PART D. CHAPTER 10: BEVERAGES

INTRODUCTION

Beverages, broadly defined as any type of energy or non-energy-yielding drink, substantially contribute to the dietary patterns of Americans in both favorable and adverse ways. Beverages can provide energy and key nutrients to improve health and prevent chronic diseases. From a physiological perspective, beverages fulfill unique roles in the diet by fulfilling hydration needs, quenching thirst, and assisting with food mastication and digestion. In addition, culturally, beverages serve a unique role in enhancing social interactions, sensory properties of foods, and quality of life.

Despite these benefits, beverages can contribute to excess energy, primarily in the form of added sugars, which promotes positive energy balance and weight gain. The *2015-2020 Dietary Guidelines for Americans* included recommendations to limit the amount of added sugars consumption, especially in the form of sugar-sweetened beverages (SSB), as a result of the moderate to strong evidence that higher added sugars consumption is associated with overweight and obesity, type 2 diabetes, and cardiovascular disease (CVD).[1] Given the diverse nutritional, sensory, and physical characteristics of beverages consumed in America, a critical examination of all beverage categories is needed to gain a better understanding of the role of beverages in a healthy dietary pattern.

This chapter examines the available data concerning the relationships between beverage consumption and achieving nutrient and food group recommendations; growth, size and body composition; and risk of overweight and obesity in children and adults. The 2020 Dietary Guidelines Advisory Committee also reviewed the relationship between beverages and gestational weight gain; this topic is discussed in ***Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy***.

Importance and Relevance of this Topic

Beverages are consumed at most ingestive events. They can be part of a meal or snack, consumed as “the” meal or snack, or “sipped” throughout the day with no discrete ingestive event. Although beverage consumption as a whole has declined over the past decade in children and adults,[2] beverages continue to be a significant source of energy and nutrients in the diet. Specifically, beverages contribute 18 percent of daily energy for adults ages 20 to 64 years and 13 to 16 percent of daily energy in children ages 19 years and younger (Bev_DS[1]). Further, although some beverages, like milk and 100% fruit juice, provide at least one-third of the daily intake of shortfall nutrients (e.g., vitamin C, vitamin D, calcium), others, including SSB, provide at least one-third to one-half of the added sugars within the diet in children and adults.[3,4] Thus, beverages contribute positive health benefits, but they also may lower diet quality and increase risk of developing chronic diseases including obesity, type 2 diabetes, and CVD.

A number of published systematic reviews and meta-analyses have examined the specific relationship between SSB and chronic diseases. Consistent evidence in prospective cohort studies (PCSs) and randomized controlled trials (RCTs) within these articles report associations between SSB consumption and adiposity markers in children and/or adults.[5-7] Similar associations also have been observed with respect to type 2 diabetes and CVD. However, given the discrepancy of findings and methodological limitations with some of the studies included in recent reviews, a few recent reviews have questioned the link between SSB and chronic disease.[8,9] Understanding is limited with respect to whether selected beverages, such as milk, juice, or low- or no-calorie sweetened beverages (LNCSB) are associated with markers of adiposity in children and adults. Thus, this chapter takes a broad look at the effects of beverage consumption on multiple diet quality and health outcomes in children and adults.

Setting the Review Criteria

A critical first step in examining the scientific literature on beverage consumption and growth, size, body composition, and risk of overweight and obesity was to establish a definition for beverages and identify the specific beverage categories of interest. The Committee broadly defined beverages as any type of energy or non-energy-yielding drink consumed from a cup, glass, or bottle. Given this definition, soups and any other liquids or semi-solids that were not considered "drinks" were excluded. This definition does not include human milk, infant formula, or beverages consumed during complementary feeding, which are addressed in ***Part D. Chapter 4: Duration, Frequency, and Volume of Exclusive Human Milk and/or Infant Formula Feeding*** and ***Part D. Chapter 5: Foods and Beverages Consumed During Infancy and Toddlerhood***. The Committee classified beverages into the following categories: milk,

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[1] For details, see data supplements that provide results of analyses conducted for the Committee, referenced as Beverages (Bev_DS) and Food Categories Sources (Cat_DS). These supplements can be found at https://www.dietaryguidelines.gov/2020-advisory-committee-report/data-analysis.

flavored milk, dairy drinks and substitutes, 100% juice, SSB, LNCSB, nutritional beverages, coffee and tea, plain water (tap or bottled), and flavored or enhanced water. Given that the focus of this chapter is on beverages as a "food category," the Committee generally did not examine specific nutrients, compounds, and sensory and physical characteristics. One exception is the examination of the fat content of milk. Alcohol also was considered a beverage category, and this topic is discussed in ***Part D. Chapter 11: Alcoholic Beverages***.

When assessing outcomes, the Committee distinguished "healthy growth" from "excessive growth" in children. Thus, weight status (prevalence or incidence of overweight or obesity), body mass index (BMI) and BMI z-scores, and body composition measures, such as waist circumference, body fat, and abdominal obesity, were considered to reflect "adiposity," whereas height and lean mass were considered to reflect "healthy growth." In adults, weight status (prevalence or incidence of overweight or obesity), BMI, and body composition measures, such as waist circumference, body fat, and abdominal obesity, were considered to be "markers of adiposity." Sarcopenia was not included in this review.

The Committee also considered a number of factors that act as covariates or confounders when interpreting studies of beverage consumption. Of particular concern was adjustment for total energy intake. This is crucial, given that beverages might displace nutrient-dense foods or add excess energy to the diet. Further, although the Committee was unable to explore potential mechanisms linking beverage consumption and adiposity, considering adjustment for total energy intake allowed the Committee to determine whether beverages contribute to adiposity irrespective of the additional energy from the beverage. Alternately, when not controlling for total energy intake, effects could be attributed to the additional energy that the beverage provides to the total diet. Therefore, findings from analyses that did and did not control for energy intake were reviewed.

LIST OF QUESTIONS

1. What is the relationship between beverage consumption and achieving nutrient and food group recommendations?
2. What is the relationship between beverage consumption and growth, size, body composition, and risk of overweight and obesity?

METHODOLOGY

The Committee developed a data analysis protocol for Question 1 that described how the Committee would use data analyses to answer the question. The protocol included an analytic framework that described the overall scope of the analyses, including the population and type of analyses and data sources identified to answer the question. It also included the definitions of key terms.

This question relied on analysis of data from What We Eat in America (WWEIA), the dietary component of the National Health and Nutrition Examination Survey (NHANES). Existing data tables were used when available. In some cases, new analyses were conducted by the Data Analysis Team (DAT) to provide additional information, at the Committee's request. For example, the DAT conducted analyses by specific population groups such as infants and toddlers and women who are pregnant or lactating.

A description of the data analysis methodology is provided in ***Part C. Methodology***, including more information on the data sources. Complete documentation of the data analysis protocol and the referenced results is available on the following website: [placeholder for site]. Below is a summary of the unique elements of the protocol developed to answer the question addressed in this chapter.

Data analyses outlined in the analytic plan focused on beverage contributions to food group intakes, as well as intakes of nutrients and other food components. Life stages from infancy through older adults and including women who are pregnant or lactating were considered. Dietary intake data were collected using 24-hour dietary recalls as part of WWEIA, NHANES. For the general population ages 2 years and older, the 2015-2016 cycle of data were examined. For infants and toddlers ages 6 to less than 24 months, WWEIA, NHANES 2007-2016 were combined. For women who are pregnant or lactating, as well as analyses describing current intakes, WWEIA, NHANES 2013-2016 were used.

Beverage categories specific to the data analyses are used to describe results in the summary of evidence. Discrete beverage categories are described as follows:

- **Milk:** Plain and flavored milk, other dairy drinks and milk substitutes (excludes milk or milk substitutes added to alcoholic beverages, coffee, tea, and/or foods such as cereal)
- **100% Juice:** 100% fruit and/or vegetable juice
- **Coffee and tea:** Regular and decaffeinated coffee or tea with additions such as milk, cream and/or sweeteners, and coffee and tea drinks, including ready-to-drink products that may contain added sugars.

- **Diet beverages:** Diet soft drinks, diet sports and energy drinks and other diet drinks that are low- and no-calorie-sweetened with 40 kcal or less per reference amount customarily consumed.
- **Sweetened beverages:** Energy-containing soft drinks, fruit drinks, and sports and energy drinks with added sugars that contain more than 40 kcal per reference amount customarily consumed. This category does not include flavored milks or coffees and teas with added sugars.
    - Soft drinks: Energy-containing drinks made with carbonated water.
    - Fruit drinks: Energy-containing fruit and/or vegetable drinks that are not 100% juice.
    - Sports and energy drinks: Energy-containing sports and energy drinks; nutritional beverages and protein and nutritional powders consumed with a beverage; smoothies and grain drinks.
- **Water:** Tap, bottled, flavored, carbonated, and enhanced/fortified water containing less than 5 kcal per reference amount customarily consumed.

Because data analysis and systematic review are different approaches to review the evidence, the presentation of the summary of evidence is organized differently below. In each case, however, the conclusion statements are informed by the evidence reviewed, as outlined in the protocol. The Committee took the strengths and limitations of the data quality and analyses into account in formulating conclusion statements. The grading process used for questions answered by the NESR systematic review methodology does not apply to questions using data analysis; therefore, data analysis conclusions were not graded.

Question 2 in this chapter was answered using a systematic review conducted with support from USDA's Nutrition Evidence Systematic Review (NESR) team.

NESR's systematic review methodology provided a rigorous, consistent, and transparent process for the Committee to search for, evaluate, analyze, and synthesize evidence. The Committee developed a systematic review protocol, which described how the Committee would apply NESR's methodology to answer the question. The protocol included an analytic framework and inclusion and exclusion criteria to guide identification of the most relevant and appropriate body of evidence to use in answering the question. The analytic framework outlined core elements of the systematic review (i.e., population; intervention and/or exposure and comparator (i.e., the alternative being compared to the intervention or exposure); and outcomes), and included definitions for key terms, key confounders, and other factors to be considered when reviewing the evidence. The inclusion and exclusion criteria were selected before the literature review to operationalize the elements of the analytic framework, and specify what made a study relevant for the systematic review question.

Next, a literature search was conducted to identify all potentially relevant articles, and those articles were screened by two NESR analysts, independently, based on the criteria selected by the Committee. For each included article, data were extracted and risk of bias assessed. The Committee qualitatively synthesized the body of evidence to inform development of conclusion statements, and graded the strength of evidence using pre-established criteria for risk of bias, consistency, directness, precision, and generalizability. Finally, recommendations for future research were identified. A detailed description of NESR's systematic review methodology is provided in ***Part C. Methodology***, including standard inclusion and exclusion criteria applied in many of the Committee's systematic reviews. Complete documentation of each systematic review is available on the following website: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews. Below is a summary of the unique elements of the protocol developed to answer the question addressed in this chapter.

For the systematic review on beverages and growth, size, body composition, and risk of overweight and obesity, the population of interest was children and adolescents (ages 2 to 18 years), adults (ages 19 to 64 years), and older adults (ages 65 years and older).

The intervention or exposure of interest was the type and amount of specific beverage consumption, including the following beverage types: milk (i.e., dairy milk and milk substitutes including flavored milk), 100% juice, LNCSB (e.g., diet soft drinks or diet sports and energy drinks), and SSB (i.e., beverages sweetened with various forms of added sugars). Studies were excluded if the intervention or exposure of interest was a nutrient added to a beverage (i.e., the beverage was the delivery mechanism for the exposure nutrient). Further, studies were excluded if the beverage of interest was not commercially available (e.g., experimentally manipulated beverages). Liquid supplements, alcoholic beverages, and soups also were excluded. Initially, the Committee planned to examine *all* types of beverages and beverage patterns. The Committee later revised the protocol to focus the review of evidence on beverages considered to be of greatest public health concern: milk, 100% juice, SSB, and LNCSB. Beverage categories that were not examined include: water, nutritional beverages, coffee and tea, plain water (tap or bottled), and flavored or enhanced water.

The comparator of interest was consumption of a different amount of the same beverage, including no consumption or versions of the beverage diluted with water. The comparison also could be water or the solid version of the beverage (relevant for juice, e.g., oranges vs orange juice). Two additional beverage-specific comparisons were assessed. For sweetened beverages, a comparison of SSB and LNCSB was included. For milk, comparisons of dairy milk with different amounts of fat were included. Different types of beverages within a category were not compared (e.g., different types of 100% juice or different types of sweetener for LNCSBs). Initially, the comparator was described as different type or amount of beverage consumed (including no consumption or plain water as a control when appropriate) and different volume, nutrient content, sensory property, or physical form. However, to improve clarity, more directly answer the systematic review question, and focus on comparisons of greatest public health importance, the description of the comparator was updated to include different amount of the same beverage (including no consumption and versions diluted with water), beverage vs solid, beverage vs water, SSB vs LNCSB, and dairy milk with different amounts of fat. The description of the comparator also was updated to exclude studies comparing different beverage types.

Outcomes included measures of: body weight; weight-for-age; height; length/stature-for-age; BMI; BMI z-score; weight-for-length; body circumferences: head, arm, waist, thigh, neck; body composition and distribution (e.g., percent fat mass, percent fat-free mass). Outcomes also included incidence and prevalence of: underweight, failure to thrive, stunting, wasting, healthy weight, overweight, obesity.

When establishing inclusion and exclusion criteria, the Committee used standard NESR criteria for study design, publication status, language of publication, country, study participants, and health status of study participants. In addition, the Committee clarified that Mendelian randomization studies are eligible for inclusion by noting this study design specifically in the inclusion criteria. Studies were included if they were published from January 2000 to June 2019, with the exception of studies where the intervention or exposure was SSB and the comparator was different level of SSB or water, which were included if they were published from January 2012 to June 2019. This different publication date range criteria was applied to the review of SSB evidence because the 2015 Dietary Guidelines Advisory Committee reviewed evidence on the relationship between added sugars, including SSB, and body weight/obesity, published up to January 2012.[1] This Committee initially established an inclusion criterion that experimental studies must have a minimum duration of 8 weeks. However, this criterion was removed for consistency with other reviews addressing the same outcome.

REVIEW OF THE SCIENCE

Question 1. What is the relationship between beverage consumption and achieving nutrient and food group recommendations?

Approach to Answering Question: Data analysis

Conclusion Statements

Beverages are diverse in their contribution to food groups and dietary components. Selection of beverage choice can contribute positively to food groups currently consumed in amounts below recommendations (i.e., dairy, fruit) and nutrients that are under consumed (e.g., potassium, calcium, vitamin D). Beverages can also increase dietary components that exceed recommended limits (i.e., added sugars).

Plain fluid milk, plain calcium fortified soy beverage, and 100% juice contribute to meeting food group and nutrient needs without contributing energy from added sugars. Coffee, without additions of added sugars is a notable source of potassium for adults.

Beverages account for 13 to 16 percent of total daily energy intake in children and adolescents, 18 percent of total daily energy intake for adults ages 20 to 64 years, and 13 percent of total daily energy intake for adults ages 65 years and older. Beverages' contribution to added sugars intake is 32 percent for young children and 49 percent for adolescents. Among adults, beverages contribute 58 percent of added sugars intakes for adults ages 20 to 64 years and 35 percent of added sugars intakes for adults ages 65 years and older.

The top beverage sources of added sugars are regular soft drinks, fruit drinks, sports and energy drinks, smoothies, and coffee and tea inclusive of added sugars.

Summary of the Evidence

The following sections describe the results of data analyses conducted to answer Question 1. Additional details can be found in data supplements, referenced below as Beverages (Bev_DS).

The food group and food component contribution of beverages is diverse. Generally, beverages contribute to 2 food groups, dairy foods and fruit. Fluid cow milk and calcium-fortified soy beverages contribute to the dairy foods group. For each, an 8 oz portion of the beverage contributes 1 cup equivalent (cup eq) to the dairy foods group. One cup of 100% fruit juice contributes one cup eq of fruit. Cow milk, calcium-fortified soy beverages, and 100% juice also may be added to, or be an ingredient in, beverages. Thus, other beverages may contribute to these food groups (e.g., coffee with cow milk added).

Beverage intakes, including the proportions of population groups consuming beverage types, are described in ***Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients***. For this question, the focus is on the contribution of beverages to intakes of energy, food groups, nutrients, and other food components, such as added sugars.

Infants and Toddlers Ages 6 to 24 Months

Older infants, ages 6 to 12 months, consume fluids predominantly through human milk and/or infant formula (Bev_DS). Approximately one-third of these infants consume some 100% fruit juice and nearly 60 percent drink plain water on a given day. Cow milk and sweetened beverages are reported for about 5 percent of infants. Other beverages are rarely consumed in this population. Excluding human milk and infant formula, whole milk accounts for 36 percent of energy consumed through beverages, 100% juice contributes 32 percent, and reduced-fat, low-fat, and fat-free milk accounts for 14 percent.

Toddlers, ages 12 to 24 months, consume a wider variety of beverage types. Together, all beverages account for 32 percent of total energy (371 kcal) intake among toddlers. More than half consume some 100% juice, which contributes 5 percent of total energy intake, 10 percent of carbohydrates, and 8 percent of potassium in their diets. A large proportion of toddlers have reported consumption of cow milk; 64 percent report whole milk and 23 percent report reduced-fat, low-fat, or fat-free milk on a given day. A very small proportion of toddlers have flavored milk or milk substitutes of any kind (6 percent and 5 percent, respectively). Cow milk is a source of energy and several nutrients that have been identified as underconsumed in this population, with whole milk providing 18 percent of total energy, 57 percent of vitamin D, 39 percent of calcium, and 25 percent of potassium in the diets of toddlers. Whole cow milk also contributes 36 percent of saturated fat in the diets of toddlers. Plain cow milk that is reduced-fat, low-fat, or fat-free is consumed by a smaller proportion of toddlers and contributes to similar food components as whole milk (e.g., vitamin D, calcium, potassium). Sweetened beverages (i.e., soft drinks, fruit drinks, and sports and energy drinks with added sugars) are consumed by 29 percent of toddlers and account for 3 percent of total energy intake and 27 percent of added sugars intake. They make very little contribution to other nutrient intakes.

Children

The volume of total reported daily beverage intakes is 31 fluid ounces (fl oz) for children ages 2 to 5 years, 38 fl oz for children ages 6 to 11 years, and 52 fl oz for children ages 12 to 19 years.[3] The proportion of children with reported intakes of beverage categories other than water vary by age. More than half of children ages 2 to 5 years report consuming milk as a beverage (65 percent) on a given day. A significantly smaller proportion of children ages 6 to 11 years (53 percent) and 12 to 19 years (34 percent) consume milk as a beverage.[3] The mean volume of milk reported is similar across age groups (12 to 13 fl oz). The reported intakes of sweetened beverages are significantly more common after age 5 years, while intake of 100% juice is significantly less common. Mean volume of 100% juice is significantly lower for children ages 6 to 11 years (7 fl oz) when compared to other age groups (10 fl oz). Mean volume of sweetened beverages is significantly and incrementally higher by age group; 9 fl oz for ages 2 to 5 years, 13 fl oz for ages 6 to 11 ages, and 18 fl oz for ages 12 to 19 years. A similar trend is seen with sweetened beverages' percent contribution to total beverage energy. Among children ages 2 to 5 years, sweetened beverages comprise 19 percent of total energy from beverages, compared to 37 percent and 44 percent of total beverage energy for children ages 6 to 11 years and ages 12 to 19 years, respectively.

Differences by race and ethnicity are apparent, especially for intakes of sweetened beverages.[4] Non-Hispanic Black children have the highest intakes of sweetened beverages and Asian children have the lowest intakes. Within the category of sweetened beverages, fruit drinks in particular are reported by non-Hispanic Black children more frequently than by any other race or ethnic group. In addition, 100% juice is reported by significantly more Hispanic (34 percent) and non-Hispanic Black (33 percent) than non-Hispanic White (25 percent) or Asian (23 percent) children. Fewer Hispanic (78 percent) and non-Hispanic Black (76 percent) children report water than did non-Hispanic White (86 percent) or Asian children (93 percent). Milk is consumed by a smaller proportion of non-Hispanic Black (34 percent) children than children of other race/ethnic groups (45-56 percent).

Beverages account for 13 to 16 percent of mean energy intake.[4] Beverages, namely milk and 100% juice, account for nearly 50 percent of vitamins C and D for children ages 2 to 5 years and about 40 percent of these vitamins for older children. Approximately 20 percent to 30 percent of calcium, potassium, and magnesium come from beverages as well. Beverages, mainly sweetened beverages, account for 32 percent of added sugars for ages 2 to 5 years, 39 percent for ages 6 to 11 years, and 49 percent for ages 12 to 19 years. For younger children, nearly half of energy from beverages comes from milk, whereas 44 percent of energy from beverages comes from sweetened beverages and 13 percent comes from coffee and tea, inclusive of additions.

Adults

The volume of total reported daily beverage intake is 88 fl oz for adults ages 20 to 64 years, and males have a significantly higher intake compared to females (about 17 fl oz/day difference) (Bev_DS). For both males and females, the mean daily intake of water (53 fl oz/d) is greater than the consumption of any other beverage type. About 50 percent of adults ages 20 to 64 years report consuming sweetened beverages on a given day, while 15 percent report consuming diet beverages. Sixty-four percent of adults report consuming coffee or tea. Consumption of these beverage types ranges from 22 to 27 fl oz/d. Males consume significantly higher daily volumes of coffee or tea (5 fl oz difference) and sweetened beverages (7 fl oz difference) compared to females; a significant difference in the consumption of diet beverage consumption is not seen between sexes (Bev_DS). In this age category, only 17 percent report consuming milk, milk drinks, and milk substitutes with mean daily intakes of 16 fl oz for males compared to 12 fl oz for females.

The volume of total reported daily beverage intake is 66 fl oz for adults ages 65 years and older, which is 22 fl oz lower than the daily consumption among younger adults (Bev_DS). Similar to younger adults ages 20 to 64 years, the mean daily intake of water in older adults (39 fl oz) is greater than the consumption of any other beverage type. Coffee or tea, sweetened beverages, and diet beverages also are consumed in volumes of 14 fl oz/d or greater. Eighty-one percent of adults ages 65 years and older report consuming coffee or tea, whereas approximately 30 percent or less report consuming sweetened beverages and diet beverages (29 percent and 18 percent, respectively). In this older age category, a slightly higher percentage report consuming milk, milk drinks, and milk substitutes compared to younger adults (21 percent vs 17 percent). Likewise, a higher percentage of older adults report consuming 100% juice, compared to younger adults (24 vs 15 percent) though mean intake in fluid ounces is similar for older and younger adults, at 12 and 9 fl oz on a given day, respectively (Bev_DS). .

In adults ages 20 to 64 years, beverages contribute 18 percent of the total daily intake of energy (Bev_DS). The contribution of beverages is significantly less in females at 17 percent compared to 20 percent in males. Beverage’s contribution to intake of added sugars is 54 percent for females and 61 percent for males (Bev_DS). In adults ages 20 to 64 years, beverages also contribute about 30 percent to the daily intake of calcium and vitamin D and about 20 percent to the daily intake of potassium (Bev_DS).For both males and females, beverage consumption in adults ages 20 to 64 years contributes 32 percent and 26 percent to the total daily intake of fruit and dairy equivalents, respectively. The contribution of beverages to the total daily intake of grain, oil, vegetables, and protein equivalents is 1 percent or less (Bev_DS). .

In adults ages 65 years and older, beverages contribute 13 percent to the total daily intake of energy, 27 percent less than the contribution for adults ages 20 to 64 years (Bev_DS). The percent of added sugars coming from beverages is also lower among older adults when compared to younger adults. Older adult males consume 37 percent and females consume 33 percent of total added sugars from beverages (Bev_DS). Older adults had no significant sex differences in these contributions. Similar to younger adults, the consumption of beverages contributes approximately 30 percent or more to the daily intake of riboflavin, vitamin C, vitamin D, calcium, and caffeine (Bev_DS). For both males and females, beverage consumption in adults ages 65 years and older contributes 25 percent and 30 percent to the total daily intake of fruit and dairy equivalents, respectively. This contribution is slightly lower for fruit equivalents and slightly higher for dairy equivalents as compared to younger adults. The contribution of beverages to the total daily intake of grain, oil, vegetables, and protein equivalents is 3 percent or less (Bev_DS).

Women Who Are Pregnant or Lactating

The volume of total reported daily beverage intake for women ages 20 to 44 years who are not pregnant or lactating and those who are pregnant and those who are lactating is 78 fl oz, 79 fl oz and 88 fl oz, respectively (Bev_DS). Regardless of pregnancy or lactation status, the mean daily intake of water (53 to 65 fl oz/d) is greater than the consumption of any other beverage type. Eighty-five percent of women ages 20 to 44 years who are pregnant, and 94 percent of those who are lactating consume water on a given day. Forty-three percent of women who are pregnant consume coffee or tea, with mean reported intake of 18 fl oz on a given day. A higher percentage of women who are lactating (60 percent) report coffee or tea consumption, with mean reported intake of 23 fl oz. Diet beverages are the least frequently consumed non-alcoholic beverage among women ages 20 to 44 years who are pregnant or lactating (7 and 9 percent report consumption, respectively). The percentage of women who are pregnant or lactating who consume milk, milk drinks, and milk substitutes (33 percent and 26 percent, respectively), is greater than the percentage of women who are not pregnant or lactating who consume these beverages (14 percent), though the volumes consumed are similar (Bev_DS).

In women who are neither pregnant nor lactating, beverages contribute nearly 20 percent to total energy intake (Bev_DS). Beverages contribute slightly less to total energy intake for women who are pregnant or lactating (15 percent and 9 percent). For women who are pregnant and those who are lactating, beverages contribute 31 and 29 percent to daily intakes of calcium; 19 and 17 percent to intakes of potassium; 23 and 19 percent to intakes of magnesium; and 36 and 26 percent to intakes of vitamin D, respectively (Bev_DS).

For women who are pregnant, beverage consumption contributes 21 percent and 35 percent to the total daily intake of fruit and dairy equivalents, respectively (Bev_DS). Among women who are lactating, the contribution of beverages is slightly higher for the fruit equivalent (28 percent), and slightly lower for the dairy equivalent (28 percent). Beverages contribute slightly more to total intake of fruit equivalents (32 percent), and slightly less to dairy equivalents (24 percent) for women who are neither pregnant nor lactating as compared to women of the same age who are pregnant or lactating. Beverages contribute 48 percent to total added sugars intake among women who are pregnant and 31 percent among women who are lactating. Irrespective of pregnancy or lactation status, the contribution of beverages to the total daily intake of grain, oil, vegetables, and protein equivalents is 2 percent or less.

To access the data analyses referenced above, visit:
https://www.dietaryguidelines.gov/2020-advisory-committee-report/data-analysis

Question 2. What is the relationship between beverage consumption and growth, size, body composition, and risk of overweight and obesity?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Sugar-Sweetened Beverages

Moderate evidence indicates that higher sugar-sweetened beverage intake is associated with greater adiposity in children. Grade: Moderate

Limited evidence suggests that higher sugar-sweetened beverage intake is associated with greater adiposity in adults. Grade: Limited

Insufficient evidence is available to determine the relationship between sugar-sweetened beverages compared with low- and no- calorie sweetened beverages on adiposity in children. Grade: Grade Not Assignable

Limited evidence suggests no association between sugar-sweetened beverages compared with low- and no- calorie sweetened beverages on adiposity in adults. Grade: Limited

Low and No-Calorie Sweetened Beverages

Limited evidence suggests no association between low- and no-calorie sweetened beverage consumption and adiposity in children. Grade: Limited

Limited evidence suggests that low- and no- calorie sweetened beverage consumption is associated with reduced adiposity in adults. Grade: Limited

Milk

Limited evidence suggests that milk intake is not associated with adiposity in children. Grade: Limited

Insufficient evidence is available to draw a conclusion about the relationship between the type of milk (i.e., milk fat content, flavor) and adiposity in children. Grade: Grade Not Assignable

Limited evidence suggests that higher milk intake is associated with a greater increase in height compared to lower intake in children. Grade: Limited

Limited evidence suggests that milk intake is not associated with adiposity in adults. Grade: Limited

100% Juice

Limited evidence suggests 100% juice intake in children is not associated with adiposity or height in children. Grade: Limited
Limited evidence suggests 100% juice consumption is not associated with measures of adiposity in adults. Grade: Limited

Summary of the Evidence

Sugar-Sweetened Beverages

- Seventy-six studies were identified through a literature search from June 2012 to June 2019 were included in this systematic review.[10-85] Studies were synthesized based on comparator (no/different amount of SSB or LNCSB) and age of participants (children or adults).
  - SSB consumption compared to different amounts or water
    - Children: 46 articles
      - RCTs: 2 articles
      - Non-randomized controlled trials (non-RCTs): 1 article
      - PCSs: 43 articles
    - Adults: 27 articles
      - RCTs: 3 articles
      - Non-RCTs: 1 article
      - PCSs: 23 articles
  - SSB consumption compared to LNCSB
    - Children: 2 articles
      - RCTs: 2 articles
    - Adults: 6 articles
      - RCTs: 5 articles
      - PCSs: 1 article
- In studies examining SSB intake in children, the majority of studies (about 80 percent) reported a significant effect or association between SSB intake and adiposity. However, this was not always consistent within studies that reported multiple outcome measures. Risk of bias and generalizability also were of concern.
- In studies examining SSB intake in adults, the majority of studies (about 70 percent) reported a significant effect or association between SSB intake and adiposity. However, this was not always consistent within studies that reported multiple outcome measures. The 3 included RCTs raised significant risk of bias concerns related to the methodology, particularly around the comparator, and concerns with generalizability.
- Two articles from 1 RCT addressed the relationship between SSB compared to LNCSB intake in children and the evidence was insufficient to draw a conclusion.
- The studies comparing intake of SSB and LNCSB in adults were inconsistent in findings and in methodology. Of the 5 RCTs, 3 did not find a significant difference between groups.

However, 2 of these studies had small sample sizes and may have been underpowered. The 2 studies that did report a significant effect did not show a significant effect across all reported outcomes. For example, 1 study reported differences based on the type of sweetener within LNCSB and the other did not find a difference in weight or BMI between groups, but did report that those who consumed LNCSB were more likely to achieve 5 percent weight loss.

Low- and No-Calorie Sweetened Beverages

- Thirty-seven studies identified through literature search from January 2000 to June 2019 were included in this systematic review, which examined the relationship between LNCSB and outcomes related to growth, size, body composition, and risk of overweight and obesity.[29,34-36,38,40,43,53,55,56,58,59,65,67,71,77,81,82,86-104]
  - Of the 17 articles in children, all were PCSs.
  - Of the 20 articles in adults, 6 were from RCTs and 14 were from PCSs.
- In studies examining LNCSB intake in children, the majority of studies (about 75 percent) reported no association for the main outcome measure(s) of adiposity among the study populations. The remaining studies had mixed associations and raised methodologic concerns.
  - 3 articles had findings of increased adiposity measures.
  - 1 article had findings of decreased adiposity measures.
  - 1 article reported only height-related outcomes.
- The body of evidence from children had several limitations:
  - Inadequate adjustment for confounders
  - Inconsistency in methods for assessing beverage intake
  - Short study duration
  - High attrition
- In studies examining LNCSB intake in adults, the majority of studies (72 percent) reported a significant effect or association between LNCSB intake and adiposity. However, this was not always consistent within studies that reported multiple outcome measures.
  - One well-designed RCT and 2 large PCSs reported an association between LNCSB and reduced adiposity.
- The body of evidence from adults had several limitations:
  - Experimental studies had short study duration, no assessment of compliance, and

difference in comparators.

- Cohort studies had confounding, difference in assessment methods, poor generalizability, and high attrition.

Milk

- The body of evidence includes 62 articles: 30 articles on children and 32 articles on adults.[29,30,38,39,43,49,58,59,65,79,81-83,86-88,92,94,98,100,104-145] Of the evidence on children, 4 articles were from RCTs and 26 articles were from PCSs. Of the evidence on adults, 7 articles were from RCTs; 24 articles were from PCSs; and 1 article used a Mendelian randomization design.
- The majority of the findings for measures of adiposity in children were not significant. The few findings that were significant were not consistent in direction.
- Four studies reported on height, a measure of healthy growth in children, as an outcome: 3 cohort studies reported a significant positive association between milk intake and height in children, and 1 RCT found no effect of milk intake on height compared to drinking water though this study's duration was only 12 weeks.
- Seven cohort studies specifically examined types of milk (i.e., milk fat levels, flavored milk) and adiposity outcomes in children. However, the results were not consistent.
- The majority of the studies in adults found no significant association between milk intake and adiposity. The studies had some significant associations but these were inconsistent in direction.
- The body of evidence from children and adults had several significant limitations, including lack of specificity and consistency in definition of the exposure, the use of non-validated methods for assessing beverage intake, uncontrolled confounding, and inconsistencies in findings.

100% Juice

- 42 articles examined the relationship between 100% juice intake and outcomes related to growth, size, body composition, and risk of overweight or obesity: 23 articles on children and 19 articles on adults.[14,22,29,30,34,38,39,42,43,58,59,65,81,83,86-88,94,98,100,104,114,115,118,125,136,146-161] Of the evidence in children, 1 article was from an RCT and 22 articles were from PCSs. Of the evidence on adults, 4 articles were from RCTs; 1 article from a non-RCT; and 14 articles were from PCSs.

- Evidence in children:
  - The 1 RCT and the majority of the higher quality PCSs found no statistically significant relationship between 100% juice intake and adiposity.
  - The few studies that were significant were not consistent in direction.
  - The evidence in children was limited by lack of clarity in defining the juice exposure, inconsistent quantification of juice consumption, inconsistent measures of adiposity, lack of evidence from stronger study designs, and inadequate adjustment for confounders.
- Evidence in adults:
  - The 4 RCTs and 1 non-RCT found no statistically significant relationship between 100% juice intake and adiposity.
  - The PSCs found inconsistent evidence depending on the specific measure of adiposity. For example, roughly half of the studies (n=4) found that greater consumption of 100% juice intake was related to a greater increase in weight, while the others (n=3) found no significant relationship. Studies examining waist circumference were more consistent, with 5 of the 6 studies finding no significant association with 100% juice intake. Further, all studies (n=3) examining body fat or prevalence of (abdominal) obesity found no significant associations with 100% juice intake.
  - The evidence from the RCTs and non-RCT were limited by the short durations and small sample sizes.
  - The evidence from the PCSs were limited by the single measurement of the exposure, reliance on self-reported outcome data, inadequate adjustment for confounders, and limited generalizability of the experimental data.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/beverages-and-added-sugars-subcommittee/beverages-growth-size-body-composition-obesity

DISCUSSION

Beverages serve multiple important roles in the diet. Foremost, they help to meet hydration needs. Declines of only 2 percent of body water result in compromised cognitive and physical performance and this may occur rapidly, necessitating regular fluid intake.[162-165] Approximately 70 percent of drinking is peri-prandial, stemming largely from the ability of beverages to facilitate swallowing. The Committee examined data on the role of beverage consumption in achieving nutrient and food group recommendations. Selected beverages contribute important nutrients (e.g., protein, minerals, vitamins) and thereby enhance diet quality. Some beverages inherently contain energy or may have energy-yielding substances added to them (e.g., addition of milk or sugar to coffee) and thereby serve as a source of energy. Moreover, water and components in beverages may influence digestive, absorptive, and metabolic processes. Drinking beverages is also a widely-practiced social behavior that reflects and reinforces cultural norms and contributes to quality of life. Although these potentially beneficial roles are commonly accepted, questions also have arisen about whether the types, amounts, and frequency of beverage consumption may contribute to health complications, most notably, overweight and obesity. Hence, the Committee was asked to review the evidence pertaining to the relationship between beverage consumption and growth, size, body composition, and risk of overweight and obesity for children as well as adults.

For this analysis, outcome variables for children included body weight (prevalence or incidence of overweight or obesity), BMI and BMI z-scores, and body composition measures, such as waist circumference and body fat. Height also was considered for children. These indices permitted differentiation between normal and excess weight gain. For adults, the outcome measures included weight status (prevalence or incidence of overweight or obesity), BMI, and body composition measures, such as waist circumference, body fat, and abdominal adiposity. Very limited data were available on each particular outcome. Consequently, reports containing data on any of these outcomes were included and the outcome was collectively termed “adiposity.”

The motivation to evaluate the contribution of beverages to unhealthy weight gain stems largely from recognition that despite being energy dilute (i.e., low energy:weight ratio), beverages contribute a considerable amount of energy to the diet due to their high level of intake. At the time the *2015-2020 Dietary Guidelines for Americans* were developed, beverages accounted for 19 percent of total energy intake in the U.S. population of which SSB contributed 35 percent.[1] Since that time, the energy derived from beverages has declined, but remains high. Currently, beverages account for 13 to 16 percent of total daily energy intake in children and 18 percent of total daily energy intake in adults ages 20 to 64 years, of which SSB contribute about 32 percent. This has led to an observation that SSB, in particular, are important contributors to the positive energy balance driving weight gain and overweight and obesity. However, this observation is confounded by sugar as an energy source as well as a metabolic and behavioral stimulus. Body weight change is driven primarily by total energy balance and, at the metabolic level, the source of the energy may hold limited importance. Comparisons between diets varying in energy source reveal more similarity than differences in effect.[166] SSB are targeted for moderation because they provide little nutrient value besides energy and simple carbohydrate. SSB may evoke a weaker energy compensation response compared to solid foods, so are more apt to add to, rather than displace, other energy sources.[167] Other beverages, such as milk and 100% juices, are more nutrient-dense and thus play an added role in health promotion and disease prevention.

The Dietary Reference Intake (DRI) for water is set as an Adequate Intake (AI) level to "…prevent deleterious, primarily acute, effects of dehydration, which include metabolic and functional abnormalities".[168] Estimates of water consumption by children (ages 4 to 13 years)[169] and adults (ages 20 years and older)[170] have been published using NHANES 2005-2010 data. Considering all sources water from beverages and foods, tap and bottled contributed 25 percent to 30 percent of dietary water intake among children and 30 percent to 37 percent of dietary water intake among adults. At least 75 percent of children, 83 percent of women and 95 percent of men ages 71 years and older have intakes below the AI values that were established by the Institute of Medicine, Food and Nutrition Board based on median total water intakes in the United States for each age group. More recent NHANES 2013-2016 data show on a given day, adults consume an average of 53 fl oz of water (1.6 liters) with average intake much lower among older adults (39 fl oz or 1.1 liters). The AI for these groups is 3.7 liters per day for men and 2.7 liters per day for women, which may be obtained from multiple sources (including foods and many types of beverages). Thus, water itself as a beverage currently represents between 30 percent and 59 percent of the AI in these groups.

Although these data question the adequacy of hydration status in segments of the population, they cannot be viewed as a basis for assigning risk for health complications because adequate hydration can be achieved over a wide range of intake levels in the setting of normal renal function.[168] Additionally, water needs may be met by intake of many sources (i.e., other beverages and foods). Plain water has been recommended to displace other energy-yielding beverages in the diet to dilute the energy density of the diet, reduce total energy intake, and aid weight management.[171] The success of this strategy has not been established and warrants further study, as described in ***Part E. Future Directions***. The Committee did not review evidence on water intake and adiposity because of concerns about the adequacy of estimates of water ingestion. Methods to accurately quantify water intake are needed.

Different beverages contribute varying levels of energy and nutrients that affect diet quality. However, diet composition may not just reflect the nutrient profile of ingested beverages themselves. Beverages also may modify food choices with variable impact on diet quality. An improved understanding of such a secondary effect will be important for assessing the role of beverages in a healthy diet (see ***Part E. Future Directions***).

The Committee assessed the strength of evidence based on methodologic quality and the uniformity of the evidence as determined by consensus of findings across studies. Where methodologic quality was strong, greater weight was assigned to RCTs compared to PCSs. Agreement between the 2 study designs permitted stronger conclusions. PCSs were especially limited when the estimate of intake was obtained only at baseline and used to characterize usual intake over the duration of the, often multiple year, follow-up period. Such an approach fails to account for individual and population-level changes in ingestive behaviors over time.

Sugar-sweetened Beverages

Sweetened beverages, not including coffee and tea with their additions, account for approximately one-third of total beverage consumption and contribute approximately 30 percent, 50 percent, and 60 percent of added sugars to the diet of young children, adolescents, and adults, respectively. Because of this large contribution, they may be a marker of added sugars intake. The 2015 Committee reviewed the evidence on added sugars and health outcomes up to 2012 and found that intake of added sugars from food and/or SSB was associated with excess body weight in children and adults.[1] However, the vehicle by which added sugars are ingested may have a substantive impact on various outcomes. For this reason, the 2020 Committee decided to focus on the unique question regarding the effects of SSB on health outcomes rather than analyzing the data as an extension of the findings from the 2015 analysis of added sugars, including foods and SSB. For analysis, the evidence was partitioned into studies examining the effects of ingestion of SSB with the comparator of water or a different amount of SSB as well as studies of SSB vs LNCSB. Effects in children and adults were assessed separately. Where the comparator was water or different level of SSB consumption in children (46 studies), the evidence included only 2 RCTs and 2 non-RCTs. For adults, only 3 of the 27 studies reviewed were RCTs and 1 was a non-RCT.

Findings on SSB intake in children showed marked uniformity, with about 80 percent indicating a positive association between intake and at least 1 marker of adiposity. However, the evidence varied across the component indices of adiposity within and across studies and the risk of bias and generalizability of findings were of concern. Thus, the conclusion was: Moderate evidence indicates that higher sugar-sweetened beverage intake is associated with greater adiposity in children. Findings for adults were similar, but weaker, with about 70 percent of studies noting a positive association between SSB intake and at least 1 marker of adiposity.

This was tempered by concerns about the risk of bias and generalizability. Hence the conclusion was: Limited evidence suggests that higher sugar-sweetened beverage intake is associated with greater adiposity in adults.

Low- and No-calorie Sweetened Beverages

The 2015 Committee indicated that evidence was insufficient (due to a paucity of data) to recommend the use of low- or no-calorie sweeteners (LNCS) as a strategy for long-term weight loss and weight maintenance. Because the long-term effects of LNCS were considered uncertain, the 2015 Committee concluded that those sweeteners should not be recommended for use as a primary replacement or substitute for added sugars in foods and beverages. Additional evidence has become available since that report and was reviewed by the 2020 Committee to examine the role of LNCSB on growth, size body composition, and risk of overweight and obesity. The concern about the use of LNCSB for weight management has multiple dimensions. One relates to the safety of these compounds. This was not an issue considered by this Committee. However, the World Health Organization, U.S. Food and Drug Administration, European Food Safety Authority, and other regulatory bodies have issued guidance that the commercially available LNCS are safe when consumed in moderation.[172] The question of whether and in what direction and magnitude LNCSB may alter food choice and, as a consequence, diet quality, was also outside the scope of the present analysis. This is an issue of considerable importance that warrants future attention. This review focused on the role of LNCSB on adiposity.

Thirty-seven articles published between January 2000 and June 2019 were included in the systematic review. All 17 articles pertaining to children were PCSs and many had methodologic limitations (e.g., imprecise measurement of beverage intake, short study duration, high attrition, inadequate adjustment of confounding variables). Seventy-five percent (12 studies) reported no association between LNCSB consumption and the main study outcome among the entire study population, and the remaining 5 studies included mixed findings. In the absence of RCTs and with a predominance of null findings, the conclusion reached was that: Limited evidence suggests no association between LNCSB consumption and adiposity in *children*. The paucity of a strong evidence base is problematic for setting policy on use of these compounds to manage body weight in children because of the high prevalence of overweight and obesity in this age group[173] and the increasing presence of these beverages in the food supply.[174]

The literature search meeting the eligibility criteria for adults yielded 6 RCTs and 14 PCSs. Seventy-five percent (16 articles) indicated a significant association between LNCSB intake and adiposity. However, effects were not consistent across the component adiposity indices, the studies had substantive methodological limitations, and the 1 RCT and 2 PCSs viewed as methodologically strong found no association between LNCSB intake and adiposity. Nevertheless, the conclusion reached was: Limited evidence suggests that LNCSB consumption is associated with reduced adiposity in *adults*. The studies reviewed in adults and children did not provide evidence that LNCSB promote weight gain or adiposity.

Taken together the current review is broadly consistent with findings from the 2015 Committee. However, recognizing that: a) mean responses may not reflect individual responses, b) robust, effective tools to manage body weight are lacking, c) individuals with overweight or obesity are at elevated risk of multiple health complications, and d) multiple national regulatory bodies agree that LNCS can be used safely, the Committee recommends these food ingredients be considered as an option for managing body weight.

Low- and No-calorie Sweetened Beverages vs Sugar-Sweetened Beverages

The role of LNCSB vs SSB on indices of body weight has been the topic of multiple meta-analyses in recent years. The 2 largest data sets differed (by age of participants in one and outcome measure in the other) and had only partial overlap in included studies.[175,176] Nevertheless, they yielded similar findings. PCSs revealed no association or a slight positive association between LNCSB vs SSB and BMI, but not waist circumference, while the RCTs consistently indicated LNCSB vs SSB consumption was associated with lower adiposity. However, many of the studies included in these meta-analyses did not meet the eligibility criteria established in the Committee's systematic review. In the Committee's review, the evidence was derived primarily from RCTs (2/2 for children; 5/6 for adults). The 2 reports in children were based on a single study. Hence, the Committee determined that the evidence was insufficient to evaluate the effects of SSB vs LNCSB in children.

For adults, 3 RCTs reported no significant differences in adiposity outcomes in comparisons between SSB and LNCSB consumption. However, limited sample sizes in 2 of these studies left open questions about the adequacy of statistical power. The remaining 2 RCTs yielded mixed findings. One study revealed differences based on type of LNCS, a contrast not examined by any other study. Consequently, the conclusion was: Limited evidence suggests no association between sugar-sweetened beverages compared with low- and no- calorie sweetened beverages on adiposity in adults.

Given the high level of consumption of SSB and concern about their contribution to positive energy balance, and the widespread use of LNCSB as a potential approach to mitigate this outcome, resolution of this question about substituting LNCSB for SSB to manage body adiposity remains a high priority.

Milk

Views on the role of milk in a healthful diet are strongly-held. They range from strongly critical to strongly supportive and are based on diverse criteria, including environmental sustainability, animal welfare, allergenicity, prevalence of lactose intolerance, nutrient density, disease risk, and weight management. In adults, the role of milk in adiposity was the sole focus of this review. For this beverage category, indices of growth (height and lean body mass) also were considered for children. Additionally, potential differential effects of milk varying in flavor and fat content were explored only in children.

Based on the analytical model, the systematic literature review yielded 62 articles; 30 pertaining to children and 32 on adults with a predominance of PCSs. Studies in children included 4 RCTs and 25 PCSs, while those in adults included 7 RCTs, one based on a Mendelian randomization design, and 24 PCSs. For children, studies examining healthy growth were synthesized separately from studies examining adiposity.

One RCT assessed milk intake and height in children and reported no association, but it was only of 12 weeks duration, limiting its power to detect such changes. The 3 available PCSs indicated a positive association between milk intake and height. As a result, the conclusion was: Limited evidence suggests that higher milk intake is associated with a greater increase in height compared to lower intake in children.

With respect to adiposity outcomes in children, findings from 1 RCT indicated a positive association. However, the result appeared to reflect a reduction in energy intake by the water intake comparator group, and the single additional RCT reported no association. The 4 PCSs reported largely null findings on overweight and obesity. Fifteen of 16 reports indicated a non-significant association between milk intake and BMI-Z score or BMI and 4 PCSs yielded weak and largely non-significant (3 of 4 studies) associations with body fat or waist circumference. The uniformity of these observations led to the conclusion: Limited evidence suggests that milk intake is not associated with adiposity in children.

Seven PCSs provided evidence on variations in milk composition and adiposity in children, with 6 contrasting graded concentrations of fat and one manipulating flavor. With only a single study addressing the relationship between flavored milk intake and adiposity, no conclusions could be reached. Studies comparing responses to ingestion of milk varying in fat content yielded mixed findings across component adiposity outcomes and inconsistent findings across studies. Hence, the conclusion was: Insufficient evidence is available to draw a conclusion about the relationship between the type of milk (i.e., milk fat content, flavor) and adiposity in children.

In adults, the RCTs and PCSs yielded mixed findings across component adiposity outcomes and inconsistent findings across studies. This body of evidence included studies of substantive sample size and study duration, strengthening the confidence placed in their findings. The uniformity of findings led to the conclusion: Limited evidence suggests that milk intake is not associated with adiposity in adults.

100% Juice

Analysis of juice consumption and adiposity was limited to studies of 100% juice and did not differentiate between types of fruit or vegetable juice. Forty-two studies (23 in children and 19 in adults) meeting inclusion criteria were evaluated. Only 1 RCT was included for the analysis in children and only 4 RCTs and 1 non-RCT were included for the analysis in adults. Generally, the literature evaluated was of limited quality due to lack of consistency in describing the juices under study, how intake was quantified, and measures of adiposity. In addition, many studies inadequately adjusted for possible confounders.

The RCT and the majority of PCSs related to children reported no significant associations between 100% juice intake and component indices of adiposity. Those that did indicate significant findings were inconsistent across the adiposity indices and studies. This led to the conclusion: Limited evidence suggests 100% juice intake in children is not associated with growth, size, body composition, or risk of overweight or obesity in children.

The RCTs and non-RCT examining the relationship between 100% juice intake and adiposity in adults reported non-significant associations. The PCS evidence yielded inconsistent results, though the studies showed greater consistency for waist circumference (5 out of 6 studies) and measures of body fatness (3 out of 3 studies) finding no significant association. The RCTs had limited sample sizes and the PCSs typically included only a single measure of intake at baseline, had limited generalizability, and inadequately adjusted for possible confounders. Thus, the conclusion was: Limited evidence suggests 100% juice consumption is not associated with measures of adiposity in adults.

SUMMARY

The relationship between beverage consumption and diet quality has been explored previously, but this is the first time that a Dietary Guidelines Advisory Committee has directly examined the relationship between beverage consumption and health outcomes related to growth, size, body composition, and risk of overweight and obesity. Given that beverages vary in energy content, energy sources and nutrient composition, separate analyses were conducted on different categories of beverages (i.e., SSB, LNCSB, milk, 100% juice).

All beverages contribute to hydration needs. The degree to which hydration is a problem in segments of the population is an open question. Many beverages (e.g., milk and 100% juice) are nutrient-rich and contribute substantively to attainment of recommended intake goals. Beverages in the milk and 100% juice categories were not associated with indices of adiposity, but the strength of the evidence to evaluate this outcome was limited. Thus, when nutrient-rich beverages are incorporated into the diet, it will be important to be mindful of their contribution to total energy intake. On the other hand, SSB contribute the highest percent of energy from beverages to the diet but typically contribute very little toward meeting nutrient and food group recommendations. Among the beverages examined in the NESR systematic review, only SSB intake was associated with adiposity and this held in both children and adults. The evidence was viewed as moderate for children and limited for adults. Because of their low nutrient/energy content ratio and the high prevalence of overweight and obesity in the population, it is important to continue encouraging only limited intake of this class of beverages. Importantly, the influence of intake of these beverages on food intake was not evaluated so understanding of their impact on total diet quality remains incomplete.

The effects of LNCSB on adiposity outcomes was also assessed. No significant association was observed between consumption of beverages containing these sweeteners and adiposity outcomes in children, but their intake was associated with reduced adiposity in adults. Again, the evidence base used to draw these conclusions was limited, but viewed as sufficient to acknowledge such beverages may be a useful aid in weight management in adults. The role beverages play in diet quality and energy balance varies across the life span so recommendations should be tailored appropriately.

Lastly, beverage patterns, defined as the quantities, proportions, variety or combinations of different beverages in the diet, were not examined by the 2020 Dietary Guidelines Advisory Committee due to a lack of available literature. This Committee's examination of individual beverages of public health importance lays the foundation for the future examination of overall beverage patterns and highlights the need for additional research in this area. Furthermore, due

to time constraints, not all beverage types were evaluated. Each type contains different components (e.g., energy, nutrients, carbonation, flavors, phytochemicals) and is consumed under different conditions. Thus, the implications of each for growth, size, body composition, and risk of overweight and obesity has not been fully explored by this Committee. Beverage intake behaviors, such as the predominant time of day of use, frequency of ingestion, typical and range of portion sizes, and whether they are consumed alone or in association with foods, are also important factors to consider when developing use guidelines. Finally, critical to a full understanding of the role of beverages in health will be determination of the relative importance of their physical form vs nature of the energy and components they contain. That is, do the form of food (solid, liquid) and mode of ingestion (e.g., drunk, spoon delivery) hold unique implications for health? This leaves several areas for additional research and consideration by future Dietary Guidelines Advisory Committees, which are further discussed in ***Part E. Future Directions***.

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