, balanced diets of children.
3. One hundred percent fresh or reconstituted fruit juice can be a healthy part of the diet of children older than 1 year when consumed as part of a well-balanced diet. Fruit drinks, however, are not nutritionally equivalent to fruit juice.
4. Juice is not appropriate in the treatment of dehydration or the management of diarrhea.
5. Excessive juice consumption may be associated with malnutrition (overnutrition and undernutrition).
6. Excessive juice consumption is associated with diarrhea, flatulence, abdominal distention, and tooth decay.
7. Unpasteurized juice products may contain pathogens that can cause serious illnesses and should be given to children cautiously, if at all.
8. A variety of fruit juices, provided in appropriate amounts for a child's age, are not likely to cause any significant clinical symptoms.
9. Calcium-fortified juices provide a bioavailable source of calcium and often vitamin D but lack other nutrients present in human milk, infant formula, or cow milk.

RECOMMENDATIONS

1. Juice should not be introduced into the diet of infants before 12 months of age unless clinically indicated. The intake of juice should be limited to, at most, 4 ounces/day in toddlers 1 through 3 years of age, and 4 to 6 ounces/day for children 4 through 6 years of age. For children 7 to 18 years of age, juice intake should be limited to 8 ounces or 1 cup of the recommended 2 to 2.5 cups of fruit servings per day.
2. Toddlers should not be given juice from bottles or easily transportable covered cups that allow them to consume juice easily throughout the day. Toddlers should not be given juice at bedtime.
3. Children should be encouraged to eat whole fruit to meet their recommended daily fruit intake and should be educated regarding the benefit of fiber intake and the longer time to consume the same kilocalories when consuming whole fruit compared with fruit juice.
4. Families should be educated that, to satisfy fluid requirements, human milk and/or infant formula is sufficient for infants and low-fat/nonfat milk and water are sufficient for older children.
5. Consumption of unpasteurized juice products should be strongly discouraged in infants, children, and adolescents.
6. Grapefruit juice should be avoided in any child taking medication that is metabolized by CYP3A4 (see list described previously).
7. In the evaluation of children with malnutrition (overnutrition and undernutrition), the pediatrician should determine the amount of juice being consumed.

8. In the evaluation of children with chronic diarrhea, excessive flatulence, abdominal pain, and bloating, the pediatrician should determine the amount of juice being consumed.
9. In the evaluation of the risk of dental caries, pediatricians should routinely discuss the relationship between fruit juice and dental decay and determine the amount and means of juice consumption.
10. Pediatricians should routinely discuss the use of fruit juice and fruit drinks and should educate older children, adolescents, and their parents about differences between the two.
11. Pediatricians should advocate for a reduction in fruit juice in the diets of young children and the elimination of fruit juice in children with abnormal (poor or excessive) weight gain.
12. Pediatricians should support policies that seek to reduce the consumption of fruit juice and promote the consumption of whole fruit by toddlers and young children (eg, child care/preschools) already exposed to juices, including through the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).[58,59]

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ABBREVIATIONS

AAP: American Academy of Pediatrics
CYP3A4: cytochrome P450 3A4

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